The ESO supernovae type la progenitor survey (SPY)*

The radial velocities of 643 DA white dwarfs

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ABSTRACT

Close double degenerate binaries are one of the favoured progenitor channels for type Ia supernovae, but it is unclear how many suitable systems there are in the Galaxy. We report results of a large radial velocity survey for double degenerate (DD) binaries using the UVES spectrograph at the ESO VLT (ESO SN Ia Progenitor surveY – SPY). Exposures taken at different epochs are checked for radial velocity shifts indicating close binary systems. We observed 689 targets classified as DA (displaying hydrogen-rich atmospheres), of which 46 turned out to possess a cool companion. We measured radial velocities (RV) of the remaining 643 DA white dwarfs. We managed to secure observations at two or more epochs for 625 targets, supplemented by eleven objects meeting our selection criteria from literature. The data reduction and analysis methods applied to the survey data are described in detail. The sample contains 39 double degenerate binaries, only four of which were previously known. 20 are double-lined systems, in which features from both components are visible, the other 19 are single-lined binaries. We provide absolute RVs transformed to the heliocentric system suitable for kinematic studies. Our sample is large enough to sub-divide by mass: 16 out of 44 low mass targets ($\leq 0.45 M_{\odot}$) are detected as DDs, while just 23 of the remaining 567 with multiple spectra and mass > 0.45 M_{\odot} are double. Although the detected fraction amongst the low mass objects (36.4 ± 7.3%) is significantly higher than for the higher-mass, carbon/oxygen-core dominated part of the sample ($3.9 \pm 0.8\%$), it is lower than the detection efficiency based upon companion star masses $\geq 0.05 M_{\odot}$. This suggests either companion stars of mass < 0.05 M_{\odot}, or that some of the low mass white dwarfs are single.

Key words. Techniques: radial velocities - binaries: close - binaries: spectroscopic - Supernovae: general - white dwarfs

1. Introduction

Type Ia supernovae (SNe Ia) play an outstanding role in the study of cosmic evolution, for instance, they served as standardizable candles in the studies that led to the discovery of the acceleration of the Universe's expansion (e.g. Riess et al. 1998; Perlmutter et al. 1999). There is general consensus that SNe Ia events are due to thermonuclear explosions in degenerate matter (Hoyle & Fowler 1960). However, the nature of their progenitors, as well as explosion mechanisms and origin of different subclasses still pose serious problems.

Hoyle & Fowler suggested that explosion occurs when a critical mass (likely the Chandrasekhar limit, $1.4 M_{\odot}$) is reached. The most natural candidates for explosions are then white

dwarfs in binaries accreting matter from non-degenerate hydrogen companions via stable Roche-lobe overflow (Schatzman 1963; Wheeler & Hansen 1971; Whelan & Iben 1973) or stellar wind capture (Truran & Cameron 1971; Tutukov & Yungelson 1976). This is the earliest "classical" so-called single-degenerate (SD) scenario.

Another "classical" scenario is the "double-degenerate" (DD) one, in which explosion is, hypothetically, the outcome of the merger of two white dwarfs of (super)-Chandrasekhar total mass (Webbink 1979; Tutukov & Yungelson 1979, 1981; Webbink 1984; Iben & Tutukov 1984). The merger of components is due to the orbital shrinkage because of the loss of angular momentum via gravitational wave radiation and subsequent unstable mass loss. Initially, it was envisioned that the lighter of two white dwarfs fills its Roche lobe first since $R_{\rm WD} \propto M_{\rm WD}^{-1/3}$ and, by virtue of the same M - R relation, in systems with mass ratios $\geq 2/3$, the merger occurs on the dynamical time scale

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(comparable to few orbital periods). The disrupted white dwarf transforms into a "heavy disc" or "envelope" from which the matter accretes onto the central object. This inference was confirmed by Smooth Particle Hydrodynamics (SPH) calculations by Benz et al. (1990) and in many other theoretical studies.

Later, it was realised that the stability of the mass transfer depends also on the efficiency of spin-orbit coupling, which affects the variation of accretion rate as the merger takes place (Marsh et al. 2004). SPH-calculations using a physical equation of state, showed that the lighter component disrupts within about 100 orbital periods and the merger may proceed either via a disk or direct impact, depending on the mass ratio of the components (D'Souza et al. 2006; Dan et al. 2009).

Currently, two possible DD scenarios are commonly discussed. In "violent" (a.k.a. "prompt") mergers the matter of the lighter WD, may, even before its complete disruption, start to accrete onto the surface of the companion on a dynamical timescale. Detonation is supposed to be initiated in a He+C+O mixture at the interface of the merging white dwarfs. Helium detonation produces a shock wave, which propagates and focusses towards the center of the accretor and results in ignition of carbon and explosion (Livne 1990; Livne & Glasner 1991).

If the explosion does not occur promptly (at lower mass ratios than required for violent merger, see, e.g., discussion by Sato et al. (2016)), an object consisting of a cold virtually isothermal core, a pressure-supported envelope, a Keplerian disc, and a tidal tail forms (Guerrero et al. 2004). A He or C+Omixture may explode in the envelope which is the hottest part of the object and lead to the detonation of carbon at the periphery of the accretor. If two C/O white dwarfs gradually merge, depending on the rate of settling of the envelope matter onto the core, either central ignition of carbon and a SN Ia happens or a neutron star or a massive Oxygen-Neon (O/Ne) white dwarf forms (Nomoto & Iben 1985; Mochkovitch & Livio 1990).

In both varieties of the DD scenario, explosion of the C/O core, which may have a sub- $M_{\rm Ch}$ mass, results in the disruption of the entire configuration. The major fraction of the accretor mass burns to radioactive Ni, which determines the optical luminosity and the spectrum of the SN, while the donor burns to intermediate mass elements which define the observational manifestations of SNe at maximum brightness (Shigeyama et al. 1992; Sim et al. 2010).

An advantage of the DD scenario is that it produces a delaytime distribution (DTD) which overlaps with the Hubble time, while in the SD channel delays are shorter than ≈ 3 Gyr (see, e. g., Yungelson 2010; Bours et al. 2013). If mergers of carbon/oxygen core white dwarf pairs (C/O+C/O), as well as mergers of C/O white dwarf and massive He and hybrid (C/O core + thick He mantle) white dwarfs are taken into account, population synthesis studies can reasonably reproduce the current Galactic SNe Ia rate as well as the slope of their observationally inferred delay time distribution (e.g., Yungelson & Kuranov 2017).

We refer the interested reader for further details concerning evolution of close binaries leading to the formation of progenitors of SNe Ia and the physical processes involved in explosions of SN Ia and their observational manifestations to a number of recent reviews (e.g. Hillebrandt et al. 2013; Postnov & Yungelson 2014; Maoz et al. 2014; Ruiz-Lapuente 2014; Branch & Wheeler 2017; Taubenberger 2017; Livio & Mazzali 2018; Röpke & Sim 2018, and references therein).

The significance of the DD scenario relies upon the existence in nature of a sufficient number of DDs prone to merge and the physical parameters of their components. A given Galactic SN

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Ia rate and pre-supernova lifetime implies a specific number of progenitors in the Galaxy. Searches for DDs thus test them as progenitors of Type Ia SNe, but also provide benchmarks for testing the theory of binary star evolution, since in the process of formation, DDs pass through two to four very badly understood stages of common envelope evolution.

The first known DD, L870-2, was discovered by chance in the 1980s (Saffer et al. 1988), but its orbital period of 1.55 days is too long for it to merge within a Hubble time and thus be representative of the putative DD progenitors of present-day Type Ia supernovae, which must have periods of less than 10 to 15 hours. Systematic surveys of the same decade (Robinson & Shafter 1987; Foss et al. 1991) failed to find any DDs among 44 and 25 targets, respectively. A sure-fire DD as well as some candidates were found by Bragaglia et al. (1990) among 54 objects. The (premature) conclusion of these studies was that the space density of DDs was below that required for reproducing the observed rate of SNe Ia. The low masses ($M_{tot} < M_{Ch}$) of the confirmed and candidate DDs as well as their long merger timescales were raised as further arguments against the DD scenario.

In the 1990s, more successful targeted searches were made, focusing upon low mass (helium) white dwarfs, which primarily form via binary evolution (Marsh 1995; Marsh et al. 1995; Moran et al. 1997; Maxted et al. 2000b). By the year 2000, around 180 white dwarfs had been checked for RV variations yielding a sample of 18 DDs with $P < 6^{d}$ 3 (Marsh 2000; Maxted et al. 2000a). None of the 18 discovered DD systems seemed massive enough to qualify as a SN Ia precursor. However, by this time, theoretical simulations suggested that less than a percent of all potentially observed white dwarfs are close DDs qualifying as SN Ia progenitors (Iben et al. 1997; Nelemans et al. 2001b), and so the failure to find a clear progenitor in 180 white dwarfs is not a surprise.

The observational focus of the 1990s on low mass white dwarfs as more promising targets for DDs worked against the chances of finding potential Type Ia progenitors. Still, given the ubiquity of white dwarfs, the number of DDs found showed that there is a large population of these binaries within the Galaxy. Clearly a definitive test of DDs as SNe Type Ia progenitors requires (a) a larger sample of targets, and (b) one not selected by mass. We therefore embarked upon a large spectroscopic survey of white dwarfs using the UVES spectrograph at the ESO VLT UT2 (Kueyen) to search for white dwarfs and pre-white dwarfs with variable RVs (ESO SN Ia Progenitor surveY - SPY). There have been a number of introductory articles to SPY (Napiwotzki et al. 2003, 2001a, 2005) and many results (Napiwotzki et al. 2002; Pauli et al. 2003; Napiwotzki et al. 2004; Nelemans et al. 2005; Koester et al. 2005b; Napiwotzki et al. 2007, to name a few), but there has been no full write-up of the original radial velocity survey. In this paper our aim is to accomplish this for the (majority) hydrogen-atmosphere DA white dwarfs.

Since the completion of the SPY survey, there have been many discoveries of DDs dominated by the light of "extremely low mass" (ELM) white dwarfs (Brown et al. 2010, 2012, 2016a,b), many of which will merge well within a Hubble time (Kilic et al. 2012). These discoveries post-date the SPY survey since ELM white dwarfs were missed in earlier surveys for white dwarfs due to their low gravities which makes them hard to distinguish from early-type main-sequence stars. Some of the ELM binaries host massive white dwarfs hidden in the glare of the ELM components (Kulkarni & van Kerkwijk 2010; Marsh et al. 2011; Brown et al. 2013). If the mass ratio of components in ELM DDs allows stable mass exchange, they will turn into ultracompact cataclysmic variables of the AM CVn type (Faulkner et al. 1972; Nelemans et al. 2001a). In these systems, the accretors can in principle very occasionally reach the Chandrasekhar mass (Solheim & Yungelson 2005). Otherwise, unstable mass transfer may lead to the merger of components with formation of subdwarf B, subdwarf O or R CrB stars; explosive events are not expected because of the small mass of the donors (Dan et al. 2014).

In this paper we present results of the SPY survey for the radial velocities of white dwarfs spectral type DA (hydrogen dominated spectra). The project was conceived for being operationally (and scientifically) advantageous with observations in service mode at the VLT that could be executed when the telescope would otherwise have been idle (Renzini 1999). Our sample overlaps strongly with the 615 SPY DAs analysed by Koester et al. (2009). Koester et al. performed a model atmosphere analysis of SPY spectra and determined the fundamental parameters effective temperature (T_{eff}) and surface gravity $(\log g)$. Our focus is upon radial velocities, but we present additional fundamental parameter estimates to provide a uniform set of data for future comparison with theoretical models. The sample selection for SPY, observations, and data reduction are described in Sect. 2. Our method of RV measurement is outlined in Sect. 3. Sect. 4 presents the results including the detected DDs. In Sect. 5 we discuss our results in the context of previous surveys and implications for the evolution of DDs.

2. Observations and data analysis

2.1. Sample selection

Targets for SPY were drawn from five sources: the WD catalogue of McCook & Sion (1999), the Hamburg ESO Survey (HES; Wisotzki et al. 2000; Christlieb et al. 2001), the Hamburg Quasar Survey (HQS; Hagen et al. 1995; Homeier et al. 1998), the Montreal-Cambridge-Tololo survey (MCT; Lamontagne et al. 2000), and the Edinburgh-Cape survey (EC; Kilkenny et al. 1997). Our selection criteria were spectroscopic confirmation as a white dwarf (at least from objective prism spectra) and $B, V \leq 16.5$ (depending on what information was available) for the region south of $\delta = +15^{\circ}$. The limit was chosen in order to generate a sample size of order 1000 as thought necessary to uncover a potential SN Ia progenitor (DD with $M_{\text{tot}} \geq M_{\text{Ch}}$, Nelemans et al. 2001b). We extended the survey region later to include the region $+15^{\circ} \leq \delta \leq 25^{\circ}$, but imposed a brightness limit of $B, V \leq 15.5$.

The sample of white dwarfs catalogued by McCook & Sion (1999) incorporates various sets plagued with different selection effects. While early surveys for white dwarfs typically based their selection on proper motions (Luyten 1979; Giclas et al. 1978), later catalogues of white dwarfs are usually a wasteproduct of surveys for galaxies and quasars at high galactic latitude. One important early example is the Palomar-Green survey (Green et al. 1986) which used blue colour besides the galactic latitude as criterion. Similar approaches were used by the MCT and EC surveys mentioned above. Since photographic prism spectra are available for the HQS and HES surveys the presence of strong Balmer lines could be incorporated in the selection process (Christlieb et al. 2001) and the colour criterion could be somewhat relaxed. Other white dwarfs were identified because they showed up in EUV/X-ray surveys (e.g. Pounds et al. 1993). While these approaches have somewhat complementary selection effects, there does remain a significant deficit of white dwarfs in the Galactic plane (Fig. 1). A small selection of our own was to avoid stars that satisfied our selection criteria but which had already been observed by Maxted et al. (2000a). Three of them ended up being re-observed during our survey, leaving an addition of seven to the SPY sample¹. We account for these stars later when discussing the detection efficiency of the SPY sample.

We had to create a large data base of accurate coordinates and finder charts at short notice to start the service mode observations for SPY. To speed up this process we initially focussed on catalogues with good coordinates and/or good finder charts. Important sources of the SPY observations reported in Koester et al. (2001) and Koester et al. (2009) were the PG, HES, EC, and MCT surveys, which are all biased toward hot objects. Additional sources were the proper motion selected white dwarfs of Giclas et al. (1978, 1980) as catalogued in McCook & Sion (1999). Napiwotzki et al. (2005) reported on results from a "bright" sub-sample of SPY, which covers 93% of all known white dwarfs in the survey area. This sample should be virtually free of any SPY-related selection effects. In Fig. 1 we show the Aitoff projection in galactic coordinates of the DA white dwarfs observed by the SPY project. This figure shows the paucity of white dwarfs in the Galactic plane that we referred to above.

2.2. Observations

Spectra were taken with the UV-Visual Echelle Spectrograph (UVES) of the UT2 telescope (Kueyen) of the ESO VLT. UVES is a high resolution Echelle spectrograph, which can reach a resolution of 110,000 in the red region with a narrow slit (cf. Dekker et al. 2000, for a description of the instrument). Our instrument setup (Dichroic 1, central wavelengths 3900 Å and 5640 Å) uses UVES in a dichroic mode with a 2048 × 4096 EEV CCD windowed to 2048 × 3000 in the blue arm, and two CCDs, a 2048 × 4096 EEV and a 2048 × 4096 MIT-LL, in the red arm. Nearly complete spectral coverage from 3200 Å to 6650 Å with only two ≈80 Å wide gaps at 4580 Å and 5640 Å is achieved. In the standard setting used for our observations UVES is operated with an 8″ decker in the blue arm and an 11″ decker in the red arm. The slit was rotated to the parallactic angle.

SPY was implemented as a service mode program. It took advantage of observing conditions which were not usable by most other programs (moon, bad seeing, clouds), and was run when other programs were not feasible. A wide slit (2.1") was used to minimise slit losses and a 2 × 2 binning applied to the CCDs to reduce read out noise. Our wide slit reduced the spectral resolution to $R = 18500 (0.36 \text{ Å at } H\alpha)$ or better, if seeing disks were smaller than the slit width. Depending on the brightness of the objects, exposure times of 5 min or 10 min were chosen. The S/N per binned pixel (0.044, and 0.032 Å for the blue and red channel respectively) of the extracted spectrum is usually 15 or higher. Due to the nature of the project, two spectra at different, "random" epochs separated by at least one day were observed.

Although our program was carried out during periods of less favourable observing conditions, the seeing was often smaller than the selected slit width of 2.1". This can, in principle, cause wavelength shifts, if the star is not placed in the centre of the slit. However, since according to the standard observing procedure the star was first centred on a narrow slit before the exposure with the broader slit was started, it can be expected that the star is usually relatively well centred in the slit. We used telluric lines present in the red region of some spectra to estimate the size

¹ WD0401+250, WD0752-146, WD0950-572, WD0954+247, WD0954-710, WD1407-475, WD2151-015

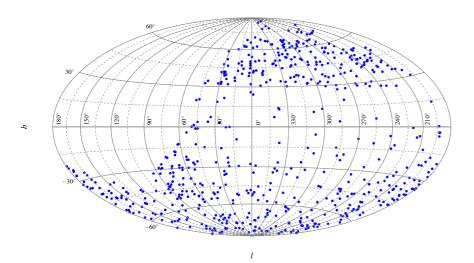


Fig. 1. Aitoff projection in Galactic coordinates of the DA white dwarfs observed by SPY.

of the resulting wavelength shifts (Sect. 2.4) and estimated an additional RV scatter of 0.67km s⁻¹.

2.3. Data reduction

ESO provided at the time of the SPY observations (commencing in 2000) a data reduction pipeline for UVES, based on MI-DAS procedures. The quality of the reduced spectra is in most cases good and we made extensive use of the pipeline reduced spectra for selecting targets for follow-up observations and the model atmosphere analysis of Koester et al. (2001). However, sometimes the reduction pipeline produced artefacts of varying strength, e.g. a quasi-periodic pattern in the red region similar in appearance to a fringing pattern. In a few cases either the blue or the red part of the pipeline reduced spectrum had extremely strong artefacts of unknown origin.

Therefore we created a semi-automatic "SPY pipeline" to perform the final reduction of the spectra. Our procedure makes use of several routines of the "UVES" context of MIDAS, which provides reduction routines adapted for the UVES spectrograph. The reduction is done individually for the blue (3200-4500 Å), lower red (4600-5600 Å), and upper red (5700-6650 Å) region of the spectrum. The position of the individual orders on the CCD is defined automatically tracing the order definition flatfield. However, usually the star is not perfectly centred on the slit along the spatial axis in all wavelength regions. The offset from the centre is determined and accounted for manually, along with the width of the stellar spectrum and the corresponding sky background area.

After accounting for cosmic ray hits and bad CCD pixels, bias and interorder background are subtracted. Wavelength calibration is then performed automatically using the Th-Ar reference spectrum. This is followed by the extraction of one dimensional spectra for each order of the sky background, flatfield, and object frames. For each spectrum, sky background subtraction and flatfielding are performed, and finally the orders are merged. Now, the resulting spectrum is divided by a smoothed spectrum of a DC WD, which by definition shows no spectral features at all and therefore provides an excellent means of correcting for the instrumental response. We checked a number of white dwarfs classified DC for the absence of spectral features even at our high resolution and selected two feature free ones (WD 0000–345 and WD 1520–340).

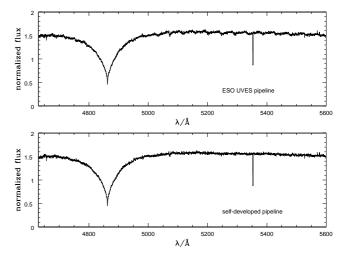


Fig. 2: The ripple problem and its solution. The top spectrum shows the reduced and merged spectrum of a DA WD. It displays a strong quasi-periodic pattern. The lower spectrum resulted after application of our "shift correction".

A number of merged spectra did not appear smooth, but instead displayed a quasi-periodic ripple pattern over the whole wavelength range or at least over a significant part (Fig. 2). The appearance is similar to the effect mentioned above seen in some of the pipeline reduced spectra. Obviously, this behaviour is due to a mismatch in the flux levels of the corresponding ends of adjacent orders. Such effects should in principle be accounted for by the flatfield division. We do not find a relation as to when flatfield division is performed, since the ripples remain unchanged if we first divide the (two-dimensional) object and flatfield frames, and then extract the individual orders. In order to investigate this problem, we chose several stars where the signal-to-noise was large enough that we could extract each order with the width of only one pixel, and still obtain a useful resulting spectrum. The flatfield orders were extracted in the same way, but with an offset perpendicular to the dispersion direction (hereafter separation). We now went through a range of separations, and found that the ripples first disappear, then appear again with different shape. However, the separation which yields the smoothest spectrum is not always zero and the ideal separation changes with wavelength. To summarise, it is apparent that for each 'pixel row' of the two dimensional object spectrum, there is only one flatfield pixel row which fits ideally, but this can change as one moves along the order.

Given that we do not understand the problem's cause, it would seem unreasonable to construct a complex algorithm which would take these findings into account. However, without direct relation to the former, we found that the reduction can be improved significantly by *shifting* the flatfield orders with respect to the object orders a few pixels in the dispersion direction (as opposed to the perpendicular separation discussed above). This appears counterintuitive, but it produced the desired result and the practical implementation was easier.

The offset needed changed from night to night and sometimes between spectra taken the same night. This was taken into account in the reduction routine, which automatically went through a range of shift values. We selected spectral regions without strong features. For each shift, the reduced spectrum was fitted by a low-order polynomial, and a χ^2 was computed from the difference between the spectrum and the fit. The best shift was chosen to be the one which led to the lowest χ^2 value. Note that for each star, the shift was computed individually, although it was then applied to the flatfield, which is the same for all stars of one night. We emphasise that this does *not correspond to a real wavelength shift of the spectra*. This is demonstrated by our assessment of the stability of the wavelength scale in the Sect. 2.4.

The procedure outlined above works very well for the DAs (Fig. 2), which are the topic of this article, and for most other white dwarf spectral classes as well. However, for stars of other spectral types, e.g. helium-sdOs which show a large number of spectral lines, the automatic determination of the shift does not yield a useful result because the spectrum is too crowded with features. For these stars we determined the best shift manually by comparing the reduction results for various shifts. The determined shift values show no correlation with quantities like airmass or observing time. Although usually the overall shift varies only slightly during one night, there can be stars with completely different shift values, which do not stand out by position, observing time, or any other quantity. We therefore conclude that the observed effect must be intrinsic to the object frames, not to the flatfield which is only taken once per night. However, we could not identify an obvious reason for the origin of this problem.

We also included the observations from the later run 072.D-0487(A), taken during January, February and March 2004. This last set of data was reduced using the Reflex pipeline (Freudling et al. 2013). Reflex is an environment that was developed to provide an easy and flexible way to reduce VLT/VLTI science data using the ESO pipelines. The output data after using the pipeline are wavelength and flux calibrated spectra. Note that the ripple problem occurs less often in the latest pipelines.

2.4. Telluric lines

A number of telluric absorption features are known in the red spectral range. In the H α region these are mostly caused by water in the atmosphere. Overall Paranal is a very dry place and thus the water features in our UVES spectra are usually weak. However, since the SPY spectra were taken preferentially during periods of relatively poor weather conditions, stronger telluric absorption is present in a number of spectra. Since the RV determination can be skewed if a strong telluric feature coincides with the stellar H α core, we corrected the telluric contribution.

For this purpose we produced a telluric UVES template, which was created from 50 UVES spectra selected from the complete SPY data set of \approx 2000 spectra on the basis of strong water absorption and simple spectral appearance in the red range. This

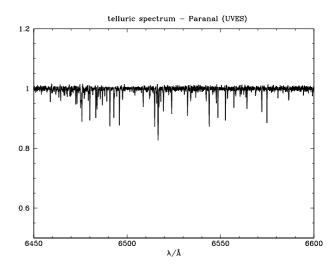


Fig. 3: Telluric template spectrum in the H α region.

included white dwarfs of spectral types DA, DB, DBA, and DC. For each spectrum the local continuum was evaluated in an iterative procedure. The spectra were convolved with a Gaussian of 1 Å FWHM. Data points more than $3\times$ the noise level below the continuum were clipped. This procedure was repeated until the number of clipped wavelength points remained constant. The noise level was estimated from neighbouring featureless parts of the spectra. The inner line cores of H α , if present, were excluded by hand. Since the white dwarf sample covers a large range of RVs, this does not produce gaps in the final co-added spectrum. Finally each spectrum was divided by the smoothed continuum. The individual spectra were rebinned to a common wavelength scale and the absorption was scaled to a "normalised telluric absorption strength". Afterwards all 50 individual telluric spectra were co-added to the template spectrum shown in Fig. 3.

To correct the telluric contamination of the stellar spectra, we measured the strength of the telluric features in the 6450 Å to 6500 Å interval. No sharp stellar lines are present in this range. The template was scaled accordingly and the correction was done by dividing the stellar spectrum by the scaled template.

The presence of telluric lines complicates the analysis of the stellar spectra. However, there is a bright side as well. Telluric absorption lines can be used to measure RV velocities to very high precision (Griffin 1973). We checked the RV stability of the UVES/SPY observations by cross-correlating the template with individual spectra with strong telluric features. The resulting scatter is equivalent to ± 0.67 km s⁻¹ indicating good stability; this number was added in quadrature to the radial velocity uncertainties described in the next section when it came to judging evidence for radial velocity variability.

3. Radial velocity measurement

The radial velocities (RVs) of DA can be most accurately measured from the sharp line cores of the Balmer lines. These are most pronounced in H α , and to an lesser extent in H β (Fig. 4). These line cores are formed in high layers of the stellar atmosphere, where the density is low and pressure broadening small². The low densities allow the occupation numbers

² Halenka et al. (2015) carried out theoretical calculations and claimed that pressure shift can mimic RV shifts of tenth of km s⁻¹, if the inner line wings of H β are measured. The authors found negligible effects

to deviate from local thermal equilibrium (LTE) and allow for NLTE effects, which are responsible for the strength of the cores (Greenstein & Peterson 1973). Since most white dwarfs are slow rotators (Koester & Herrero 1988; Heber et al. 1997b; Koester et al. 1998), the line cores are basically Gaussian with widths corresponding to the temperature in the formation layer.

Radial velocities of stars are often measured using crosscorrelation algorithms. Observed spectra are correlated against model spectra or observed template spectra. The advantages of this method are the flexibility and its straightforward usage. As discussed in Napiwotzki et al. (2001a), the broad line wings of the Balmer lines cause complications if the traditional crosscorrelation method is applied to white dwarfs. Thus we developed a modification of the cross-correlation method, which is based on a χ^2 test (Napiwotzki et al. 2001a) and measured the relative RV shifts between the observed spectra. This proved to be a quick and flexible way to select RV variable stars for followup observations (e.g. Napiwotzki et al. 2001b). However, experience showed that this method has its drawbacks (error estimates are not always reliable and sometimes spurious results are produced, especially for stars with weak line cores), and thus we developed more sophisticated methods for the final analysis. Another motivation for a different approach to the RV measurements was our interest to use the absolute RVs for a study of the space velocities of the white dwarfs in the SPY sample (Pauli et al. 2003, 2006; Richter et al. 2007).

Several investigations (Saffer et al. 1988; Foss et al. 1991; Marsh et al. 1995; Maxted & Marsh 1999) modelled the line profiles with Lorentzians or Gaussians. However, these functions describe the line profiles only approximately and combinations of three or four functions can be necessary for an accurate modelling (Maxted & Marsh 1999). Model atmosphere line profiles on the other hand can reproduce the observed Balmer lines of DA white dwarfs quite accurately (Heber et al. 1997b), if the NLTE effects are taken into account. Koester et al. (2001) determined fundamental parameters of about 200 white dwarfs observed during the first nine months of the SPY observations, 163 of them of spectral type DA (compiled in their Table A.1). Koester et al. (2009) obtained the parameters of a much larger sample (including 615 DA white dwarfs). Thus, all the necessary information to apply line profile fits is available for our sample.

3.1. Model atmospheres

Radial velocities are derived by fitting the profiles of the H α and H β Balmer lines with model spectra and computing the optimum RV. In the few cases with a clear detection of photospheric Ca II H&K lines, these were also included. White dwarfs with temperatures above 20 000 K were analysed with the grid of self consistent pure hydrogen NLTE model atmospheres for DA white dwarfs of Napiwotzki et al. (1999). Cooler white dwarfs were analysed with the grid described in Koester et al. (1998). These model spectra used NLTE line formation physics as applied to the LTE atmosphere models of D. Koester.

Fundamental parameters are derived from the spectral analysis of the complete Balmer series as described in Koester et al. (2009) for the SPY DA sample. The input physics of the model grids used for determining the RVs is not exactly the same as for the models used for the Koester et al. (2009) analysis. Thus we redetermined the fundamental parameters temperature and gravity with the grids actually used for the RV measurement and the fitting programme FITSB2 described below. This ensures that the fitting process is self-consistent.

In the case of double-lined systems, temperatures and gravities of both components were determined. This was an iterative process with a first fit carried out using first guess RVs. The estimated fundamental parameters were then used for determining RVs from fitting the H α and H β lines. These initial estimates were refined by refitting temperature/gravity and RVs until parameter changes in subsequent steps became negligible. Model spectra for the two parameter sets were coadded after scaling them accordingly using the mass-radius relations derived from the tracks of Benvenuto & Althaus (1999) complemented by the Hamada & Salpeter (1961) zero temperature models for the highest masses. During these fits, the white dwarf mass-radius relation was used as a constraint to reduce parameter degeneracy.

3.2. FITSB2 and the fit process

The programme FITSB2 can fit line profiles and measure RVs. It was originally developed to analyse the spectra of double-lined (SB2) systems, but can be applied to spectra of single-lined systems (RV variable or not) as well.

The basic philosophy for fitting line profiles follows the FIT-PROF program described in Napiwotzki et al. (1999). Both, the observed and theoretical Balmer line profiles are normalised to the local continuum in a consistent manner. Wavelength shifts are calculated for the actual RV estimate for each spectrum. The synthetic spectra are convolved to the observational resolution with a Gaussian and interpolated to the actual parameters with bi-cubic splines and interpolated to the observed wavelength scale.

Parameters are determined by minimising χ^2 . The optimisation is done by means of a simplex algorithm, which is based on the AMOEBA routine of Press et al. (1992). The advantages of this approach are a high degree of stability and flexibility. New functions and parameters can be easily integrated. One disadvantage is that the convergence of simplex algorithms is not very fast and thus CPU time intensive. However, in practice this is not a major limitation for line profile fitting with FITSB2.

FITSB2 offers a number of options for fitting line profiles: model spectra, Gaussians, Lorentzians, and polynomials or a combination of these four. Most white dwarf spectra were simply fitted using model profiles calculated for the appropriate parameters. The default fit interval was ± 15 Å relative to the line centre. However, sometimes it was appropriate to use larger wavelength intervals. The intervals were adjusted according to the measured RVs. In a number of cases the model line profiles did not give a satisfactory fit of the observed spectra, potentially compromising the accuracy of the measured RV. If that happened Gaussians, Lorentzians and/or polynomials were used to improve the fit; see Sect. 4 for a discussion and examples.

Our observational set-up results in vastly oversampled spectra. Moreover, Doppler broadening results in a substantial broadening of the NLTE line cores of the H α and H β (the Doppler width of H α at 10000 K is 2.2Å). This allowed us to use a simple method to estimate the local noise. A moving parabola was fitted to 20 pixels and the standard deviation computed. This was repeated for all pixels. Afterwards, the pixel by pixel standard deviations were smoothed by a 50 pixel boxcar.

Radial velocity errors were calculated using bootstrapping. This method randomly selects N points of the N points of the observed spectra. Points can be selected more than once, which has

for H α . Our empirical test presented in Appendix A indicates a much smaller effect, if present at all.

the effect that on average $1 - e^{-1}$ points of the original spectrum are represented in the new spectrum. Radial velocities are refitted using the bootstrapped spectrum. This process is repeated and the errors are computed from the standard deviation of the derived parameters. Error estimates using bootstrapping are better at taking into account uncertainties resulting from imperfections of the input data (e.g. hot or dead pixels) and non-Gaussian noise than standard estimates from the co-variance matrix.

Error estimates from bootstrapping are subject to statistical fluctuations and a sufficient number of bootstraps need to be done. The bias-corrected three step method of Andrews & Buchinsky (2000) is applied to estimate the number of necessary iterations. We required that the probability of the error estimates being wrong by more than 10% is less than 1%. The number of bootstraps depends on the distribution of bootstrapped parameters with long tails requiring more bootstrap steps to achieve the required accuracy. Our accuracy requirements resulted in a minimum of 332 bootstraps. Note that the parameters describing Gaussians, Lorentzians and polynomials modifying the model spectrum are treated as free parameters and thus enter the error budget.

4. Results

Survey spectra were taken for a total of 689 targets classified as DA. It turned out that the spectra of 46 stars revealed the presence of red companions (Koester et al. 2009), almost all M type main sequence stars, but also at least one brown dwarf (Maxted et al. 2006). The DA+dM nature of most of these targets was not known at the time they were scheduled for observations. For many of the white dwarfs only low quality classification spectra of the blue range existed, which did not allow the detection of the cool companion.

A further 18 targets could not be checked for RV variations, because only one spectrum was taken, leaving 625 white dwarfs we could analyse for RV variations and the presence of a compact companion. Our RV measurements of the 643 DAs without a cool companion are summarised in Table B.1. We applied heliocentric corrections to the velocities, but no corrections for gravitational redshift. The latter can exceed 100 km s⁻¹ for high mass white dwarfs and need to be taken into account when calculating space velocities, but in this study the emphasis is on velocity variations.

We used the same criterion for variability as used by Maxted et al. (2000a). For each star a weighted mean of the RVs is computed. We then calculate χ^2 from the deviations of the in-dividual RVs from the mean. χ^2 measures the goodness of fit of the "model assumption" of a constant RV. The comparison with a χ^2 distribution with the appropriate number of degrees of freedom yields the probability p of obtaining the observed value of $\chi^2_{\rm a}$ or higher from random fluctuations. The computed values of χ^2 and log p are tabulated in Table B.1 and the distribution of $\log p$ is displayed in Fig. 5. We chose a detection threshold of $p < 10^{-4}$, i.e. white dwarfs with p values below this value are considered to be binaries (indicated as "DD") in Table B.1. This limit corresponds to 0.1 expected false detections due to random chance in the complete SPY sample of ≈ 1000 white dwarfs and pre-white dwarfs. Two targets, WD0032-317 and WD1241-010, have $p < 10^{-3}$, indicative of a higher-than-average chance of their being binaries, but do not meet our $p < 10^{-4}$ criterion. WD1241-010 is in fact a known DD (Marsh et al. 1995); WD0032-317 could reward future study. Three targets did not show RV variations exceeding our detection threshold, but visual inspection identified them as double-lined systems, consisting of two white dwarfs. They are indicated by "dd" in Table B.1. See Sect. 4.4 for a discussion of individual objects identified this way.

When a combination of model atmosphere spectra with Gaussians, Lorentzians, and/or polynomials is used for the line profiles fitting this is marked in the comments column of Table B.1. See Sect. B for a detailed description of the table.

4.1. Peculiarities

As stated above, the fits of the H α and H β line make use of model atmosphere profiles. These are computed for the fundamental parameters derived from the fit of the entire Balmer line series as outlined in Koester et al. (2009). Thus in an ideal world the only free parameters during the fitting procedure would be the RVs. This worked well for about half of the programme stars (e.g. for HS 0002+1635 in the top left panel of Fig. 4). However, the fit between observed and synthetic line profiles was less than perfect for very hot and for cool white dwarfs.

Very hot white dwarfs. The hottest stars in the SPY sample displayed stronger emission cores than predicted by the models (example WD 2146–433; Fig. 4, top right). The problems are probably explained by the presence of metals in the atmosphere, which modify the atmospheric structure and thus the line profiles (Werner 1996). However, Latour et al. (2015) report that discrepancies still persist, if the correct abundances are adopted for model calculations and a good fit can only be achieved with arbitrarily increased abundances. We took the pragmatic approach of amending the cores of our model spectra by adding Gaussians and/or Lorentzians to achieve a good fit.

Cool white dwarfs. Many cool DAs showed broader and stronger line cores than predicted by the models (e.g. WD 0126+101; Fig. 4, bottom left). Koester et al. (1998) reported on the presence of flat bottom profiles of the cores of H α for pulsating white dwarfs of the ZZ Ceti type. The reason for these flat cores is very likely the velocity field associated with the pulsations (Koester & Kompa 2007). Similar and even stronger effects are present in our sample for a number of cool white dwarfs outside the ZZ Ceti instability strip (WD 0126+101 has a temperature of 8557 K; Koester et al. 2009). One can speculate that the reason of this discrepancy are violent convective motions in the atmospheres as seen in hydrodynamic models (Tremblay et al. 2013a).

A more detailed comparison with models could give interesting insights, but here we took again a pragmatic approach and combined the model atmosphere spectra with Gaussians, Lorentzians, and/or polynomials to achieve a good fit of the line cores.

Magnetic white dwarfs. The SPY sample includes ten magnetic white dwarfs, most of them new discoveries based on the Zeeman splitting of the Balmer lines (Koester et al. 2009). Our model spectra do not include the effects of magnetic fields. We simply modelled the observed spectra as well as possible using combinations of Gaussians and Lorentzians (see WD1300–098; Fig. 4, bottom right). This is a rather crude and unphysical approach, but once a good reproduction of the line profiles is achieved, accurate RV velocities can be measured. Note that the absolute velocities measured this way, should be treated with caution. For that the measurements should be repeated with a

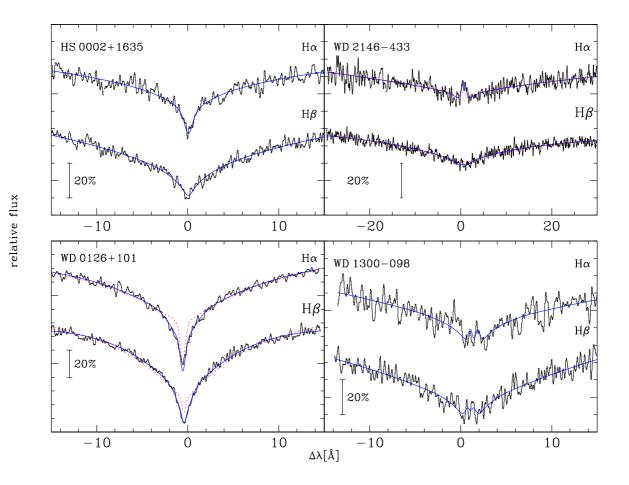


Fig. 4: Observed H α and H β profiles compared to the fitted model spectrum. The graph shows one observed spectrum for each binary and the best fitting model spectrum (blue smooth line). Here and in the following figures we display the observed spectra smoothed with a Gaussian of 0.15 Å FWHM, hardly affecting the spectral resolution. $\Delta\lambda$ is the wavelength offset relative to the laboratory wavelengths of H α and H β , respectively. *Top left:* HS 0002+1635, fitted with model spectra without modifications. *Top right:* WD 2146–433, a hot DA with a Gaussian added to better reproduce the central emission core (model spectrum without correction shown as dashed red line.) *Bottom left:* WD 0126+101, one of the cool DAs displaying a broader and stronger central core than predicted by the models (model spectrum without correction shown as dashed red line.). *Bottom right:* WD 1300–098, one of the magnetic white dwarfs.

proper treatment of the magnetic fields. None of the magnetic white dwarfs displayed any RV variation.

Spectral types DAB and DAO. Four of the white dwarfs in our sample are of spectral type DAB and two of spectral type DAO (HE $1106-0942^3$ and WD 1305-017) showing lines of He I or He II, respectively in addition to the hydrogen lines. We used NLTE atmospheres computed for a mix of hydrogen and helium for analysing the DAOs.

HS 0209+0832 is a genuine DAB white dwarf showing helium line profile variations (Heber et al. 1997a). Two other DABs (WD 0128-387 and WD 0453-295) were analysed by Wesemael et al. (1994), who showed that a consistent fit of lines and spectral energy distribution is only achievable with a composite spectrum combining a hydrogen-rich and a helium-rich WD. Similarly, Bergeron & Liebert (2002) found WD 1115+116 to be a DA+DB double-lined binary system from a model atmosphere analysis. This was confirmed by Maxted et al. (2002)'s measurement of a 30 day orbital period, the longest measured for any DD. A detailed decomposition of the spectrum is beyond the aims of this investigation and the He I lines are weak. We fitted the hydrogen-rich component with a DA model atmosphere and used Gaussians to fit He I lines. We included only the 4713.3 Å, 5015.7 Å and 5875.8 Å lines not displaying strong forbidden components. Results for the DABs will be discussed in Sect. 4.4.

4.2. Detection efficiency

The mean detection efficiency of the SPY sample is plotted in Fig. 6. For each star observed, the detection probability was evaluated as a function of orbital period using the same times and radial velocity uncertainties as observed along with the 0.67 km s⁻¹ uncertainty added in quadrature that we discussed earlier. The probabilities were obtained by calculating the critical orbital inclination i_c for which our log p = -4 threshold was met, and

³ This star is amongst the hottest and is the most luminous star in our sample. Stroeer et al. (2007) classified it as a subluminous O star (sdO) and derived atmospheric parameters similar to those listed in Table C.2.

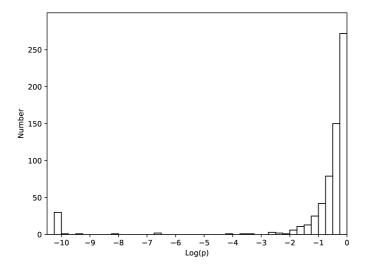


Fig. 5: Distribution of $\log p$ from Table B.1. The peak on the right represents statistical noise only. Our detection threshold is $\log p < -4$. Two systems have $-4 < \log p < -3$; the bin at $\log p = -10$ summarises all objects with $\log p \le -10$; many of them have $\log p$ much less than this value.

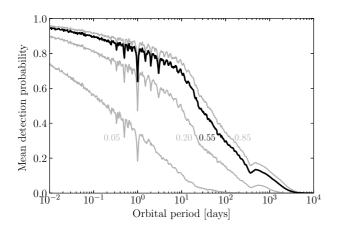


Fig. 6: The mean detection efficiency of the 632 targets with more than one RV in our sample as a function of orbital period, including 7 additional targets from Maxted et al. (2000a) that satisfy the SPY survey criteria. Dips in efficiency at e.g. P = 1 d correspond to typical time intervals between exposures. The calculations account for randomly inclined orbits and orbital phases and were based on the assumption that the visible white dwarf has a mass of 0.55 M_{\odot} and companion masses of 0.05 (brown dwarf), 0.20 (ELM), 0.55 (typical white dwarf) and 0.85 M_{\odot} (Chandrasekhar mass system) as indicated on the plot.

then using $P(i \ge i_c) = \cos(i_c)$ on the assumption of randomly inclined orbits. Random orbital phase offsets were accounted for by averaging over a uniform grid of 20 initial orbital phases in each case. We included the radial velocities measured by Maxted et al. (2000a) for 10 targets that fulfil the SPY criteria but which we had excluded from the survey because of the earlier study. Three of these targets were in fact re-observed in SPY and so the combined datasets were used for these. The remaining seven were a small addition to overall sample, to give a total of 632 targets.

The detection probabililty of a given DD depends upon the masses of the component stars. We assumed a mass of $M_1 = 0.55 \,\mathrm{M}_{\odot}$ for the dominant primary star, while the assumed companion mass M_2 differentiates the different lines plotted in Fig. 6; the lines shown are invariant for constant values of $M_2^3/(M_1 + M_2)^2$. The key point of the plot is that SPY has good sensitivity over all of the known range of DD orbital periods. For typical orbital periods of DDs of around a day and normal mass white dwarf companions, the detection probability is of order 80%, while it exceeds 90% for periods of a few hours or less. The high precision of the SPY velocities means that there is even significant sensitivity to orbital periods as long as 100 days or more. Low mass companions cause lower amplitude RV changes, and so the detection probability drops significantly for brown dwarf mass companions ($M_2 \sim 0.05 \,\mathrm{M}_{\odot}$), but, since all known examples of unresolved white dwarf/brown dwarf binaries are of short period (Parsons et al. 2017), ~ 10 hours or less, SPY has significant sensitivity to such systems as well. Calculations such as those of Fig. 6 could be used to correct for DDs missed in SPY (WD1241-010 is one such system; Marsh et al. 1995), but we refrain from doing this as the correct approach is a more nuanced multi-dimensional problem that allows for multiple selection effects when comparing theoretical and observational populations, which we discuss in more detail in Section 5.2.

4.3. DA white dwarfs with Ca II lines

A number of DA white dwarfs observed by SPY display Ca II absorption lines (Koester et al. 2005b) and are thus of spectral type DAZ. The most prominent features are the Ca II H and K resonance lines. These lines are much narrower than the H α and H β Balmer lines used by us and the Ca K line is well suited for accurate RV measurements. The other component of the doublet, Ca H, is usually too strongly disturbed by the near-by strong H ϵ line to be useful.

The Ca II lines are broadened by quadratic Stark (and eventually neutral) broadening, which both lead to small asymmetries and line shifts. This could be a potential problem in particular, when lines are very strong, but if χ^2 is small then we can be confident that the impact is too small to make a noticeable effect.

Nine of the DA white dwarfs of the sample presented show detectable Ca II lines of photospheric origin. This was established by Koester et al. (2005b) from a comparison of the RV measured from the calcium lines and the Balmer lines. Interstellar Ca lines are present in the spectra of some hotter white dwarfs.

Here we will use the photospheric Ca lines to check the internal consistency of the RV measurements. While the H α and H β lines are registered with the two CCDs in the red channel of UVES, the Ca K lines are observed with the third CCD in the blue channel. CCD specific problems or systematic errors during the spectral reduction process and RV measurement should show up in a comparison.

Results for the Ca K line and the corresponding Balmer line measurements are listed in Table 1 and a plot of the resulting differences is shown in Fig. 7. The agreement is very good. Only two values out of the 19 in Fig. 7 show deviations exceeding the 1σ limits computed from the individual error limits. The resulting reduced χ^2 amounts to 0.72, well in agreement with purely statistical scatter. We conclude that SPY was routinely able to measure radial velocities of white dwarfs at the few km s⁻¹ level, and, on brighter targets, to well below 1 km s⁻¹.

Table 1: Radial velocities v(Ca) measured from photospheric Ca K lines compared to the Balmer line values v(H).

date	UT	v(Ca)	<i>v</i> (H)
		$\rm kms^{-1}$	$\mathrm{km}\mathrm{s}^{-1}$
15/09/00	09:28	19.2±1.5	19.8±1.3
02/09/01	09:17	17.4 ± 2.0	18.7 ± 1.7
23/04/00	03:55	29.4±1.5	29.5 ± 0.7
17/05/00	02:07	29.3 ± 2.2	29.2±1.5
23/04/00	04:27	23.7±1.1	28.4 ± 1.5
19/05/00	01:23	19.3±0.9	22.6±1.4
23/04/00	04:44	22.6±2.3	23.1±0.3
17/05/00	03:08	25.1±2.3	23.6±0.4
23/04/00	04:54	37.5 ± 1.1	37.5 ± 1.4
17/05/00	03:31	35.3±1.7	38.1±3.2
22/04/00	02:44	11.6±2.4	10.6 ± 0.7
17/05/00	03:44	10.7 ± 3.0	12.1±1.4
04/07/00	23:28	13.2 ± 3.4	11.1±0.6
23/04/00	01:30	32.1±2.5	31.9±1.0
19/05/00	03:08	31.4±2.3	31.5±1.3
13/07/00	04:07	20.5 ± 3.6	22.9 ± 2.0
16/07/00	02:03	21.4±3.0	19.4±1.6
06/08/00	04:18	43.4±0.7	44.4±1.1
17/09/00	04:02	39.3±0.5	39.8±1.2
	15/09/00 02/09/01 23/04/00 17/05/00 23/04/00 19/05/00 23/04/00 17/05/00 22/04/00 17/05/00 04/07/00 23/04/00 19/05/00 13/07/00 16/07/00 06/08/00	15/09/00 09:28 02/09/01 09:17 23/04/00 03:55 17/05/00 02:07 23/04/00 04:27 19/05/00 01:23 23/04/00 04:27 19/05/00 01:23 23/04/00 04:44 17/05/00 03:08 23/04/00 04:54 17/05/00 03:31 22/04/00 02:44 17/05/00 03:44 04/07/00 23:28 23/04/00 01:30 19/05/00 03:08 13/07/00 04:07 16/07/00 02:03 06/08/00 04:18	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$

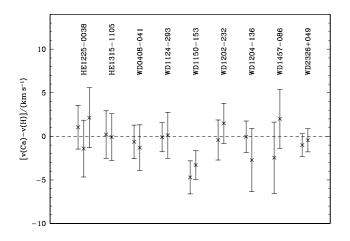


Fig. 7: Differences between v(Ca) and v(H) for the individual spectra as listed in Table 1. Error limits are computed by combining the error estimates for the lines in quadrature.

4.4. Double degenerates

Our RV measurements are summarised in Table B.1. RV variable DDs are indicated by "DD". We detected a total of 39 DDs (see Table 2 for more details). Of these, 19 are single-lined (SB1) and 20 double-lined (SB2). For ten of the SB2 systems radial velocity curves have been measured and masses of the components derived. Ten SB2 systems are still awaiting follow-up spectroscopy. Similarly, for nine SB1 systems radial velocity curves have been measured and minimum masses of the components derived. Four of these DDs have been published in previous works not related to SPY, while three others have orbits presented in papers unrelated to SPY but subsequent to their detection as DDs in SPY – see Table 2 for references.

Fig. 8 shows the distribution of our white dwarf sample in the $T_{\text{eff}}/\log g$ plane with single white dwarfs shown in the upper

panel and DDs shown in the lower panel. The atmospheric values have been taken from Koester et al. (2009). For $T_{\rm eff}$ <12 500 K the values of $T_{\rm eff}$ /log g from 1D models are not accurate and hence we applied the corrections between 1D and 3D models of Tremblay et al. (2013b) for a mixing length parameter ML2/ α =0.6, which is the value used in the Koester models.

4.4.1. Double-lined systems

In Fig. 9 we show spectra of 18 of the 20 double-lined DDs found in the survey, excluding only the two DAB white dwarfs, WD0128-387 and WD1115+166, which we discuss below. Double-lined systems are of particular interest since, once fully characterised, they deliver mass ratios and fundamental parameters for both stars and thus are of special importance for the understanding of the prior evolution of the systems. We now discuss special cases.

WD 2020–425: The spectrum shown in Fig. 9 appears to show only the H α core of one object. However, comparison of the two spectra taken at different epochs (Fig. 10) demonstrates the existence of a second component. This white dwarf is in the parameter range described before (Sect 4.1), in which H α has neither an absorption nor an emission core. WD 2020–425 has parameters, which make it a possible SN Ia progenitor (Napiwotzki et al. 2005). Its period is short enough to let it merge within a Hubble time and the combined mass of both white dwarfs is very close to the Chandrasekhar limit. However, the lack of a sharp core of the second, high mass, white dwarf results in relatively high uncertainties, so that a mass below Chandrasekhar can not be ruled out.

HS 0237+1034 No second epoch survey spectrum exists for HS 0237+1034. However, it is a double-lined DD consisting of two DA white dwarfs (Fig. 9).

MCT 0136–2010: Two spectra were taken for this target. The RV shift measured between the two spectra is not significant. The reason for us to classify it as DD is its double-lined spectrum. This is not too obvious at a first glance at Fig 9. However, the two spectra taken at different epochs (Fig. 11) are clearly different and the χ^2 difference between a fit with and without a second component is 130.5, highly significant. Figure 11 shows the H α profile fitted with a single model.

The small RV offsets in both epochs makes a small RV amplitude and thus a long period likely. Although it is thus unlikely to qualify as SN Ia progenitor, it appears to have a high mass. The fundamental parameters derived by Koester et al. (2009) from a single-lined fit are $T_{\rm eff} = 8416 K$ and $\log g = 8.405$, making it an interesting object for further follow-up.

Spectral types DAB and DAO: Two of the DABs (WD 0453–295 and WD 1115+166) show large RV variations and are clearly short period DDs. The spectrum of WD 0453–295 shows two H α components making this a DA+DBA binary. No second H α component is visible in WD 1115+166 and it is thus a DA+DB binary, in agreement with the detection of the binary period and anti-phased motion in the hydrogen and helium lines by Maxted et al. (2002). The RV shift measured for WD 0128–387 has barely 1 σ significance. However, we noted that in our spectra the He I lines of the DB com-

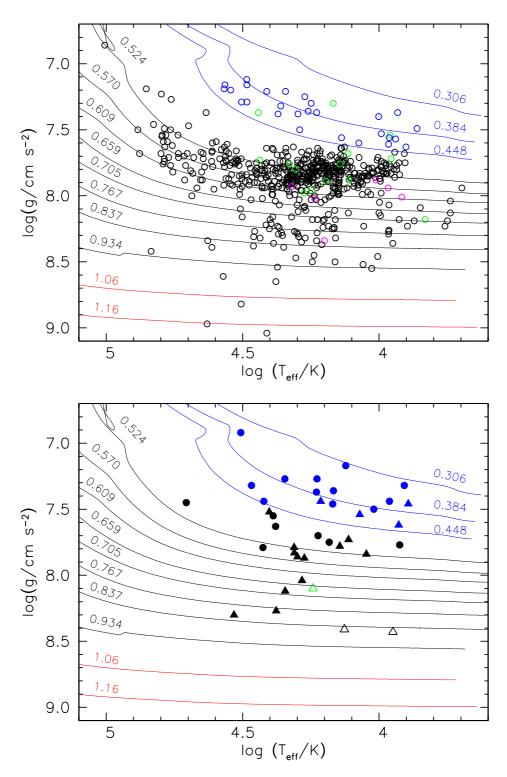


Fig. 8: Comparison of the SPY sample to evolutionary tracks for He-core (blue, Panei et al. 2007), C/O core (black, Renedo et al. 2010) and O/Ne core white dwarfs (red, Althaus et al. 2005) in the T_{eff} – log g plane. The tracks are labelled with their mass. Upper panel: Position of all stars in Table C.2 excluding the DD white dwarfs and stars without a mass determination. Magnetic white dwarfs are shown in magenta, those with only one spectrum in Table B.1 in green. The hot, low gravity star HE1106–0942, the high gravity DA WD0346–011, and the magnetic, high gravity DA WD2051–208 are off-scale. Lower panel: same for DDs. SB1 systems (19) are shown as filled circles and SB2 systems (19) as triangles; the SB2 WD0135-052 is not shown as we were not able to determine masses for it. Filled triangles mark systems that are RV variable, while open ones label SB2 systems that were found by visual inspection of their spectra, but are not considered RV variable (WD0128–387 and MCT0136–2010) or where only one spectrum was taken (HS0237+1034). The parameters of the brighter component were used. The gravity of HE0225–1912 has been offset by -0.05 dex to improve visibility.

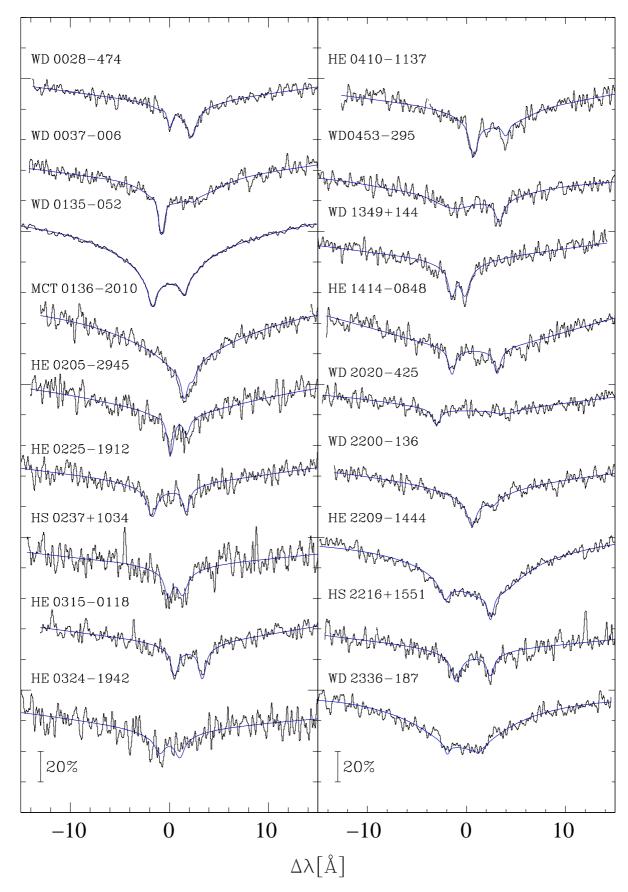


Fig. 9: H α region of 18 of the 20 the double-lined systems detected in the survey. Each system shown displays two H α cores; the two systems excluded, WD0128-387 and WD1115+166, are DABs and show only a single component at H α . The figure shows one observed spectrum for each binary along with the best fitting model spectrum (blue smooth line). The observed spectra were smoothed with a Gaussian with 0.15 Å for display. $\Delta\lambda$ is the wavelength offset relative to the laboratory wavelength of H α .

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Relative flux

Table 2: List of the DDs identified in this survey. References are provided for those that have previously been identified as DDs, in many cases from the SPY survey. The mass of the primary M_1 is given (see appendix C). M_2 and P are secondary masses and periods determined by follow-up observations.

Object	log p	Туре	M_1 (M_{\odot})	M_2 (M_{\odot})	P (d)	References
WD0028-474	< -100	SB2	0.54	≥ 0.46	0.39	SPY: Koester et al. (2009), Napiwotzki et al. (2007). Rebassa-Mansergas et al. (2017)
WD0037-006	< -100	SB2	0.51			
WD0101+048	-17.54	SB1	0.49			
WD0128-387	-0.48	SB2	0.85			
HE0131+0149	-9.47	SB1	0.50			
WD0135-052	< -100	SB2	0.00		1.56	Mass could not be derived (see Sect. C); Saffer et al. (1988), Bergeron et al. (1989)
MCT0136-2010	-0.39	SB2	0.86			
HE0205-2945	-4.07	SB2	0.41			
WD0216+143	-6.75	SB1	0.54			
HE0225-1912	-28.02	SB2	0.55	0.23	0.22	SPY: Napiwotzki et al. (2007)
HS0237+1034	0.00	SB2	0.67			• · · ·
HE0315-0118	< -100	SB2	0.50	0.49	1.91	SPY: Koester et al. (2009); Napiwotzki et al. (2007). Rebassa-Mansergas et al. (2017)
HE0320-1917	-42.87	SB1	0.31	≥ 0.45	0.86	SPY: Nelemans et al. (2005), Koester et al. (2009)
HE0324-1942	-8.18	SB2	0.78			
HE0325-4033	-9.86	SB1	0.49			
WD0326-273	< -100	SB1	0.36	≥ 0.96	1.88	SPY: Nelemans et al. (2005), Koester et al. (2009)
WD0341+021	< -100	SB1	0.38			Probably long period, Maxted et al. (2000a)
WD0344+073	-19.26	SB1	0.39			
HE0410-1137	-40.63	SB2	0.49	0.36	0.51	SPY: Napiwotzki et al. (2007). Rebassa-Mansergas et al. (2017)
WD0453-295	< -100	SB2	0.40	0.44	0.36	SPY: Karl (2004), Napiwotzki et al. (2007)
HE0455-5315	-66.18	SB1	0.47			
WD1013-010	-39.55	SB1	0.32	≥ 0.62	0.44	SPY: Nelemans et al. (2005), Koester et al. (2009)
WD1022+050	< -100	SB1	0.37	>0.28	1.16	Maxted & Marsh (1999), Morales-Rueda et al. (2005), Nelemans et al. (2005)
HS1102+0934	-47.41	SB1	0.38	≥ 0.45	0.55	SPY: Nelemans et al. (2005), Koester et al. (2009). Brown et al. (2013)
WD1115+166	-22.28	SB2	0.69	≥ 0.52	30.1	Maxted et al. (2002)
WD1124-018	< -100	SB1	0.49			
WD1210+140	< -100	SB1	0.33	≥ 0.44	0.64	SPY: Nelemans et al. (2005), Koester et al. (2009)
HS1334+0701	-6.51	SB1	0.35		0.23:	SPY: Karl (2004), period ambiguous
WD1349+144	-53.30	SB2	0.53	0.33	2.21	SPY: Nelemans et al. (2005), Koester et al. (2009)
HE1414-0848	< -100	SB2	0.52	0.74	0.52	SPY: Napiwotzki et al. (2002), Morales-Rueda et al. (2005), Nelemans et al. (2005)
HE1511-0448	-17.85	SB1	0.50	≥ 0.67	3.22	SPY: Nelemans et al. (2005), Koester et al. (2009)
WD1824+040	< -100	SB1	0.40	≥ 0.73	6.27	Saffer et al. (1998), Morales-Rueda et al. (2005), Nelemans et al. (2005)
WD2020-425	< -100	SB2	0.81	0.54	0.30	SPY: Koester et al. (2009); Napiwotzki et al. (2007)
WD2020-425 WD2200-136	< -100 < -100	SB2 SB2	0.81	0.54	0.50	ST 1. ROUSIEI ET al. (2007) , mapiwolzki et al. (2007)
HE2209–1444	-38.47	SB2 SB2	0.40	0.72	0.28	SPY: Karl et al. (2003), Morales-Rueda et al. (2005), Nelemans et al. (2005)
HS2216+1551	-99.25	SB2	0.64			1 (200 <i>3</i>)
WD2330-212	-99.23 -27.79	SB2 SB1	0.04			
WD2336-187	-16.23	SB1 SB2	0.45			
HE2345-4810	-10.23 -15.62	SB2 SB1	0.30			
1112273-4010	13.02	501	0.45			

ponent are blueshifted by 60...70km s⁻¹ relative to the Balmer lines. The Balmer lines show a weaker blueshifted component, too. This could be explained by gravitational redshift, if the DA were the more massive white dwarf in the system. However, according to the model atmosphere analysis of Wesemael et al. (1994) the DB has higher gravity (log g = 9.0) than the DA

 $(\log g = 8.5)$ thus ruling out gravitational redshift as explanation. We conclude that, although the evidence is somewhat circumstantial, WD 0128–387 is a close DD system consisting of a DA and a DBA. No significant RV variations were detected for the two DAOs HE 1106–0942 and WD 1305–017 included in the SPY sample.

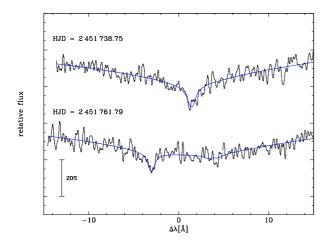


Fig. 10: H α region of the two spectra of WD 2020–425 taken at different epochs.

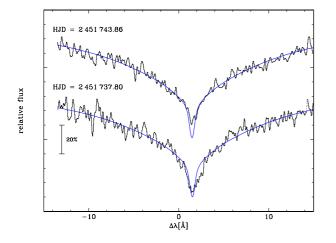


Fig. 11: H α region of the two spectra of MCT 0136–2010 taken at different epochs fitted assuming a single-lined spectrum.

4.5. Notes on individual objects

WD 1845+019: This object is listed as a white dwarf with a cool companion candidate in Hoard et al. (2007). The authors find this white dwarf has a near-IR excess in Two Micron All Sky Survey (2MASS, Skrutskie et al. 2006). Maxted & Marsh (1999) found spectroscopic evidence for a long-period, red companion inferred from the presence of narrow, stationary emission near the core of H α . The SPY spectra show similar emission at H α , whereas Schmidt & Smith (1995) did not report any sign of such emission from spectra which also covered H α . It is not known whether the close neighbour star described by Debes et al. (2005) is gravitationally bound to the white dwarf and whether it is the same as the companion star inferred by Maxted & Marsh (1999). This object was erroneously listed in Koester et al. (2009) as a double degenerate. We measured RVs modelling H α as a composite of a DA spectrum and a Gaussian emission. Our measurements have small error bars and are consistent with constant velocities.

WD 2359–434: The line cores of this white dwarf have a strange flat profile with a weak narrow component already re-

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ported in Koester et al. (1998). Koester et al. (1998) speculated that WD 2359–434 is magnetic and that what they see is only the unshifted component of the Zeeman triplet, with the other components shifted outside their observed spectral range or smeared out due to the inhomogeneity of the field. Aznar Cuadrado et al. (2004) included this object in their spectropolarometric observations and discovered a weak magnetic field of 3 kG. However, our spectra do not show any shifted Zeeman components. A complicated field structure could smear out the shifted components, but a 3 kG field would be too weak to produce smearing over the necessary wavelength range.

Landstreet et al. (2012) reanalysed UVES and FORS data of this object and detected a non-uniform magnetic field in the range 3.1-4.1kG. On the other hand, Kawka & Vennes (2012) obtained a magnetic field of 9.8kG from spectropolarometric observations.

Infrared spectroscopy puts very tight constraints on any cool main sequence or substellar companion (Dobbie et al. 2005). Even brown dwarfs with a spectral type earlier than T8 (corresponding to a mass of $0.05 M_{\odot}$ for an age of $10 \, \text{Gyr}$) can be ruled out. No sign of an infrared excess produced by warm circumstellar dust can be seen in the J,H and K bands.

For our RV measurements we modelled the flat bottom line profiles assuming fast rotation and broad Lorentzians, i.e. the narrow component was ignored. Our assumption of fast rotation is only an attempt to model the profile and does not imply that WD 2359–434 is really a fast rotator. Our spectra, taken four days apart, do not show a significant RV shift.

4.5.1. Magnetic white dwarfs

Ten magnetic white dwarfs have been identified in the SPY survey by Zeeman splitting. WD 0058–044 and WD 0239+109 were already published by Koester et al. (2001). HS 0051+1145, HE 1233–0519 and WD 2051–208 were first identified in SPY and details can be found in Koester et al. (2009). Three other magnetic white dwarfs (WD 0257+080, WD 1953–011 and WD 2105–820) were studied by SPY, confirming their magnetic nature, but were already published in previous works. More information on these objects can be found in Koester et al. (2009). Further to these objects in this work we have also identified two other magnetic white dwarfs that were already published (WD 1300–098 and WD 1350–090). More details on these two objects are given below.

WD 1300–098: The SPY spectra of this object showed Zeeman splitting in the Balmer lines (Koester et al. 2009). This was later confirmed in Gianninas et al. (2011).

WD 1350–090: This is a well known magnetic white dwarf which was found through spectropolarimetry to have a weak magnetic field of 85kG (Schmidt & Smith 1994). Wellhouse et al. (2005) studied the NIR values of this object looking for companions, but did not find one. The Zeeman splitting in the Balmer lines of the SPY spectrum of this white dwarf was first reported in Koester et al. (2001).

4.6. Comparison with Maoz & Hallakoun (2017)

Maoz & Hallakoun (2017) presented a similar analysis of a subsample of 439 DAs out of the 615 SPY DAs analysed by Koester et al. (2009) We start from 643 stars of which 18 have one spectrum only, leaving us with 625 stars. Hence, the sample of Maoz & Hallakoun (2017) is a subset of ours.

The criteria employed to identify radial velocity variables differ significantly between our two studies. While we use the log p < -4 detection threshold (see Sect. 4), Maoz & Hallakoun (2017) prefer $\Delta RV_{\text{max}} > 15 \text{ km s}^{-1}$ to identify a radial velocity variable star and $10 < \Delta RV_{\text{max}} < 15 \text{ km s}^{-1}$ for candidates. We confirm all of the Maoz & Hallakoun (2017)'s detections except for HE0516–1804 (log p = -0.72), HS2046+0044 (log p = -2.54), and WD0032–317, although as discussed earlier, this latter object could well prove to be a DD given its false alarm probability of log p = -3.74.

We find ten stars to be radial velocity variable which are not listed in Maoz & Hallakoun (2017): the known SB2 systems HE0315–0118, WD0453-295 and WD1115+0934, the known SB1 systems WD0216+143, WD0101+048, WD1022+050, and HE1511-0448 as well as the SB1s HE0455-5315, HS1334+0701, and HE2345-4810. These objects are probably among their rejects. In addition, visual inspection of the UVES spectra allowed us to identify MCT0136-2010 and HS0237+1034 as SB2 systems (see Fig. 9).

Amongst Maoz & Hallakoun (2017)'s candidate RV variable objects ($10 < \Delta RV_{max} < 15 \text{km s}^{-1}$), we confirm that HS2216+1551 is a radial velocity variable SB2 system, however, all 15 remaining candidates listed in their Table 1 are rejected using our criterion.

In summary, we reject 17 out of the 43 DDs of Maoz & Hallakoun (2017), confirming only 25 of them. Of these, 7 have system parameters published by the SPY consortium before, and 3 from other sources. From our full sample we identified 39 DDs including 20 SB2 systems. We identify 12 SB1 and 13 SB2 systems in the Maoz & Hallakoun (2017) subsample. However, the overall DD fraction in both samples is the same at 6%, if the same variability test is applied.

The ΔRV_{max} statistic employed by Maoz & Hallakoun (2017) has two intrinsic weaknesses which could perhaps have contributed to the differences between our studies. First it takes no account of the number of spectra - the expected distribution of ΔRV_{max} from purely statistical fluctuations always shifts towards larger values as the number of spectra considered increases. For instance, we find that a threshold that is only exceeded by chance 1% of the time with two spectra, is breached almost three times as often with three spectra, a purely statistical and spurious effect. There are perhaps indications in Maoz & Hallakoun (2017)'s results of the influence this effect: three of their 16 candidates have three or more spectra in SPY, whereas only one such case would have been expected by random chance. The second problem with ΔRV_{max} is that it takes no account of varying statistical uncertainties between spectra. These issues are why we employed Maxted et al. (2000a)'s χ^2 based criterion.

5. Discussion

We have presented RV measurements of a set of 643 DA white dwarfs observed for the SPY programme and remaining after 46 binaries with cool companions were removed from the original sample of 689. We obtained two or more spectra for 625 of these targets, 632 including targets covered by Maxted et al. (2000a). This sample contains 39 DDs (20 of the SB2 type, 19 of the SB1 type), 35 of them new discoveries. The directly detected rate of DDs in SPY is thus $6.2 \pm 1.0\%$ (uncertainty is 1σ from the binomial distribution). There are likely to be an additional 5 or 6 DDs in our sample that we did not detect, given typical

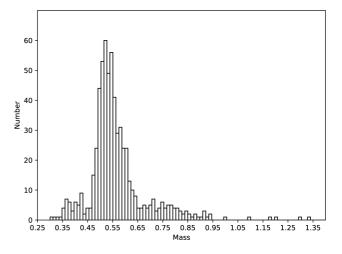


Fig. 12: Mass distribution of the SPY sample.

periods of a day and our mean detection probability (Fig. 6), but a deduction of the space density of DDs requires accounting for much more than just period selection, as we discuss below in section 5.2, so we prefer for simplicity to quote just the numbers as observed.

5.1. Dependence of DD numbers on mass

The SPY sample is large enough to see some significant variations with mass. The limiting mass for a He white dwarf is set by the minimum mass for a helium core flash which increases from 0.43 to 0.49 M_{\odot} (Dorman et al. 1993; Sweigart 1994) with decreasing metallicity, although it is common to adopt a value of $0.45 M_{\odot}$. White dwarfs with higher masses usually have cores composed of carbon and oxygen. There are scenarios that lead to the formation of low-mass "hybrid" white dwarfs with C/O cores and thick helium mantles (~ $0.1 M_{\odot}$ Iben & Tutukov 1985). Some white dwarfs with masses around $0.45 \, M_{\odot}$ may also have evolved via the extreme horizontal branch (EHB), but these objects are also considered to be the product of close binary evolution (e.g. Heber 2009; Kupfer et al. 2015; Heber 2016). So low-mass white dwarfs may not always be helium core white dwarfs, although in all cases evolution within a binary is needed to model the early mass loss that prevents evolution towards a normal C/O WD.

Fig. 12 displays the mass distribution of 615 DA white dwarfs of the SPY sample for which we could derive masses. The distribution may be four populations as suggested by Kepler et al. (2007, cf. their Fig. 8). To examine how DD numbers vary with mass, we consider those targets that (a) have masses in Table C.2 and (b) have two of more spectra and are thus sensitive to DDs. We arrive at the numbers listed in Table 3. All the DDs bar WD0135-052, for which we could not determine a mass from SPY data, contribute to this table, i.e. 38 of the 39 DDs in SPY. We identify the 44 targets with primary masses $M_1 \leq 0.45 \,\mathrm{M}_{\odot}$ (category I) as He white dwarfs. The dominant population II $(0.45 < M_1 \le 0.65 M_{\odot})$ is identified with C/O-core white dwarfs. A third population of higher masses $(0.65 < M_1 \le 1.0 \,\mathrm{M}_{\odot})$ should also consist of C/O-core white dwarfs. A few white dwarfs have masses in excess of $1.0 \, M_{\odot}$ (population IV) and could include O/Ne-core white dwarfs and mergers in addition to C/O-core stars.

Table 3: Breakdown of targets with two or more spectra into four mutually exclusive sets defined by mass. (Exception: HS0237+1034 has only one spectrum, but is double-lined.) Notation: "[" or "]" – interval includes the limiting value; "(" or ")" – interval excludes the limiting value.

Туре	Ι	II	III	IV
	[0, 0.45]	(0.45, 0.65]	(0.65, 1.00]	(1.00, 1.40]
all	44	478	83	6
SB1	12	7	0	0
SB2	4	9	6	0

Of the 44 white dwarfs that have a mass below $0.45 M_{\odot}$, 16 show radial velocity variations indicating that they are double degenerates. In terms of detection probability, a set of $0.4+0.4 M_{\odot}$ DDs is comparable to (albeit a little below) the line corresponding to a companion mass of $0.55 M_{\odot}$ in Fig. 6. Thus, assuming periods of order a day, if all 44 were DDs, we would have expected to detect ~ 37 of them as such, ~ 33 if all companions were ELMs or low-mass main-sequence stars, and still ~ 20 to 26 for 0.05 M_{\odot} brown-dwarf companions with periods comparable to those discovered to date (Parsons et al. 2017). The observed number of 16 suggests that some of remaining 28 non-detections could be single, or be harbouring very low mass companions. It has been suggested that single low mass white dwarfs result from envelope loss induced by capture and spiral-in of planetary companions (Nelemans & Tauris 1998), or are the cores of red giants stripped by explosions of their companions as supernovae (Justham et al. 2009), or are the products of mergers of components of cataclysmic binaries induced by frictional angular momentum loss following nova eruptions (Zorotovic & Schreiber 2017). All possibilities are interesting and these systems are worth further investigation.

The detection of 16 DDs amongst the 44 He white dwarf primaries is a fraction of $36.4 \pm 7.3\%$. By comparison, the 22 DDs in the remaining 567 systems with $M_1 > 0.45 \,\mathrm{M}_{\odot}$, a fraction of just $3.9 \pm 0.8\%$, is a steep drop. For the dominant population of C/O white dwarfs (set II) the binary fraction is even lower (3.3%), while among the C/O white dwarfs of set III 7.2% are binaries. No binary was found among the white dwarfs with masses exceeding $1 M_{\odot}$ (set 4). The He white dwarf DDs of set I divide 12:4 in favour of single-lined systems, while those of higher mass are skewed 7:15 towards double-lined systems (sets II-IV), in particular for set III, in which all six binary systems are double-lined. The dominant population of C/O white dwarfs (set II) divide almost equally. This is perhaps because low mass white dwarfs are large and will tend to dominate over their companions, but it could also be a consequence of the formation paths that result in these systems. There is useful potential here to constrain evolutionary models.

5.2. Selection effects in the SPY sample.

The current sample of DDs has emerged from searches that often started with mass-dependent selection, following successful searches of the 1990s which concentrated upon low mass white dwarfs (e.g. Marsh et al. 1995). The most extreme example of this strategy is the ELM survey (Brown et al. 2016a) which uncovered targets so low in mass that they were not even recognised as white dwarfs when the SPY survey was undertaken. Such surveys are biassed precisely against the high mass systems of most interest as Type Ia progenitors, except to the extent that some may harbour high mass white dwarfs hidden in the

glare of dominant low mass primary stars. They also focus on the extreme low mass wing of the white dwarf mass distribution, which is untypical of most systems. SPY is by far the most sensitive survey without mass selection built in from the start. Precursors to SPY were Bragaglia et al. (1990) and Maxted et al. (2000a) who surveyed 54 and 71 white dwarfs on 2-4 m-class telescopes, uncovering a handful of candidates, although the second of these studies emerged from searches that concentrated in the main upon low mass targets. The Sloan Digital Sky Survey (SDSS), although not designed for radial velocity work, serendipitously provides a very different type of constraint, providing a much larger sample, but also much looser radial velocity constraints. The SDSS is perhaps somewhat superior to SPY for finding massive, short-period Type Ia progenitors (Breedt et al. 2017), but SPY is far more sensitive to the bulk population of longer period and lower mass DDs. Moreover, SPY is particularly efficient in finding double-lined systems because of its high spectral resolution. At lower resolution such as the SDSS spectra, it is far more difficult because the components' line profiles are not resolved and the orbital motion will broaden the combined line profile rather than shifting the unresolved line centre. This is probably why double-lined DDs have not been found directly by the SDSS project. In addition visual inspection of SPY spectra allowed SB2 systems to be discovered that were considered RV non-variable by the detection criterion and, therefore, probably have long orbital periods. Hence, SPY will enable a more complete and reliable calibration of theoretical models. The two surveys are in many ways complementary to each other (Maoz et al. 2018), as can be judged from the detection probability plot for SDSS (Fig. 4; Breedt et al. 2017), comparable to Fig. 6 in this paper. The SDSS detection rate falls below 50% for P > 0.2 days, whereas SPY extends over 100 times longer, only dropping below 50% for P > 30 days. The numbers of DD detections in each survey corroborate this: the 6396 SDSS targets studied by Breedt et al. (2017) yielded 15 DDs, while we have found 39 DDs in 625 SPY targets. One can deduce \sim 400 other DDs in the SDSS sample that have yet to be detected as such.

The SPY sample was selected without regard to mass, but it inherits the selection effects of the input catalogues it was derived from, and accounting for these will be crucial when making comparisons to theoretical population models. A nonexhaustive list of such effects is: (a) period-dependent selection (Fig. 6), (b) selection by galactic location (Fig. 1), (c) colour selection, (d) selection by kinematics via proper motion surveys, and (e) selection by magnitude limits. All of these can be translated to a greater or lesser extent into mass-dependent selection functions. For instance, selection by temperature favours high mass targets since it takes longer for high mass white dwarfs to cool to 10000 K than it does low mass white dwarfs, owing to a combination of available thermal energy and surface area. On the contrary, magnitude-limited surveys strongly favour low mass white dwarfs because of their greater size. There are also subtler effects such as mass-dependent kinematics (Wegg & Phinney 2012) which can lead to both proper motions and scale-heights varying with white dwarf mass. The correct way to allow for these effects is to impose them as closely as possible upon theoretically-derived samples rather than attempt to remove them from the observations. To this end we include a compilation of temperatures and gravities of the SPY sample along with Gaia IDs in Appendix C to facilitate future calculations. SPY-like samples can be generated from theoretical populations by selecting targets of similar colours and magnitudes and imposing in addition a similar selection by Galactic latitude. A full calculation would also simulate the detection of DDs along the lines of Rebassa-Mansergas et al. (2019). Such modeldependent calculations are far beyond our scope here where we aim instead to try to convey a feel for the level of the selection effects affecting the SPY sample, beyond the obvious ones of Galactic latitude and period discussed earlier.

Given the heterogeneous origins of the SPY input catalogue from a multitude of proper-motion, colour and objective prism surveys as well as serendipitous discoveries, it is close to impossible to unravel the selection effects of the original survey papers. Instead, we take advantage of the Gaia DR2 survey (Gaia Collaboration et al. 2018) to quantify the extent of massdependent bias within the SPY sample selection as shown in Fig. 13. We do so by choosing an approximately volume-limited sub-sample from Gaia as an approximation of what is naturally produced by population synthesis calculations. Unsurprisingly, the SPY sample⁴ is very differently distributed to the Gaia sample as shown in the Hertzsprung-Russell diagram on the left of Fig. 13. Above all, it is strongly skewed towards blue colours and high temperatures, reflecting the origins of the sample. The temperature selection automatically implies mass-dependent selection because of differential white dwarf cooling rates, as discussed above.

To judge the significance of additional mass-dependent selection biases, particularly that associated with the magnitudelimited input catalogues, we next look at the distribution of magnitudes across the main white dwarf cooling track, restricting ourselves to Gaia colours $G_{BP} - G_{RP} < 0$ to avoid a region of bifurcation in the Gaia H-R diagram believed to be associated with helium-dominated atmospheres (Gentile Fusillo et al. 2019). (The differential effect of atmospheric composition in this region can be seen directly in Fig. 13 where our hydrogendominated DA sample clusters mainly along the upper of the two branches once $G_{BP} - G_{RP} > 0$.) The restriction in colour builds differential cooling mass-selection into the Gaia-selected reference sample too, so we are looking here for additional effects such as kinematic and magnitude bias. The key result is in the right-hand panel of Fig. 13 which shows that over-luminous targets ($\Delta M_G < -0.5$) are over-represented in SPY compared to a near-volume-limited Gaia sample, whereas faint systems $(\Delta M_G > +1)$ are under-represented. This is as one would expect of a magnitude-limited sample, but the bias is slight compared to samples chosen for low mass, which are equivalent to applying the restriction $\Delta M_G < -0.5$ from the start. Translating Fig. 13 into a mass-bias is complex, since, while we can assume that $\Delta M_G > 0$ targets are more massive than average, double-lined systems with equal contributions from both components get a -0.75 magnitude boost, and could be reasonably massive but still end with $\Delta M_G < 0$. Such calculations are beyond our scope here as they would need to be made separately for any model population. The key point perhaps is that although the biases in the SPY sample are small compared to others in the literature, they are still significant and must be accounted for in any calculation of intrinsic DD fractions and merger rates.

Twenty of the 39 binaries found in SPY are double-lined, an astonishingly large fraction. As remarked above, double-lined systems are potentially up to 0.75 magnitudes brighter than single white dwarfs of the same mass, boosting the chance that they are included in a magnitude-limited sample. Since the SPY sample was compiled from a number of catalogues and surveys with

different faint limits, the survey does not have a well defined cutoff magnitude, however we can estimate the significance of the effect from the systems in hand. Figure 14 shows the probability of a white dwarf to be included in SPY. It was derived by comparing the brightness distribution of observed white dwarfs with a population produced using the model described in Napiwotzki (2009). Numbers of observed white dwarfs found in each bin are compared to the model predictions. Only relative probabilities are important. The probability is modeled with a simple linear function and assumed to be one for white dwarfs brighter than 13.55. The fitted probability p is

$$p = \begin{cases} 1.00 & V \le 13.55\\ 5.27 - 0.3154V & 13.55 \le V \le 16.55\\ 0.00 & V > 16.55 \end{cases}$$
(1)

Fundamental parameters were determined by fitting the spectra with model spectra representing the two components (see appendix C for details). We then calculated the contribution of the secondary star to the combined brightness and from that the brightness of the primary star alone. The probabilities of the system and the primary star alone were calculated using Eq. (1) and used to estimate the probability of the primary alone making it into the SPY sample. Example, if the probabilities are 60% and 30%, respectively, we count the system as 0.5. It turned out that 12.5 of the 20 double-lined binaries (63%) would have appeared in the survey. The total number of detected binaries would have dropped from 39 to 31.5 (81%).

5.3. Implications for SN Ia progenitor scenarios.

Since the initiation of the SPY project, ideas about possible progenitors of SNe Ia have evolved considerably. In particular, the extensive work in following up SNe Ia has revealed a richer diversity than was previously imagined (Taubenberger 2017). The most profound change perhaps has been a move away from the Chandrasekhar mass model, as there now seems to be good evidence for sub-Chandrasekhar ejecta masses in observed SNe Ia (e.g., Scalzo et al. 2014).

We note that among the objects already discovered by SPY there are two systems – WD2020–425 ($M=(0.81+0.54)M_{\odot}$), P=0.3 day) and HE2209–1444 ($M=(0.72+0.43)M_{\odot}$), P=0.28 day), which may well qualify as candidates for sub-Chandrasekhar SN Ias progenitors. Moreover, the SPY project is not completed, as yet. Out of 39 DDs identified in the survey, only 19 have measured M_2 or lower limits thereof from radial velocity curves. There are 10 SB2 DD still needing follow-up observations by UVES (see Tab. 2). The most interesting SB2 system to follow up is HE0324–1942, because its primary mass ($\approx 0.8 M_{\odot}$) is as high as that of WD2020–425.

The expectation of finding a super-Chandrasekhar pre-SN Ia white dwarf pair in the sample of about 1000 objects brighter than $V \approx 16^{\text{m}}5$ was based on a count of the number of model systems satisfying the criteria $M_{tot} > M_{Ch}$ and $t_{merger} < t_{Hubble}$, while any selection effects were ignored. However, a numerical experiment modelling observations of a similar sample of white dwarfs by an instrument like VLT/UVES in which the effects of observational selection (orbital inclination, observational strategy, observing conditions, etc.) were taken into account (Rebassa-Mansergas et al. 2019), has shown that finding such a pair of white dwarfs may require a much larger sample of objects – they estimate a factor of ten. Given that the sample size of 643 presented in the paper does not match even the original aim of around 1000 targets (owing in the main to subdwarfs

⁴ Apart from the following seven SPY targets that have either no parallax or no colour in Gaia: PG0922+162A, PG0922+162B, WD1015+076, HE1117-0222, WD1121+216, WD1147+255 and WD1214+032

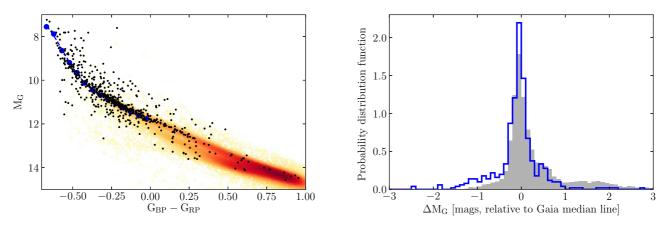


Fig. 13: *Left:* The SPY sample (black dots) plotted in a Hertzsprung-Russell diagram (Gaia absolute magnitude versus Gaia colour) on top of a background of 11 561 white dwarf candidates selected from the Gaia-derived sample of Gentile Fusillo et al. (2019) and colour-coded by plot density. The parallax π and parallax error σ_{π} were restricted by $\pi > 10$ mas and $\pi > 5\sigma_{\pi}$ to give a near volume-limited sample to d = 100 pc, although there is still incompleteness in the lower part of the plot since $M_G > 14$ at 100 pc corresponds to G > 19. The large blue dots on the left mark the main cooling track of the Gaia white dwarfs, avoiding the bifurcation that sets in at $G_{BP} - G_{RP} > 0$. The dashed line represents a polynomial fitted to these that was then subtracted from the Gaia and SPY targets to derive differential absolute magnitude histograms. *Right:* Histograms of the differential magnitudes for Gaia (solid grey) and SPY (outline blue). The SPY sample has relatively more intrinsically bright objects than the Gaia sample, and thus fewer massive white dwarfs.

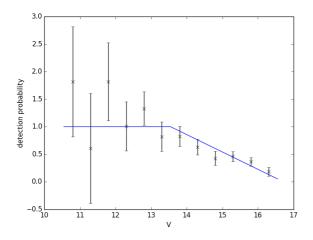


Fig. 14: Relative probability of a white dwarf being included in SPY as a function of brightness. Error bars are derived from the Poisson distribution.

(Lisker et al. 2005; Stroeer et al. 2007) which are hard to distinguish from white dwarfs from colours alone, and not to mind the $\sim 20\%$ detection efficiency loss), the SPY sample may well not deliver a super-Chandrasekhar, short period DD, but with the switch of emphasis towards sub-Chandrasekhar mergers, it nonetheless retains its significance, and is the only large survey sensitive to masses and periods typical of the bulk of the DD population.

The discovery of the DDs presented here is only a first step; the next is the determination of their orbital periods, which has been accomplished already in some cases, and should be a priority in future work on this sample. Once this is accomplished, we should be in a position to be able to compare the properties of DDs in samples generated through binary population synthesis to an observed sample of relatively weak mass bias, and hence be able to judge on the SNe Ia rate that the Galactic population of DDs can plausibly sustain.

6. Summary

In this paper we have presented the methods and results of radial velocity measurements of 643 DA white dwarfs observed with UVES and the VLT as part of the SPY survey. We find 39 double degenerates in this sample, including 20 double-lined systems which show spectral components from both white dwarfs. One of the double-lined systems (WD 2020–425) is a candidate SN Ia progenitor with a total mass close to the Chandrasekhar limit, but the uncertainties of the mass for this binary are too large to be certain of this at present. The absolute radial velocities we presented will allow for future searches for long-period binarity, while the sample of DDs is well-suited for tests of binary population models.

The overall DD fraction in the SPY sample is 6%. We compared our results to the results of Maoz & Hallakoun (2017), who studied a subsample of the SPY data set and derived a DD fraction of $10\%\pm2\%$ (1σ , random) $\pm2\%$ (systematic). We showed that their detection criterion for radial velocity variability is overly optimistic. Applying our detection criterion, we showed that 17 of their candidate DDs are unlikely to be RV variable, reducing their SPY subsample to 25 DDs. Accordingly, the DD fraction in the Maoz & Hallakoun (2017) subsample is in fact 6%, consistent as it should be with our result for the full SPY sample.

Our detected DD fraction among C/O white dwarfs is $3.9 \pm 0.8\%$, below the 10% fraction previously found, perhaps reflecting the prominence of low mass He white dwarfs in literature studies. The detected DD fraction amongst He white dwarfs in SPY is much higher at $36.4 \pm 7.3\%$, although it seems unlikely that all He white dwarfs are binary. We estimated that the number of binaries needs to be corrected by a factor of 0.8 to account for the increased probability of double-lined systems to be included in SPY, but there is a similar factor in reverse because

our detection efficiency is 80 to 90% for typical DD periods, and a full comparison with theoretical models needs to take multiple selection effects into account, despite their being weaker in SPY than in any comparable survey. We provide the data needed to accomplish such a task.

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Table A.1: Systematic shifts measured for the H100 sample

measurement	interval Å	remark	RV shift km s ⁻¹
$\frac{\text{RV}(\text{H}\beta)-\text{RV}(\text{H}\alpha)}{\text{RV}(\text{H}\beta)-\text{RV}(\text{H}\alpha)}$	±15 Å ±30 Å		-0.8 ± 0.4 -2.5 ± 0.4
$RV(H\beta) - RV(H\alpha)$ $RV(H\beta) - RV(H\alpha)$ $RV(H\alpha + H\beta) - RV_{best}$	$\pm 30 \text{ Å}$ $\pm 30 \text{ Å}$	core smoothed core smoothed	-8.7 ± 0.6

Notes. The 1σ uncertainty of the average is given, calculated using bootstrapping.

Appendix A: A test of the possible impact of pressure broadening on Balmer lines

The densities in atmospheres of white dwarfs are sufficiently high that pressure shifts of line profiles are a concern. If present, these effects mimic an RV shift. Laboratory experiments by Wiese & Kelleher (1971) and Wiese et al. (1972) measured substantial pressure redshifts for H β , H γ , H δ and to a lesser extent for H α . Shipman & Mehan (1976) included the shifts determined in these experiments and solved the radiation transfer for white dwarf atmospheres. The resulting line profiles were analysed following the procedure applied to observed spectra at that time to determine the line centre. This investigation found that effects for H α and H β were below the 1 km s⁻¹ level. A later analysis by Grabowski et al. (1987) revisited the Wiese et al. (1972) data and carried out a more detailed fit of the measurements with three parameters (plus a correction term). Stellar line profiles were computed using model atmospheres and analysed in a fashion similar to the previous investigation by Shipman & Mehan (1976). The new study by Grabowski et al. (1987) confirmed small pressure shifts for H α exceeding 1– 2 km s^{-1} only for cool, high gravity (log g = 9) white dwarfs. However, for H β the authors find large shifts often in the range $5-10 \,\mathrm{km \, s^{-1}}$.

A recent study by Halenka et al. (2015) calculated theoretical line profiles using a so-called modified full computer simulation method. This method treats shifts and asymmetries as corrections depending on the local plasma conditions to a simpler first order description of line profiles. The authors compare the new calculations with laboratory data and find improvements to previous attempts. Atmospheric line profiles of $H\alpha$ and H β were calculated using the new theoretical calculations. The result is even smaller pressure shifts for H α than reported in Grabowski et al. (1987). The effect does not exceed 1 km s^{-1} even when the measurement is carried out 25 Å from the line centre. Contrary to that the new study finds an effect for H β about twice as large as previously, exceeding 10 km s⁻¹ at a distance of 15 Å. The authors point out that the impact on RV measurements should be very small, if the resolved NLTE core of the lines is measured in high resolution spectra. The Doppler core is formed in low density regions of the atmosphere where the Stark effect is of no importance compared to Doppler broadening.

We carried out an empirical test of the possible impact of H β pressure shifts on our RV measurements. We selected a subset of white dwarfs from Table B.1 with clearly visible NLTE core and good spectra, yielding an RV accuracy of 2 km s⁻¹ or better. We excluded targets with a gravity below 7.8. Lower gravity white dwarfs have lower density atmospheres, which would result in smaller effects. We selected the first 100 objects fulfilling these criteria from our catalogue with a total of 201 spectra between them (high S/N 100; H100).

Our measurements of the H100 sample are summarised in Table A.1. We first determined the offsets between H α and H β measured over the ±15 Å interval, i.e. in the same fashion as our original measurements, only that we then included both lines in a simultaneous fit. The result is a very small systematic difference between both lines of -0.8 km s^{-1} . The offset increased to -2.5 km s^{-1} when we increased the fitted interval to ±30 Å. It can be expected that the largest signal is still delivered by the resolved Doppler broadened NLTE core. We thus convolved the model spectra with a Gaussian of 3 Å FWHM, which smoothes the core away and tweaked the fit process to give small weights to the Doppler core. This procedure now gives the results from measuring the Stark broadened wings only. The offset between H β and H α increases to -8.7 km s^{-1} .

Somewhat surprisingly we measure on average smaller RVs for H β than for H α , i.e. blueshifts not redshifts as predicted by Halenka et al. (2015). However, let us keep in mind that the fit process includes a normalisation of model and observed spectrum. It is well possible that this will cancel out, or maybe, even overcompensate line asymmetries. Halenka et al. (2015) carried out a normalisation of their model spectra, but used the true continuum for this exercise. The FITSB2 normalisation process, as applied for our measurements, restricts itself to the fitted region. An asymmetry in the outer wings of the line, if present, will thus result in a tilt.

A detailed investigation is beyond the scope of this article. Our main interest here is an estimate of possible systematic offsets of our RVs. The small RV offset between H α and H β measurements for our H100 sample done the standard way over the ±15 Å interval gives us confidence that the systematic RV errors for white dwarfs with well developed NLTE cores is not larger than 1 km s⁻¹. Note also the good agreement between our RVs measured from Balmer lines and the Ca K line (Fig. 7).

We used the best guess RVs (RV_{best}) from Table B.1 as reference point to get an estimate of systematic offsets for RVs measured using the ± 30 Å interval. We fitted RVs of our H100 sample over ± 30 Å, combining H α and H β , the NLTE core smoothed away. The average difference to RV_{best} is -3.7 km s⁻¹.

We actually do not know RV_{best} for DA targets with weak NLTE cores, for which we needed to use a wider fit interval. However, we made an attempt to measure the differences between H α and H β RVs. Uncertainties are quite substantial due to the weak features of these spectra. These measurements also produced a few outliers, a tendency which is much reduced if both Balmer lines are combined. This is the main reason we included H β for our RV measurements in the first place. To avoid spurious results we excluded spectra with an uncertainty of the RV difference exceeding 15 km s⁻¹. The average of the remaining 31 measurements has an RV offset of $-14.6 \pm 2.6 \,\mathrm{km \, s^{-1}}$. This is larger than what we measured for our H100 sample with smoothed NLTE core. It is plausible that the generally weaker features of these stars increase the impact of line asymmetries or other systematics. Assuming that the pattern observed for the H100 sample holds, we estimate that the systematic error for the simultaneous fit of H α and H β amounts to about $-7 \,\mathrm{km \, s^{-1}}$.

In summary we estimate that systematic offsets of the DAs with prominent NLTE cores (the vast majority) should not exceed 1 km s^{-1} , for targets with weak Doppler cores a systematic offset of about 7 km s^{-1} is possible. These are small enough that they will have no impact on the *relative* RV measurements at different epochs, but need to be considered for *absolute* RVs.

Appendix B: Radial velocity measurements for all DA white dwarfs

Table B.1 lists all RV measurements of the DA white dwarfs in the SPY sample.

Column 1 gives the designation. "WD" indicates that this source was selected from the McCook & Sion (1999) version of the WD catalogue. Other designations indicate that other sources were used (see text).

Column 2. Julian date. The dates are for mid-exposure and corrected to heliocentric values.

Column 3. Individual heliocentric RV measurements for the epochs. If photospheric Ca II lines were present, the Ca K lines was included in the measurement. Observations done under poor conditions (usually repeated afterwards) are included in this table. Errors are often large due to poor signal to noise levels, but could carry useful phase information.

Column 4. Wavelengths range used for the RV measurements, shifted according to the measured RV. An empty entry indicates the standard ± 15 Å interval. Larger values were used, when a sharp line core was missing (see text). Sometimes an asymmetric range was chosen to avoid flaws in the spectra.

Column 5. Weighted average of the RV measurements. The error is computed including the estimate for instrumental systematics calculated from the telluric lines and comparison between Ca and H lines when present.

Column 6. χ^2 values computed for the null hypothesis that RV is constant. Again, our estimates for the systematic errors are included.

Column 7. The next column gives the probability p that χ^2 has a value as high as the measured one or higher for an RV constant star. The smaller the values the higher the confidence that the star is RV variable.

Column 8. A binary is assumed for probability $\log p < -4$ and marked as DD in this column. Double-lined systems not exceeding our RV variation threshold, but identified by visual inspection are marked dd.

Column 9. Comments and observations. Abbreviations:

SB2: Double-lined DD.

G&L: Model spectrum modified using one or more Gaussians and Lorentzians (see text).

polyn.: Model spectrum modified using a low order polynomial.

 v_{rot} : Rotation included in fit. That does not necessary indicate that the star is rotating. The aim was to achieve a good match of the observed profiles for fitting RVs without considerations of the physical soundness.

+Ca K: Photospheric Ca II present and included in fit.

Table B.1: RV measurements for the SPY DA white dwarfs.

-2400000	$\rm kms^{-1}$	Å	1 11				
		Π	$\rm kms^{-1}$				
51739.7790	49.6±1.4		48.7±1.1	0.40	-0.28		polyn., G&L, v _{rot}
51743.8041	47.7±1.5						
51740.7447	94.7±5.6		81.6±2.4	4.36	-0.95		
51742.8050	72.6 ± 6.8						
52799.9168							
51803.7127	25.3±1.7		24.2±1.3	0.36	-0.26		
	23.3±1.7						
52610.5530	18.2 ± 2.1		16.4±1.4	0.63	-0.37		
52889.7085	15.2 ± 1.7						
51803.6565	13.1±2.5		14.9±1.3	0.39	-0.27		G&L
52490.9246	15.5 ± 1.3						
51739.8071	23.2±1.0		24.2±1.0	1.12	-0.54		polyn., G&L
51742.8241	26.0 ± 1.4						
51803.6229	18.6±1.2		17.3±0.9	1.08	-0.52		
51804.5870	16.1±1.1						
51803.6345	50.4 ± 2.2		48.7±1.9	1.14	-0.54		polyn., G&L
51804.5991	44.5±3.5						
51803.7254	16.3±0.8		14.7±0.7	3.34	-1.17		polyn.
51804.6667	12.7±0.9						
52535.6847	-5.5 ± 2.3		-3.7 ± 1.7	0.70	-0.40		
52543.8234	-1.7 ± 2.4						
52532.6001	36.3±0.9		34.8±0.8	2.83	-1.03		
52535.6130	32.5±1.2						
51759.8949	96.1±2.2		91.5±1.0	2.97	-1.07		polyn., G&L
51761.8611	90.3±1.0						
52482.7523	28.1±6.2	40.0	30.4±4.2	0.16	-0.16		
52501.9075	32.4 ± 5.7	40.0					
52212.7174	-45.2 ± 2.8		54.0±1.4	885.20	<-100	DD	SB2, G&L
52272.5402	83.0±1.4						,
52543.8594	43.5±3.5		44.4±1.5	0.05	-0.08		
52544.7685	44.6±1.5						
52482.7623	57.1±2.6		57.3±2.2	0.01	-0.04		polyn., G&L
52260.5382	57.8 ± 4.1						
51803.6896	56.1±25.8	40.0	18.5±12.2	1.60	-0.69		
	52.9±2.7		51.8±2.1	0.19	-0.18		
52535.6383							
51803.6666		30.0	33.8±3.0	14.00	-3.74		
		2010	33.5+0.8	1.28	-0.59		G&L
			20102010	1.20	0.07		
			14.8+1.3	3.78	-1.29		
				2110	/		
			90.7+1 5	0.75	-0.41		G&L
			20172110	0.75	5.11		
			52.9+1.2	0.00	-0.01		
			22.721.2	0.00	0.01		
			-22 4+0 8	2327 70	<-100	חח	SB2, G&L
			22.120.0	2221.10	100	20	~D2, 001
			67 6+1 0	0.00	-0.02		G&L
			07.0±1.0	0.00	0.02		Jul
			30.5±0.7	0.54	_0.34		polyn.
			JU.J±U./	0.34	-0.34		Poryn.
			24.4 ± 1.0	0.02	0.01		
			24.4±1.0	0.05	-0.01		
52007.1110	24.4 ± 1.5 32.8±0.9		31.7±0.7	1.03	-0.51		<u> </u>
	51740.7447 51742.8050 52799.9168 51803.7127 51804.6533 52610.5530 52889.7085 51803.6565 52490.9246 51739.8071 51742.8241 51803.6229 51804.5870 51803.6345 51804.5991 51803.7254 51804.6667 52535.6847 52535.6847 52532.6001 52535.6130 51759.8949 51761.8611 52482.7523 52501.9075 52212.7174 52272.5402 52543.8594 52544.7685 52482.7623 52482.7623 52260.5382 51803.6896 52114.9154 52532.6336	51740.7447 94.7 ± 5.6 51742.8050 72.6 ± 6.8 52799.9168 79.9 ± 2.7 51803.7127 25.3 ± 1.7 51804.6533 23.3 ± 1.7 52610.5530 18.2 ± 2.1 52889.7085 15.2 ± 1.7 51803.6565 13.1 ± 2.5 52490.9246 15.5 ± 1.3 51739.8071 23.2 ± 1.0 51742.8241 26.0 ± 1.4 51803.6229 18.6 ± 1.2 51804.5870 16.1 ± 1.1 51803.6345 50.4 ± 2.2 51803.7254 16.3 ± 0.8 51804.5870 16.1 ± 1.1 51803.7254 16.3 ± 0.8 51804.6667 12.7 ± 0.9 52535.6847 -5.5 ± 2.3 52543.8234 -1.7 ± 2.4 52535.6130 32.5 ± 1.2 51759.8949 96.1 ± 2.2 51761.8611 90.3 ± 1.0 52482.7523 28.1 ± 6.2 52501.9075 32.4 ± 5.7 52212.7174 -45.2 ± 2.8 52272.5402 83.0 ± 1.4 52532.6336 52.9 ± 2.7 52532.6336 52.9 ± 2.7 52532.6336 52.9 ± 2.7 52535.6469 32.5 ± 0.8 52114.9154 7.7 ± 13.9 52532.6336 52.9 ± 2.7 52535.6469 32.5 ± 0.8 52542.7792 34.9 ± 1.0 52535.6469 32.5 ± 0.8 52542.7792 34.9 ± 1.0 52535.6469 32.5 ± 0.8 52542.7603 7.5 ± 1.5 52535.6469 32.5 ± 0.8 52542.7603 $7.5\pm 1.$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{cccccccccccccccccccccccccccccccccccc$

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Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta \lambda$	\overline{RV}	χ^2	$\log p$	comments
	-2400000	$\rm kms^{-1}$	Å	$\rm kms^{-1}$			
	52531.6468	30.8±0.8					
WD0048+202	52536.7120	31.7±2.1		32.2±0.8	0.05	-0.01	
	52610.5968	32.1±1.1					
	52544.7290	32.4±1.0					
HE0049-0940	52543.8699	28.7±0.9		29.3±0.7	0.23	-0.20	
	52544.7781	29.6±0.6					
WD0050-332	52163.6634	18.0 ± 3.2	30.0	23.1±1.5	5.20	-0.80	
	52482.7856	19.7 ± 3.1	30.0				
	52532.6503	29.1±2.5	30.0				
	52542.7912	22.6±2.6	30.0				
HS0051+1145	52536.7221	41.7±9.6		43.3±2.9	0.02	-0.05	G&L, ⁵
	52544.7581	43.4 ± 3.0					,
WD0052-147	52543.8800	58.1±1.6		58.7±1.2	0.17	-0.17	
	52544.7880	59.4±1.6					
WD0053-117	52543.8897	28.7±0.7		28.9±0.7	0.05	-0.08	G&L
11200000 117	52544.7977	29.1 ± 0.6		20.720.7	0.05	0.00	
WD0058-044	51738.8042	41.3±2.0		41.0±1.9	0.03	-0.07	G&L, ⁶
WD0050-044	51741.8086	40.2 ± 3.6		41.0±1.9	0.05	-0.07	Gæl,
WD0101+048	52530.8546	48.4±0.6		55.0±0.7	75.98	-17.54 DI	D G&L, v_{rot}
WD0101+046	52847.9008	48.4 ± 0.0 63.6±0.8		55.0±0.7	15.90	-17.34 DI	$J \cup U \otimes L, V_{rot}$
WD0100 105				22.0.2.0	0.01	0.02	7
WD0102-185	52675.5315	34.2±4.5	125/150	33.8±2.9	0.01	-0.03	,
WD0100 140	52849.9046	33.6±3.7	12.5/15.0	17 4 . 1 1	0.24	0.25	1
WD0102-142	51761.9167	18.2±1.4		17.4±1.1	0.34	-0.25	polyn.
	52529.8719	16.6±1.4					
HE0103-3253	52532.6585	39.2±1.5		39.2±1.1	0.00	-0.00	
	52542.7999	39.2±1.3					
WD0103-278	52532.6684	45.3±0.9		45.6±1.0	0.46	-0.30	
	52536.6069	48.3 ± 3.2					
MCT0105-1634	51739.7961	15.4 ± 5.7		18.5 ± 3.4	3.47	-0.75	
	51742.8518	6.5 ± 7.2					
	52883.6855	27.5 ± 5.3					
WD0106-358	51737.7759	35.3±2.5		35.8±2.0	0.07	-0.10	
	51741.7823	36.7 ± 3.1					
HE0106-3253	51885.6255	56.6±1.1		55.6±0.8	0.59	-0.35	G&L
	52146.8722	55.0±0.7					
WD0107-192	51737.7847	-0.9 ± 1.4		-0.2 ± 1.1	0.25	-0.21	
	51741.7897	0.6 ± 1.5					
WD0108+143	51739.8220	83.9±2.3		85.0±1.9	0.36	-0.26	
	51743.8451	86.9±3.0					
WD0110-139	51738.8143	40.4±2.3		39.4±1.8	0.25	-0.21	
	51741.7991	38.0 ± 2.8		0,11,2110	0.20	0121	
MCT0110-1617	51761.9254	55.5±9.0	30.0	50.7±6.8	0.38	-0.27	
	52529.8809	44.5 ± 10.2	30.0	20.7 ±0.0	0.50	0.27	
MCT0111-3806	52531.6579	25.2±2.1	30.0	27.5±1.8	1.97	-0.80	G&L
	52146.8888	32.2 ± 3.1	30.0	21.211.0	1.77	0.00	Gul
WD0112-195	51737.8432	-13.4 ± 29.2	30.0	13.0±20.2	0.91	-0.47	
112-175	51740.7732	-13.4 ± 29.2 37.1±27.9	30.0	13.0120.2	0.71	0.77	
WD0114-605	52489.9160	57.1 ± 27.9 57.4±1.9	50.0	59.4±1.6	1.36	-0.61	
WD0114-003				J7.4±1.0	1.30	-0.01	
WD0114 024	52146.9060	62.2 ± 2.3		0.4 + 2.7	1 17	0.55	
WD0114-034	51737.8531	-14.5 ± 10.4		-0.4 ± 2.7	1.16	-0.55	
WD0124 257	51740.7824	0.6±2.7		20.4.1.0	1 1 0	0 7 4	
WD0124-257	51738.8246	35.4±2.7		32.4±1.8	1.12	-0.54	
	51741.8302	30.4±2.2			0.65	0.05	
WD0126+101	51739.8320	4.5 ± 0.9		4.7±0.7	0.02	-0.05	polyn., G&L

⁵ magnetic
 ⁶ magnetic
 ⁷ flaws in 29/07/2003 spectrum

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Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta\lambda$	\overline{RV}	χ^2	$\log p$		comments
	-2400000	$\rm kms^{-1}$	Å	$\rm kms^{-1}$				
	51743.8535	4.8 ± 0.8						
WD0127-050	52536.7368	5.3±2.2		3.2±1.0	0.58	-0.35		
	52544.8056	2.8±0.8						
WD0128-387	51738.8458	106.5 ± 6.8	30.0	100.2±4.8	0.96	-0.48	dd	DAB, SB2
	51741.8467	94.2±6.7	30.0					
WD0129-205	51737.7955	62.7±1.9		60.4±1.3	1.25	-0.58		
	51741.8565	58.7±1.6						
HS0129+1041	52536.7453	56.8 ± 3.3		59.9±1.1	0.55	-0.12		
	52544.8133	60.2 ± 1.1						
	53010.5779	60.5±2.2						
HS0130+0156	52547.7017	43.1±12.9	40.0	35.6±8.4	0.35	-0.26		
	52143.8779	30.0±11.2	40.0					
HE0130-2721	52532.7033	27.3±2.3		31.0±1.6	2.59	-0.97		
	52544.8226	34.3 ± 2.2						
HE0131+0149	52536.7538	24.4±1.7		11.8±1.0	39.46	-9.47	DD	
	52143.8946	6.5 ± 1.0						
WD0133-116	51737.8129	98.8±1.4		97.3±1.0	0.91	-0.47		polyn., G&L
	51741.9056	96.3±1.0						
WD0135-052	51737.8611	-51.0 ± 0.5		20.7±0.6	7888.70	<-100	DD	SB2, G&L
	51741.8696	87.3±0.5						
MCT0136-2010	51743.8630	91.8±1.7		93.1±1.4	0.67	-0.39	dd	SB2, polyn., G&L
	51737.8046	94.9 ± 2.1						
MCT0138-4014	51761.8814	45.2±2.6		45.6±2.1	0.04	-0.07		
	52532.8186	46.3 ± 3.4						
WD0137-291	51738.9372	29.6±2.6		28.1±1.8	0.33	-0.25		
	51741.8785	26.9 ± 2.3						
WD0138-236	51739.8424	51.1±37.5	40.0	26.9±24.3	0.42	-0.29		
	51741.8905	9.3±31.9	40.0					
WD0140-392	51739.8513	57.2±0.7		57.1±0.7	0.02	-0.05		
	51741.8996	57.0±0.8						
WD0143+216	52536.7617	19.9±1.6		21.1±1.2	0.57	-0.35		polyn., G&L
	52847.9163	22.3±1.6						F J ,
WD0145-221	51740.7924	58.6±2.0		56.8±1.8	1.40	-0.63		polyn., G&L
	51742.8607	52.6±3.2		00.011.0	11.10	0.02		polym, occ
WD0145-257	52536.6432	43.2±4.2		38.3±1.5	0.89	-0.46		
1100145 257	52544.8467	37.6 ± 1.5		50.5±1.5	0.07	0.40		
HS0145+1737	52536.7741	19.8 ± 2.4		23.7±0.8	3.07	-0.67		
115014571757	52547.7218	25.7 ± 1.1		23.7±0.0	5.07	-0.07		
	53010.5692	23.1 ± 0.9						
HE0145-0610	52658.5542	<u>23.1±0.9</u> 58.3±2.9		57.7±1.4	0.05	-0.01		polyn., G&L
1120143-0010	52658.5542 52658.5679	58.3 ± 2.9 56.8±4.1		J1.1±1.4	0.05	-0.01		poryn., Oal
	52903.6836	50.8 ± 4.1 57.6 \pm 1.6						
HS0146+1847		-0.7 ± 12.8		13.3±2.2	0.82	-0.18		nolun Chr.
130140+184/	52536.7879			13.3±2.2	0.82	-0.18		polyn., G&L, <i>v</i> _{rot}
	52547.7314	14.4 ± 2.7						
	53010.5598	12.5±3.5		0.1.2.0	0.00	0.00		
HE0150+0045	52675.5430	-0.1 ± 2.8		-0.1 ± 2.9	0.00	0.00		
WD0151+017	51737.8676	60.6 ± 2.0		63.9±1.2	2.10	-0.83		
	51740.8441	65.4±1.3		52.0.1.0	0.74	0.40		1
HE0152-5009	52532.8818	53.9±1.1		52.9±1.0	0.76	-0.42		polyn.
	52544.8530	51.7±1.3			0.1.	0.1.5		
WD0155+069	52536.7996	1.2±2.3		2.2±1.4	0.15	-0.15		
	52658.5879	2.7±1.6						
WD0158-227	52537.6611	2.7±5.2	30.0	1.0±2.5	0.08	-0.11		G&L
	52544.8324	0.5 ± 2.8	30.0					
HE0201-0513	52537.6945	8.6±3.1		8.6±3.1	0.00	0.00		
HS0200+2449	52535.8178	55.0±1.7		54.2±1.4	0.31	-0.24		
	52656.5503	52.9 ± 2.1						
WD0204-233	51740.8270	98.8±1.0		98.3±1.1	1.06	-0.52		polyn.

Table B.1: RV measurements, continued.

- 1- i +	UID	DV	A 3	\overline{RV}	. 2	1		
object	HJD	RV	$\Delta \lambda$		χ^2	$\log p$		comments
	-2 400 000	$\frac{\text{km s}^{-1}}{2}$	Å	$\mathrm{km}\mathrm{s}^{-1}$				
1150204 2021	51742.8701	93.9±3.4		26.1.1.2	0.00	0.40		
HE0204-3821	52165.8909	32.3 ± 3.1		36.1±1.3	0.98	-0.49		
1150004 4010	52527.8696	36.8±1.2		22.4 . 1.7	0.00	0.00		
HE0204-4213	52532.8917	22.8 ± 2.2		22.4±1.7	0.02	-0.06		
1100004 000	52537.7137	22.1±2.5		01504	4.00	0.70		
WD0204-306	52611.7406	96.1±9.3		81.5±3.4	4.80	-0.73		polyn., G&L, v _{rot}
	52611.7485	92.2±8.6						
	52616.7588	82.3±5.4						
NID 0202 120	52851.8964	69.0±6.1	10.0	10.0.1(.0)	1.00	0.00		
WD0203-138	51740.8365	28.4±34.7	40.0	-10.9 ± 16.2	1.29	-0.28		G&L
	51742.8804	-13.6 ± 21.4	40.0					
	53010.6421	-44.4±35.4	40.0					~ ~ ~
WD0205-365	51737.8844	48.9±5.4	40.0	44.4±3.9	0.81	-0.44		G&L
	51740.8035	39.7±5.6	40.0					
WD0205-304	51802.7396	79.6±1.5		79.8±1.0	0.02	-0.05		
	52175.8668	79.9±1.1						
HE0205-2945	52175.8788	53.9 ± 5.4		34.0±3.9	15.42	-4.07	DD	SB2, G&L
	52532.8291	14.2±5.4						
WD0208-263	52532.9022	87.3±8.0	30.0	76.0±4.6	1.73	-0.72		
	52537.7245	70.5±5.5	30.0					
HS0209+0832	51737.8914	80.7±3.9	30.0	77.1±2.5	1.76	-0.38		G&L
	51737.8983	77.1±3.6	30.0					
	51740.8102	67.8±6.3	30.0					
HE0210-2012	52174.8880	36.2±1.2		37.2±1.0	0.67	-0.38		
	52527.8802	38.4±1.4						
HE0211-2824	51885.6492	56.6±0.9		56.9±0.8	0.06	-0.09		
	51947.5400	57.1±0.9						
WD0212-231	52537.7352	42.9 ± 2.7		43.3±2.3	0.04	-0.08		
	52616.7393	44.2 ± 4.3						
HS0213+1145	52536.8292	85.8±5.4		78.0±2.3	2.86	-0.62		
	52655.5866	71.6±3.9						
	53010.6258	79.4±3.2						
WD0216+143	51802.7697	20.8±2.4		6.7±1.5	27.27	-6.75	DD	
	52522.9057	-0.4 ± 1.7						
HE0219-4049	52139.9124	40.5±1.9		42.1±0.9	4.46	-0.67		
	52522.8971	45.5±1.5						
	52165.8662	41.9±1.9						
	52171.8893	39.5±1.5						
HE0221-2642	52175.8899	42.1±3.3	30.0	45.1±3.0	1.94	-0.79		
	51949.5680	54.8±6.1	30.0					
WD0220+222	52639.5488	67.6±1.2		67.6±1.4	0.00	0.00		
HE0221-0535	52536.8421	33.1±5.3		43.7±1.7	2.59	-0.97		8
	52537.7563	45.0±1.7						
HE0222-2336	52537.7666	21.4±4.4	30.0	22.8±3.6	0.17	-0.17		
	52616.7493	25.5±6.1	30.0					
HE0222-2630	52465.8944	59.9±1.4		60.7±1.4	0.74	-0.41		
*	51949.5788	63.9±3.1						
HS0223+1211	52639.5612	-50.9±5.9		-50.9 ± 5.9	0.00	0.00		G&L
HE0225-1912	52544.8831	-115.9±2.1		-95.0±1.7	123.77	-28.02	DD	SB2
	52537.7775	-66.8 ± 2.5						
HS0225+0010	52537.8495	29.7±1.9		28.3±1.4	0.55	-0.34		
	52639.5819	27.0 ± 1.9						
WD0226-329	52536.6740	20.1±1.6		21.6±0.7	2.47	-0.54		
	52611.7684	19.7 ± 1.4				5.0 1		
	52616.7667	22.9 ± 0.7						
WD0227+050	52536.8499	16.8 ± 0.5		16.5±0.5	0.74	-0.16		G&L
	52656.5650	15.7 ± 0.5						
			_	I				I

⁸ H α core corrupted in one spectrum

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Table B.1: RV measurements, continued.

object	HJD	RV	Δλ	\overline{RV}	χ^2	$\log p$		comments
00jeet	-2400000	$km s^{-1}$	Å	$km s^{-1}$	A	105 P		comments
	52882.8934	16.8±0.4	Δ	KIII 5				
WD0229-481	51759.9005	37.0±3.5	40.0	30.0±2.8	6.25	-1.36		
101	51761.8667	16.6 ± 5.1	40.0	30.0±2.0	0.25	1.00		
	53010.6148	26.4 ± 9.1	40.0					
WD0230-144	52465.9030	25.5±3.8		25.3±3.7	0.01	-0.03		G&L, ⁹
100200 111	52536.6836	24.1 ± 11.2		20.020.1	0.01	0.02		oul,
WD0231-054	51737.8733	92.4±1.5		90.5±1.2	2.65	-0.57		polyn., G&L
	52523.9105	89.3±2.2		, oie = 112	2100	0107		
	51740.8171	85.4±3.0						
HS0237+1034	52537.8687	80.6±4.1		80.6±4.2	0.00	0.00	dd	SB2
WD0239+109	51737.9060	6.1±4.3		6.3±3.0	0.00	-0.02		G&L, $v_{\rm rot}$, ¹⁰
	51740.8610	6.6 ± 4.2						, 100,
HS0241+1411	52537.8789	13.7±2.8		13.7±2.9	0.00	0.00		
WD0242-174	52260.5925	38.8±1.1		39.1±0.9	0.06	-0.10		
	53010.6088	39.4±1.1						
WD0243+155	52537.8883	27.4±1.7		27.4±1.8	0.00	0.00		
WD0243-026	51949.5403	35.4±1.5		30.1±0.9	9.15	-2.60		G&L, v _{rot}
	52530.8611	27.5±0.9						, 100
HE0245-0008	52655.6160	75.2±2.2		75.2±2.3	0.00	0.00		
HE0246-5449	52537.7922	29.5±1.9		31.4±1.2	0.80	-0.43		
	52539.7079	32.5±1.4						
WD0250-026	52465.9164	57.8±0.9		57.5±0.9	0.10	-0.13		
	52536.8655	57.1±1.2						
WD0250-007	52674.5447	57.0±1.5		55.8±1.3	0.94	-0.48		polyn., G&L
	52655.6263	53.4±2.3						
WD0252-350	51740.8527	102.1±1.4		98.0±0.9	6.10	-1.87		
	51741.9402	95.7±1.0						
WD0255-705	51759.9173	85.0±1.5		84.1±1.0	0.28	-0.23		G&L
	51761.8723	83.5±1.1						
HE0255-1100	51949.5289	-2.5 ± 2.7		-4.8 ± 1.8	0.67	-0.39		
	52537.8159	-6.5 ± 2.3						
HE0256-1802	52537.8259	20.7±2.5		23.7±2.0	1.96	-0.79		
	52616.7756	28.1 ± 3.0						
HE0257-2104	52537.8365	33.2±2.0		33.9±1.3	0.11	-0.13		
	52616.7856	34.4 ± 1.6						
WD0257+080	52535.8275	46.6 ± 2.5		47.6±1.7	0.16	-0.16		G&L, ¹¹
	52639.6042	48.5±2.3						
HE0300-2313	51884.5990	68.9 ± 1.8		66.6±1.7	3.70	-1.26		
	51885.6615	58.7±3.5						
WD0302+027	51741.9203	23.2 ± 4.4	30.0	29.2±3.4	2.61	-0.97		
	51743.8688	37.8 ± 5.3	30.0					
HE0303-2041	52538.7983	42.4 ± 1.7		43.0±1.2	0.10	-0.13		G&L
	52544.8919	43.4±1.5						
HE0305-1145	51889.6282	47.4±9.5		48.0±2.3	0.80	-0.17		
	51948.5414	45.5±3.1						
	51947.5515	50.9±3.3			0.15	0.0.5		
WD0307+149	52535.8768	7.8 ± 0.8		7.2±1.0	2.17	-0.85		
1100207 0746	52536.8833	1.1±3.3		14.0 - 1.6	0.24	0.05		
HS0307+0746	52538.8286	16.2±2.3		14.9±1.6	0.34	-0.25		
	52674.5564	13.7±2.1			0.26	0.01		
WD0310-688	52536.8909	63.1 ± 0.4		62.6±0.4	0.26	-0.01		G&L
	52611.7249	62.5 ± 0.3						
	52611.7292	62.5 ± 0.3						
LIE0209 0205	52616.7908	$\frac{62.5\pm0.3}{76.6\pm1.0}$		711.15	1 40	0.(2		
HE0308-2305	51949.5584	76.6±1.9		74.4±1.5	1.43	-0.63		I

⁹ fit without model spectrum
 ¹⁰ magnetic
 ¹¹ magnetic, second component possibly visible in higher Balmer lines

Table B.1: RV measurements, continued.

					2			
object	HJD	RV	$\Delta \lambda$	\overline{RV}	χ^2	$\log p$		comments
	-2400000	km s ⁻¹	Å	$\mathrm{km}\mathrm{s}^{-1}$				
	51947.5749	72.0±2.0				0.1.0		
WD0308+188	52538.7370	38.1±0.7		38.4±0.7	0.10	-0.12		
1100200 - 1001	52656.5728	38.7±0.9		024.10	0.64	0.70		
HS0309+1001	52332.5254	105.3 ± 3.4		93.4±1.8	9.64	-2.72		polyn., G&L
WD0315-332	52530.8718	88.8±2.0	40.0	29.2+0.1	0.00	1.05		CPI
WD0515-552	52538.8455 52539.7208	80.5±18.2 76.2±21.0	40.0 40.0	38.2±9.1	8.98	-1.95		G&L
	52852.8993	6.6 ± 12.2	40.0					
HS0315+0858	52538.8566	$\frac{0.0\pm12.2}{46.4\pm1.2}$	40.0	47.0±1.0	0.16	-0.16		
1150515+0656	52539.7315	40.4 ± 1.2 47.4 ± 1.2		47.0±1.0	0.10	-0.10		
HE0315-0118	51947.5839	-5.0 ± 1.6		46.1±1.3	1220.82	<-100	DD	SB2
1120313 0110	51949.5505	119.8 ± 2.0		-0.1±1.5	1220.02	< 100	DD	502
HE0317-2120	51946.6365	45.8±3.0		47.9±1.5	0.36	-0.26		G&L
1120317 2120	51947.5922	48.6±1.6		+7.9±1.5	0.50	0.20		Gul
WD0317+196	52538.7468	61.8±1.1		62.1±0.9	0.08	-0.11		
11202171190	53013.5370	62.5 ± 1.1		02.120.9	0.00	0.11		
WD0318-021	52334.5292	40.0±2.1		40.0±1.7	0.00	-0.01		G&L
	52336.5398	39.9 ± 2.6			0.00	0101		
WD0320-539	51759.9224	79.1±5.9	30.0	59.4±2.1	7.32	-1.59		
	51761.8889	56.6 ± 4.0	30.0					
	52851.9080	56.5 ± 2.7	30.0					
HE0320-1917	51946.6478	81.9±3.5		23.2±1.4	191.70	-42.87	DD	
	51947.6130	12.1±1.4						
HE0324-2234	52338.5233	53.4±1.7		53.4±1.3	0.00	-0.00		
	52531.8996	53.4 ± 1.9						
HE0324-0646	52332.5359	39.9±1.1		40.5±1.0	0.30	-0.23		
	52337.5190	41.5 ± 1.6						
HE0324-1942	52538.8670	-28.5 ± 8.3		12.9±6.3	33.64	-8.18	DD	SB2
	52539.7409	68.7 ± 9.7						
HE0325-4033	52538.8773	63.1±2.1		77.4±1.4	41.21	-9.86	DD	G&L, ¹²
	52539.7503	87.7±1.8						
HS0325+2142	52538.7574	71.8±0.9		71.0±0.8	0.62	-0.37		polyn.
	53013.5492	70.1±1.0						
WD0326-273	51737.9246	148.6±0.6		56.2±0.6	>10000	<-100	DD	polyn., G&L
	51740.8767	-29.0 ± 0.6						
WD0328+008	52539.7624	21.3±8.5	30.0	20.1±8.4	0.28	-0.22		
	52658.6826	-8.8 ± 43.0	30.0					
HE0330-4736	51885.6729	48.5±2.4		44.3±1.5	2.55	-0.96		
1100000 1101	51891.7954	42.1±1.7		0 (1 0	0.00	0.04		
HS0329+1121	52539.7734	8.4 ± 2.0		9.6±1.2	0.32	-0.24		
WD0220_000	53013.6063	10.3±1.3	20.0	1 1 . 2 2	0.50	0.22		
WD0330-009	52538.6954	5.6 ± 5.8	30.0	1.1 ± 3.2	0.50	-0.32		
HS0331+2240	52655.5992 52538.7663	-0.9 ± 3.8 35.2±2.3	30.0	35.8±1.5	0.07	-0.11		
П50551+2240	52862.9178	35.2 ± 2.5 36.3 ± 1.9		55.6±1.5	0.07	-0.11		
HE0333-2201	51889.6664	$\frac{50.3\pm1.9}{55.2\pm1.6}$		52.9±1.0	1.74	-0.73		
1120355-2201	51924.6052	53.2 ± 1.0 51.5 ± 1.1		J2.7±1.0	1./4	-0.75		
HE0336-0741	52336.5511	67.4 ± 2.3		67.8±1.9	0.05	-0.09		
1120220 0/71	52334.5399	68.6 ± 3.2		07.0±1.7	0.05	0.07		
WD0336+040	52539.7831	77.0±4.8		71.3±1.5	2.59	-0.34		G&L
	52695.5555	75.8±3.7		,1.5±1.5	2.57	0.0 1		
	52853.9183	68.4±2.2						
	53013.6166	71.0 ± 2.7						
HS0337+0939	52539.7927	73.3±2.1		71.2±1.6	1.05	-0.52		
	52674.5670	69.1±2.1						
HE0338-3025	52170.8792	16.6±2.1		20.5±1.5	3.38	-1.18		G&L
								1

¹² fit unusually poor, possibly composite spectrum

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Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta\lambda$	\overline{RV}	χ^2	$\log p$		comments
-	-2400000	$\rm kms^{-1}$	Å	$\rm kms^{-1}$		2.		
	52171.8989	23.9±2.0						
WD0339-035	51740.8991	82.5±1.2		79.2±1.0	8.06	-2.35		polyn., G&L
	52530.8810	75.0±1.3						
WD0341+021	52337.5299	-49.0 ± 2.1		35.9±1.2	1201.59	<-100	DD	
	52538.7061	73.0±1.3						
WD0343-007	51889.6787	21.8±23.6	40.0	13.5±12.2	0.10	-0.12		
	51891.6840	10.4 ± 14.3	40.0					
WD0344+073	52324.5280	-48.2 ± 5.1		-1.5 ± 3.4	88.72	-19.26	DD	polyn., G&L
	52539.8020	39.6 ± 5.0						
	52659.6652	14.9 ± 9.2						
HS0344+0944	52539.8117	51.3±2.3		51.3±2.3	0.00	-0.01		
	52674.5777	51.8±11.1						
HE0344-1207	51946.6268	51.3±6.5		32.3±3.0	6.48	-1.96		
	51947.6243	26.9 ± 3.4						
HS0345+1324	52539.8221	63.1±3.3		64.1±2.9	0.18	-0.17		
	52695.5333	66.8±5.8						
WD0346-011	51741.9278	171.3±8.8	40.0	176.2±4.8	0.26	-0.21		
	51743.8742	178.2 ± 5.7	40.0	1.0.22100	0.20	5.21		
HS0346+0755	52674.5878	48.4±2.9		49.7±2.6	0.43	-0.29		
115051010755	52695.5445	53.3 ± 5.0		1217 ±210	0.15	5.27		
HE0348-4445	51802.7774	51.6±3.5		53.8±2.1	0.35	-0.26		
	51804.8405	51.0 ± 3.5 55.0 ± 2.5		JJ.0±4.1	0.55	0.20		
HE0348-2404	52166.9007	47.3±1.7		47.8±1.1	0.09	-0.11		polyn.
1120340 2404	52167.8889	48.2 ± 1.3		∀ 7.0±1.1	0.07	0.11		poryn.
HE0349-2537	51889.6558	15.0±2.4		15.9±1.7	0.15	-0.16		
TIE0349-2337	51924.5781	15.0 ± 2.4 16.7±2.2		13.9±1.7	0.15	-0.10		
WD0352+049	52658.6570	131.3±22.0	40.0	114.5±16.6	0.79	-0.43		
WD0552+049	52674.6257	92.6 ± 25.1	40.0	114.J±10.0	0.79	-0.45		
WD0352+052	52334.5508	-71.7 ± 2.4	40.0	-74.4±1.9	1.80	-0.75		G&L
WD0552+052	52530.8999	-78.5 ± 2.9		$=/4.4\pm1.9$	1.60	-0.75		Ual
WD0352+018	52332.5539	85.2±2.0		84.3±1.6	0.23	-0.20		
WD0552+018				84.3±1.0	0.25	-0.20		
WD0352+096	52538.7174 52324.5378	83.2±2.4		001.00	0.(1	0.26		
WD0352+090		81.4±0.7		82.1±0.8	0.61	-0.36		
1150250 5127	52538.7292	83.0±1.0		20.0 + 1.5	0.42	0.00		
HE0358-5127	51740.9117	40.2±2.1		39.0±1.5	0.42	-0.09		
	51742.9080	46.9±22.6						
NID 0255 001	51743.8849	37.9±2.0		2 0 4 0	1.00	0.77		C 0 L
WD0357+081	51802.7890	4.2±5.5		-2.8 ± 4.0	1.89	-0.77		G&L, v _{rot}
	51804.8644	-10.0 ± 5.6						
HS0400+1451	52337.5428	86.0±1.1		87.6±0.8	1.52	-0.66		
	52538.7853	88.5±0.7						
HS0401+1454	52674.6161	11.1±2.0		11.1±2.1	0.00	0.00		polyn., G&L
HE0403-4129	51740.9212	33.1±3.2		33.4 ± 2.5	0.02	-0.05		
	51743.8944	33.9±3.9						
HE0404-1852	51895.7564	41.6±1.8		40.2 ± 1.4	0.62	-0.37		
	53010.6975	38.8 ± 1.8						
WD0406+169	52674.6065	91.9±1.8		90.9±1.1	0.23	-0.20		polyn.
	53013.5731	90.4 ± 1.2						
WD0407+179	52674.5976	61.7±0.6		61.9±0.6	1.52	-0.33		G&L
	52695.5677	63.7±1.1						
	52882.9005	61.2 ± 0.6						
WD0408-041	51802.8997	19.4±1.1	10.0/15.0	18.7±1.0	0.36	-0.26		G&L, +CaK
	52154.8915	17.8 ± 1.4	10.0/15.0					
HE0409-5154	51802.8873	65.4±2.5		68.4±1.8	3.18	-0.69		
	52165.8996	66.8±3.5						
	52258.7855	75.3±3.4						
HE0410-1137	52334.5615	6.6±1.6		26.7±1.3	181.46	-40.63	DD	SB2, G&L
	52338.5410	53.5 ± 1.9						,

Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta\lambda$	\overline{RV}	χ^2	$\log p$		comments
C C	-2400000	$\rm kms^{-1}$	Å	$\rm kms^{-1}$				
WD0410+117	52332.5634	54.0±0.9		53.2±0.7	0.51	-0.32		
	52657.6788	52.6 ± 0.8						
HS0412+0632	52324.5473	32.8±1.1		33.6±0.9	0.48	-0.31		
	52657.6865	34.5 ± 1.2						
HE0414-4039	51889.7071	70.8 ± 3.2		66.5±2.4	2.40	-0.92		
	51895.7438	60.8±3.7						
WD0416-550	51743.9146	33.8±2.0		29.8±1.2	4.80	-1.04		
	51759.9082	20.0 ± 4.8						
1150416 2052	53010.6519	28.6±1.5		52.0.2.2	0.00	0.00		
HE0416-3852	51889.6953	55.1±3.6		52.0±2.2	0.69	-0.39		
LIE0416 1024	51895.7331	50.1±2.8		(0.1.1.2	0.00	0.01		
HE0416-1034	51895.7673	69.1±1.4		69.1±1.2	0.00	-0.01		
HE0417-3033	51924.6338	69.0±1.8		(1.0 + 1.7)	1.56	-0.67		
HE041/-3033	52271.6052	59.0 ± 2.0		61.0±1.7	1.56	-0.67		
HE0418-5326	52532.8503 51743.9240	64.9±2.9 11.3±4.7		10.8±2.9	0.01	-0.04		
пе0416-3320	51761.8952	11.5 ± 4.7 10.5 ± 3.5		10.6±2.9	0.01	-0.04		
HE0418-1021	52530.8897	71.5 ± 2.2		71.2±1.7	0.02	-0.05		
1120416-1021	52270.6897	71.3 ± 2.2 70.8 ± 2.4		/1.2±1./	0.02	-0.05		
WD0421+162	52332.5713	75.2±1.5		75.3±1.0	0.01	-0.03		polyn.
WD04211102	52639.6382	75.4 ± 1.0		75.5±1.0	0.01	0.05		poryn.
HE0423-2822	52247.7771	68.5±9.8		75.3±5.5	5.81	-1.26		polyn., G&L, v _{rot} , ¹³
1120423 2022	52540.7808	88.1±7.3		15.5±5.5	5.01	1.20		polyn., $O&L$, v_{rot} ,
	52271.5931	37.5 ± 14.9						
HS0424+0141	52334.5720	104.8 ± 16.8	40.0	82.4±12.3	2.23	-0.87		
1150.2.1.01.11	52337.5543	56.6±18.0	40.0	021121210		0107		
HE0425-2015	52540.8003	55.2±2.1		57.1±1.8	1.28	-0.59		
	52542.8733	61.1±3.2						
WD0425+168	52639.6446	73.7±0.8		75.0±0.9	2.93	-1.06		
	52650.6922	78.1±1.5						
HE0426-1011	52338.5515	73.4±1.0		74.7±0.9	1.69	-0.71		polyn., ¹⁴
	52540.8223	76.3±1.1						1 7 /
WD0426+106	52540.8431	79.9 ± 4.5		77.5±4.1	1.00	-0.50		polyn., G&L
	52657.7080	65.5 ± 10.0						
HE0426-0455	51889.6415	15.1±8.2		25.0±0.9	0.87	-0.19		
	51889.6466	24.9 ± 1.1						
	51885.7860	25.2 ± 1.1						
WD0431+126	52658.6662	72.6±1.4		73.7±1.1	0.62	-0.37		
	52659.6916	74.9 ± 1.4						
HE0436-1633	52315.5722	29.2±1.3		27.2±1.0	2.13	-0.84		
	52540.8781	25.5±1.1						
WD0437+152	52658.6739	21.1±2.0		20.3±1.5	0.19	-0.18		
NID0440 020	52662.6347	19.4±2.2	40.0	106 4 10 4	2.00	1.00		
WD0440-038	52315.5617	168.0±12.6	40.0	186.4±10.4	3.80	-1.29		G&L
WD0446 700	52657.7179	224.4±18.1	40.0	257.00	0.00	0.00		
WD0446-789	52611.7553	35.7 ± 1.2		35.7±0.8	0.00	-0.00		
HE0452-3429	52608.7974 52331.6357	35.7±0.7 59.7±2.8		64.2±1.0	1.62	-0.69		
11E0432-3429	52338.5621	59.7 ± 2.8 64.8±0.9		04.2±1.0	1.02	-0.09		
HE0452-3444	51924.6198	23.8 ± 0.9		26.0±1.2	1.15	-0.55		
1120452-5444	51891.7758	23.8 ± 1.9 27.4±1.5		20.0±1.2	1.13	-0.55		
WD0453-295	52213.8622	109.3 ± 2.9	30.0	83.7±1.2	852.53	<-100	DD	DAB, SB2
11 DUTJJ 2275	52247.8269	109.3 ± 2.9 149.7±2.3	30.0	0.7.1.1.2	052.55	< 100	עע	LIND, 002
	52260.6734	44.0 ± 1.5	30.0					
			20.0	40.6±3.2	304.76	-66.18	DD	
HE0455-5315	52247.8136	-73.3 ± 8.7		40.0± 1.2	304.70	-00.15	יות	

¹³ possible second component in spectrum
 ¹⁴ model fit relatively poor, possible second component

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Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta\lambda$	\overline{RV}	χ^2	$\log p$	comments
5	-2400000	$\rm kms^{-1}$	Å	$\mathrm{km}\mathrm{s}^{-1}$	71	01	
	52532.8692	102.6±4.2					
WD0455-282	51801.8532	86.5±7.6	40.0	70.9±3.2	2.99	-1.08	G&L
	52260.6835	67.6±3.4	40.0				
HE0456-2347	52315.5495	36.4±2.3		37.2±1.9	0.44	-0.09	
	52331.6583	40.0 ± 3.7					
	53011.6811	35.6 ± 5.6					
HS0503+0154	52258.8346	15.7±20.7	40.0	11.7±6.7	0.46	-0.10	
	52327.5268	15.9 ± 8.8	40.0				
	53013.5844	3.3±11.6	40.0				
HE0507-1855	51802.8594	64.3±6.2		55.1±3.6	1.94	-0.79	
	51804.8497	50.4 ± 4.4					
HS0507+0434B	52214.8576	28.8±5.2		41.3±1.4	9.51	-1.63	polyn., G&L
	52327.5399	36.3 ± 2.4					
	52650.7089	47.2 ± 2.3					
	52258.8051	42.9 ± 2.7					
HS0507+0434A	52331.6158	37.1±1.1		37.1±0.6	1.35	-0.14	
	52337.5644	37.0±0.8					
	52258.8133	36.1±1.0					
	52658.6118	39.2±1.5					
HE0508-2343	52006.5174	120.9±1.5		120.2±1.4	0.46	-0.30	
	52008.5351	118.2 ± 2.5					
WD0509-007	51801.8672	27.7±2.5		27.1±2.0	0.07	-0.10	
	52258.8207	26.4 ± 3.0					
WD0510-418	52213.8426	19.7±39.0	40.0	32.5±5.9	4.25	-0.63	
	52247.8405	53.3 ± 29.9	40.0				
	52327.5614	-18.1 ± 20.3	40.0				
	52852.9103	36.9 ± 6.3	40.0				
WD0511+079	51802.8316	19.4 ± 3.0		19.7±2.4	0.01	-0.04	G&L, v _{rot}
	52154.9008	20.1 ± 4.0					
HE0516-1804	51884.8149	49.8±13.7		26.9 ± 3.1	1.70	-0.72	polyn., G&L, ¹⁵
	51885.8515	25.8 ± 3.1					
WD0518-105	51891.7526	128.9 ± 17.1	40.0	130.9±8.2	0.01	-0.04	
	51924.6599	131.4±9.3	40.0				
HE0532-5605	51802.8488	75.7 ± 3.4		74.1±2.6	0.31	-0.24	polyn., G&L, v _{rot}
	51803.8974	72.0±3.8					
WD0548+000	51802.8700	74.6±19.3	40.0	89.6±9.8	0.48	-0.31	G&L
	51803.9061	94.9±11.4	40.0				
WD0549+158	52295.6043	27.7±1.3		30.0±0.9	10.76	-2.34	G&L
	52542.8816	35.3±1.4					
NID 0556 453	52324.5980	27.2±1.3			5.01	4 (8	
WD0556+172	52295.6138	85.9±1.3		82.8±1.1	5.31	-1.67	
	52326.5417	79.3±1.5					
WD0558+165	52295.6248	78.9±1.4		79.7±1.0	0.29	-0.23	
	52326.5531	80.3±1.2					
WD0603-483	51884.8434	58.4±14.5	30.0	55.1±7.0	1.33	-0.29	
	51924.6708	47.3±9.1	30.0				
ND0(10 177	51944.7519	74.7±16.0	30.0	47.1.07	0.05	0.00	
WD0612+177	52322.6775	47.3±1.0		47.1±0.7	0.05	-0.08	
WD0(01 07)	52324.6056	46.9±0.7	20.0	22.0.07	0.44	0.00	
WD0621-376	51801.8757	33.5±0.8	30.0	32.9±0.7	0.44	-0.30	G&L
WD0(00 000	52006.5520	32.4±0.6	30.0		0.00	0.02	
WD0628-020	52632.8579	108.4 ± 1.2		107.7±1.0	0.28	-0.23	G&L
WD0(20, 050	52637.7947	107.0±1.2	40.0	00.0.11.0	0.40	0.00	
WD0630-050	51885.8077	3.5±16.9	40.0	29.2±11.3	2.43	-0.92	
WD0(42 207	51888.8405	49.7±15.1	40.0	44.1 - 1.0	0.00	0.00	
WD0642-285	52007.5556	44.1±1.7		44.1±1.8	0.00	0.00	
WD0646-253	52007.5639	70.9±1.0		69.0±0.9	3.48	-1.21	I

¹⁵ H α core of "a" spectrum corrupted

Table B.1: RV measurements, continued.

object	HJD	RV	Δλ	\overline{RV}	χ^2	$\log p$	comments
•	-2400000	$\rm kms^{-1}$	Å	$\rm kms^{-1}$		•	
	52231.8497	66.6±1.1					
WD0659-063	51884.8578	28.2 ± 0.8		28.1±0.9	0.06	-0.01	G&L
	51895.8489	29.1±5.3					
WD0710-016	51885.8277	27.7±1.6		267.11	2.15	1 10	COL
WD0710+216	52322.6880	40.8 ± 2.0		36.7±1.1	3.15	-1.12	G&L
WD0715-703	52324.6158	35.2±1.1 7.2±6.2	40.0	7.2±5.4	0.00	-0.00	
WD0/15-705	52006.5612 52033.4908	7.2 ± 0.2 7.3 ± 10.6	40.0 40.0	7.2±3.4	0.00	-0.00	G&L, v _{rot}
WD0721-276	52008.5477	9.2 ± 10.3	30.0	7.5±5.5	0.02	-0.05	
WD0721 270	52033.4765	6.9 ± 6.5	30.0	1.5±5.5	0.02	0.05	
WD0732-427	52008.5557	92.2±0.8	50.0	91.8±0.9	0.23	-0.20	G&L
	52033.4983	90.9 ± 1.6		,110201	0.20	0.20	
WD0752-676	52008.5629	92.3±1.5		93.2±1.2	0.36	-0.26	polyn., G&L, v _{rot}
	52033.5068	94.2±1.6					1 5 7 7 100
WD0810-728	52008.5781	47.2±2.4		46.9±1.9	0.76	-0.17	
	52033.5221	42.1 ± 4.8					
	52033.5316	48.7 ± 3.4					
HS0820+2503	52663.6537	49.4 ± 8.2	30.0	56.8 ± 5.2	0.80	-0.43	
	52688.6198	61.8±6.8	30.0				
WD0830-535	52008.5942	39.5±2.3		41.3±1.7	0.73	-0.16	
	52033.5506	45.0±5.0					
WD0020+025	52770.4835	42.4±2.5	40.0	22.2.2.6	0.50	0.26	COL
WD0838+035	52322.7123	19.7 ± 3.6	40.0	22.3±2.6	0.59	-0.36	G&L
WD0839-327	52326.5806 52008.6016	25.0±3.7 52.9±0.3	35.0/40.0	53.0±0.5	0.07	-0.10	G&L, v _{rot}
WD0839-327	52008.0010	52.9 ± 0.5 53.2 ± 0.4		55.0±0.5	0.07	-0.10	G&L, V _{rot}
WD0839+231	52322.7217	-1.6 ± 1.5		-1.8±1.3	0.01	-0.04	
WD00571251	52327.5967	-2.0 ± 1.9		1.0±1.5	0.01	0.04	
WD0852+192	52650.7402	23.7±2.1		22.5±1.5	0.32	-0.24	
	52663.6723	21.5 ± 2.0					
WD0858+160	52663.7270	69.2±1.4		68.2±1.1	0.55	-0.34	
	52689.6043	67.1±1.4					
WD0859-039	52256.8531	5.1±0.6		4.6 ± 0.6	1.15	-0.25	
	52261.8292	3.0 ± 1.2					
	52271.8497	5.0 ± 0.8					
WD0908+171	52329.6938	23.7 ± 2.1		23.2±1.1	0.04	-0.07	
	52635.8568	23.1±1.1					
WD0911-076	51657.5806	56.7±1.3		55.8±1.2	0.52	-0.33	
	51660.6279	54.5±1.7	40.0	07.5.10.7	0.10	0.00	
WD0916+064	52008.6113	15.3±18.1	40.0 40.0	27.5±10.7	2.13	-0.26	
	52033.5744 52033.5849	110.5±56.0 68.2±41.6	40.0 40.0				
	52992.7959	24.8 ± 14.4	40.0				
PG0922+162B	52320.7143	74.6 ± 2.8	+0.0	74.9±2.9	0.48	-0.31	
100722+1020	52327.6333	97.6±25.2		17.7±2.7	0.40	0.51	
PG0922+162A	52322.7422	74.3±2.4		74.7±2.0	0.04	-0.08	
	52327.6179	75.4±3.3					
WD0922+183	52329.6812	35.8±3.9		31.1±2.0	1.04	-0.51	
	52636.8425	29.6 ± 2.2					
WD0928-713	52044.5067	77.5±1.0		74.3±0.7	6.65	-1.08	G&L
	52258.7424	73.5 ± 4.5					
	52258.7676	73.5 ± 1.0					
	52387.6135	72.0±0.9		10			
HS0926+0828	52329.7058	52.5±2.9		49.2±2.1	1.38	-0.62	
1100000 00000	52663.6819	46.2±2.8		40.0.1.0	1.10	0.51	16
HS0929+0839	52663.7362	39.3±2.0		40.8±1.9	1.12	-0.54	10

 $\overline{}^{16}$ H α core of b spectrum corrupted

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Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta\lambda$	\overline{RV}	χ^2	$\log p$		comments
	-2400000	$\rm kms^{-1}$	Å	$\rm kms^{-1}$				
	52690.5600	45.3±3.7						
HS0931+0712	52322.7528	22.8±15.1	30.0	18.1±9.9	0.10	-0.12		
	52327.6568	14.6 ± 13.0	30.0					
HS0933+0028	52656.6680	31.4±13.6	40.0	38.6±6.7	0.22	-0.19		
	52663.6980	40.9 ± 7.7	40.0					
HS0937+0130	52356.6246	47.9 ± 3.7		43.1±2.4	1.66	-0.70		
	52636.8520	39.6±3.1						
WD0937-103	52322.7635	67.6±2.2		70.8±1.7	2.59	-0.97		
	52327.6866	75.0 ± 2.6						
WD0939-153	51657.5924	41.6±1.3		40.9±0.9	0.22	-0.20		polyn.
	51660.6385	40.4 ± 1.1						
HS0940+1129	52663.7462	72.4 ± 2.5		70.0±1.9	1.04	-0.51		
	52690.5719	67.4 ± 2.6						
HS0943+1401	52663.7555	46.8±2.0		46.9±1.9	0.00	-0.01		
	52695.5935	46.9 ± 4.0						
HS0944+1913	52663.7650	66.2 ± 0.8		67.3±0.8	1.74	-0.73		
	52695.5836	68.9±1.0						
WD0945+245	52317.6963	89.8±1.9		92.1±1.6	1.84	-0.76		polyn., G&L
	52327.6969	95.5±2.4		<u> </u>				
HS0949+0935	52263.8412	35.9 ± 3.7		35.0±2.6	0.05	-0.09		
	52327.7067	34.3 ± 3.5						
HS0949+0823	52663.7756	29.5 ± 3.2		29.3±1.4	7.80	-1.00		
	52663.7857	35.0 ± 2.8						
	52684.6887	25.1±3.1						
	52684.6966	34.8 ± 3.2						
	52992.7845	23.2 ± 2.7						
WD0950+077	52009.5816	18.8 ± 1.0		19.4±0.8	0.34	-0.25		
	52356.6573	20.1 ± 1.0						
WD0951-155	51657.6033	31.7±1.7		28.3±1.2	3.41	-1.19		
	51660.6485	25.9 ± 1.4						
WD0954+134	52328.6859	13.6 ± 3.0		11.8±2.4	0.52	-0.33		
	52329.7169	9.1±3.6						
WD0955+247	52260.8537	58.7±0.9		57.6±0.7	1.07	-0.52		G&L
	52272.8556	56.7 ± 0.7						
WD0956+045	51924.6892	61.8 ± 2.4		65.5±1.2	1.78	-0.39		
	51924.7132	67.8 ± 2.7						
	51946.6652	66.1±1.4						
WD0956+020	51657.6136	57.5 ± 0.8		58.5±0.8	1.21	-0.57		
	51660.6641	60.0±1.2						
PG0959-085	51706.5129	42.1±6.7	30.0	42.9±5.1	0.02	-0.05		G&L
	51703.5093	44.0 ± 7.9	30.0					
WD1000-001	52009.6047	72.9 ± 2.0		72.5±1.8	0.07	-0.10		
	52033.6012	71.4±3.7						
WD1003-023	51924.7023	31.9±1.3		31.3±1.0	0.15	-0.15		
	51946.6753	30.9 ± 1.2						
HS1003+0726	52418.5841	55.2 ± 5.8		54.7±1.3	0.38	-0.08		
	52656.7130	53.9 ± 1.6						
	53011.7997	56.2 ± 2.3						
WD1010+043	52328.6974	64.1±4.8		61.0±3.5	0.51	-0.32		
	52329.7280	57.4 ± 5.1						
HE1012-0049	51655.6269	25.2 ± 2.0		26.0±1.8	0.32	-0.24		
	51681.4868	28.3±3.5						
HS1013+0321	52418.5953	37.5±2.6		38.0±1.6	0.03	-0.06		G&L
	52663.7072	38.3±2.0						
WD1013-010	52663.7957	183.4±1.0		168.0±0.9	176.49	-39.55	DD	G&L, v _{rot}
	52684.7071	153.5 ± 1.0						
WD1015-216	51655.6784	7.8±2.7		7.6±2.2	0.01	-0.03		
	51681.4990	7.3 ± 3.7						

Table B.1: RV measurements, continued.

1	LUD		4.2	DI	2	1		
object	HJD	RV km s ⁻¹	$\Delta\lambda$ Å	\overline{RV}	χ^2	$\log p$		comments
WD1015+076	-2400000 51924.7469	16.4 ± 8.4	A	$\frac{\text{km s}^{-1}}{16.4\pm 8.4}$	0.00	0.00		
WD1015+161	52322.7865	10.4 ± 8.4 63.9±1.5		10.4 ± 8.4 65.4±0.9	0.00	-0.42		
WD1013+101	52327.7170	66.1 ± 0.9		05.4±0.9	0.78	-0.42		
WD1017-138	52387.6762	49.3±3.4	30.0	50.0±2.1	0.04	-0.08		
WD1017 150	52656.7210	50.4 ± 2.6	30.0	50.0±2.1	0.04	0.00		
WD1017+125	51924.7369	8.9±1.7	2010	13.5±1.3	7.50	-2.21		
110171120	51939.8475	18.3 ± 1.8		10.0±1.0	1.00	2.21		
WD1019+129	51924.8406	70.8±1.5		68.7±1.0	1.61	-0.69		
	51939.8575	67.4 ± 1.1		00112110	1101	0.07		
WD1020-207	51655.6891	77.1±0.9		77.1±0.9	0.00	-0.00		
	51681.5085	77.2±1.4						
WD1022+050	51919.8946	103.8±1.5		52.7±1.0	841.49	<-100	DD	polyn., G&L
	53013.8146	25.1±1.0						1 5 /
WD1023+009	52330.7550	33.9±6.5	40.0	34.0±5.8	0.00	-0.01		
	52656.7033	34.5±13.1	40.0					
WD1026+023	52009.7189	16.9±1.0		15.3±0.6	1.39	-0.30		G&L
	52418.6043	14.4 ± 1.2						
	52656.7276	14.8 ± 0.6						
WD1031-114	52087.4720	34.7±0.6		35.7±0.6	1.35	-0.61		
	52089.4805	36.7 ± 0.7						
WD1031+063	52009.7294	46.9±2.1		47.5±1.9	0.17	-0.17		
	52663.7166	49.1±3.3						
WD1036+085	52009.7412	17.1±8.6		19.1±2.1	0.03	-0.07		
	52656.7444	19.2±2.0						
HS1043+0258	52663.8213	20.3±2.0		20.0±1.3	0.03	-0.06		
	52684.7354	19.7±1.5						
WD1049-158	52387.6333	69.6±1.1		70.3±0.9	0.42	-0.29		
	52616.8086	71.1±1.1						
WD1053-550	52044.5187	19.4 ± 0.9		19.3±0.8	0.01	-0.04		
	52069.5214	19.2±0.8						
WD1053-290	51657.6374	19.7±1.1		18.8±1.1	1.24	-0.57		polyn., G&L, v _{rot}
	51681.5652	15.8±2.2			0.05	0.40		
WD1053-092	51703.4915	19.0±2.9		21.6±2.1	0.95	-0.48		
1101052 . 0044	51706.4974	24.5±3.1		26.4.1.0	0.22	0.05		
HS1053+0844	52322.7977	23.8±3.9		26.4±1.8	0.33	-0.25		
WD1056 204	52327.7283	27.2±1.9		417.10	0.00	0.00		
WD1056-384	52044.5273	41.8±1.2		41.7±1.0	0.00	-0.02		
WD1058-129	52069.5281 51681.6696	$\frac{41.7 \pm 1.3}{55.1 \pm 5.0}$		70.3±1.6	10.06	-1.40		
WD1030-129	51683.5080	55.1±5.9 77.9±2.7		/0.3±1.0	10.00	-1.40		
	51920.8751	66.1 ± 5.1						
	52087.5514	71.1 ± 2.7						
	52387.7118	64.2 ± 3.6						
HS1102+0934	52330.7772	138.6±3.5		113.6±1.9	218.35	-47.41	DD	
110110210991	52336.7983	76.0 ± 2.6		110.0±1.9	210.00	17.11		
	52657.7283	156.7 ± 3.7						
WD1102-183	51657.6487	62.1±1.2		59.9±0.7	2.19	-0.48		polyn., G&L
	51683.5160	59.4±0.9						
	52087.5433	58.7±1.1						
HS1102+0032	52393.7094	57.2±2.1		55.0±1.4	0.89	-0.46		
	52657.7357	53.7±1.6						
WD1105-048	52387.6951	47.4±0.5		47.9±0.6	0.46	-0.30		G&L, ¹⁷
	52656.7676	48.4 ± 0.5						
HE1106-0942	51739.4668	129.7±2.4		129.2±2.0	0.07	-0.10		DAO, G&L
	51743.4954	128.3 ± 3.3						
HS1115+0321	52393.7011	34.1±1.5		34.7±0.9	0.09	-0.12		
			I					-

¹⁷ unusually bad model fit

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Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta\lambda$	\overline{RV}	χ^2	$\log p$		comments
	-2400000	$\rm kms^{-1}$	Å	$\mathrm{km}\mathrm{s}^{-1}$	<i>, c</i>	C I		
	52656.7756	34.9±0.8						
WD1115+166	52330.6807	33.3±1.7	30.0	49.6±1.3	97.54	-22.28	DD	DAB, SB2, G&L
	52336.8111	65.7±1.6	30.0					
WD1116+026	52663.8385	46.1±1.5		46.8±1.1	0.18	-0.17		G&L
	52684.7530	47.4±1.4						
HE1117-0222	51656.5634	43.0±1.0		40.7±1.0	6.02	-1.85		
	51681.5835	36.4±1.5						
WD1121+216	52327.7376	61.5±0.5		61.8±0.6	0.16	-0.16		G&L
	52288.8680	62.1±0.5						
WD1122-324	51657.6597	2.9±1.2		2.9±1.0	0.00	-0.00		
	51683.5262	2.8 ± 1.4						
WD1123+189	52330.6921	13.8±10.0	40.0	12.0±8.4	0.06	-0.10		G&L
	52336.8192	7.8±15.3	40.0					
HE1124+0144	51727.4800	72.5±1.2		72.3±1.0	0.01	-0.04		
	51728.4838	72.2±1.3						
WD1124-293	51657.6709	29.4±0.7	10.0/15.0	29.4±0.8	0.00	-0.02		polyn., G&L, +CaK
	51681.5945	29.2±1.5	10.0/15.0					1 2 7 7
WD1124-018	52328.8413	-17.2 ± 2.5	,	38.1±1.7	454.57	<-100	DD	
	52330.7891	79.2 ± 2.2						
WD1125-025	52657.7604	55.8 ± 3.8	30.0	55.0±3.1	0.07	-0.10		
	52658.7043	53.6 ± 5.0	30.0					
WD1125+175	52328.7660	14.9±14.5	40.0	7.0±6.5	0.22	-0.19		
	52330.8128	5.0 ± 7.2	40.0					
WD1126-222	51657.6823	54.3±2.9		52.8±2.5	0.52	-0.33		polyn., G&L, v _{rot}
WD1120 222	51683.5356	49.0 ± 4.7		02102210	0.02	0100		porj.iii, 0002, 100
WD1129+071	52657.8575	12.7±1.0		11.7±1.0	1.02	-0.50		
(1 <u>D</u> 11 <u>2</u>) 10/1	52663.8644	10.2 ± 1.4						
WD1129+155	52322.8171	36.3±1.6		37.8±1.2	0.77	-0.42		G&L
	52327.7452	39.0 ± 1.4		01102112	0177	0		0002
WD1130-125	51681.6895	51.2±3.2		59.9±1.3	4.81	-1.55		G&L
	51683.5543	61.4 ± 1.2		• • • • = • • •				
HS1136+1359	52393.6906	13.0±6.3		15.0±4.9	0.15	-0.15		
10110011009	52657.7707	18.0 ± 7.6		1010210	0110	0110		
HS1136+0326	52657.7808	22.6±2.6		23.7±2.5	0.62	-0.36		
	52658.7136	29.4±6.1						
WD1141+077	51920.8833	38.9±2.1	30.0	35.8±1.8	3.55	-1.23		G&L
(DIIIIO)	53013.8200	29.0 ± 3.3	30.0	22.021.0	5.55	1.20		Gul
WD1144-246	51656.7204	-4.3 ± 2.5	2010	-6.1±2.0	0.77	-0.42		
	51681.6283	-9.1 ± 3.2		0.122.0	0.77	0.12		
HS1144+1517	52328.7957	32.7±1.8		33.5±1.6	0.36	-0.26		
110111111017	52330.8408	35.5 ± 3.0		55.5±1.0	0.50	0.20		
WD1145+187	52322.8263	40.0±1.4		41.1±1.1	0.56	-0.34		
WD1115+107	52327.7537	42.0±1.3		11.1 ± 1.1	0.50	0.51		
WD1147+255	52657.7908	59.4±3.8		62.0±2.4	0.45	-0.30		G&L
WD11171255	52663.8467	63.7 ± 3.0		02.0±2.1	0.15	0.50		Gul
WD1149+057	51924.8597	15.9±18.0		2.3±2.4	0.34	-0.25		G&L, ¹⁸
WD11471057	51946.6901	2.1 ± 2.3		2.3±2.4	0.54	0.25		Gal,
WD1150-153	51657.6935	25.3±0.9	10.0/ 15.0	23.0±0.8	4.75	-1.53		G&L, +CaK
150-155	51683.5645	25.3 ± 0.9 20.8±0.9	10.0/ 15.0	23.0±0.0	4.73	-1.55		OUL, TOAN
HE1152–1244	51656.5947	20.8 ± 0.9 31.5±1.1	10.0/ 13.0	30.8±0.9	0.35	-0.25		
1121132-1244	51683.5778	31.3 ± 1.1 30.1 ± 1.1		50.0±0.7	0.55	-0.23		
WD1152-287	51736.5345	$\frac{50.1\pm1.1}{113.0\pm11.0}$		91.4±2.1	3.08	-0.67		
WD1152-207	51736.5425	113.0 ± 11.0 87.4±3.5	30.0	91.4±∠.1	5.08	-0.07		
	51750.5425 51740.4619	87.4 ± 3.3 92.4 ±2.6	50.0					
		フム・サエム・U						1
HS1153 J 1/16				07+71	0.05	_0.09		
HS1153+1416	52657.7997 52684.7633	10.9±4.5 9.4±2.3		9.7±2.1	0.05	-0.08		

¹⁸ spectrum 2001–02–04T06:25:52 not fitted, poor quality

Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta\lambda$	\overline{RV}	χ^2	$\log p$		comments
	-2400000	${\rm km}{\rm s}^{-1}$	Å	${\rm kms^{-1}}$				
	51743.5091	46.3±1.3						
WD1159-098	51728.5035	72.5±1.1		73.7±0.9	0.86	-0.45		G&L
	51731.4596	74.6±1.0						
WD1201-001	51742.5076	55.5±1.4		56.5±1.2	0.72	-0.40		
ND1201 040	51739.4982	58.4±2.0	40.0	10 (0.0	1.01	0.50		
WD1201-049	52322.8366	31.2±13.7	40.0	18.6±9.8	1.01	-0.50		G&L
WD1000_000	52327.7629	5.4±14.1	40.0	22.2 . 0 (0.10	0.10		
WD1202-232	51657.7037	23.1 ± 0.4	10.0/15.0	23.3±0.6	0.19	-0.18		polyn., G&L, <i>v</i> _{rot} , +CaK
WD1204-322	51681.6363 51657.7234	23.8 ± 0.7 13.6±1.5	10.0/15.0	14.6±1.1	0.64	-0.14		
WD1204-322	51681.6440	15.0 ± 1.5 16.7±2.4		14.0±1.1	0.04	-0.14		
	53013.8274	10.7 ± 2.4 14.8±1.8						
WD1204-136	51657.7127	37.3 ± 1.4		37.5±1.0	0.02	-0.00		polyn., G&L, v _{rot}
WD1204 150	51681.6534	37.4 ± 3.2		57.5±1.0	0.02	0.00		polyn., Occl., v _{rot}
	53013.8387	37.7±1.3						
HS1204+0159	52328.8176	21.0 ± 3.0		24.6±2.5	2.49	-0.94		
	52329.7974	31.8 ± 4.2						
WD1207-157	51740.5046	6.4±1.8		6.7±1.6	0.06	-0.09		
	51743.5349	7.4 ± 2.6						
WD1210+140	52657.8068	67.8 ± 2.5		6.5±1.9	726.43	<-100	DD	G&L
	52658.7568	-62.9 ± 2.6						
WD1214+032	52657.7496	36.4±1.3		36.4±1.4	0.00	0.00		polyn., G&L, v _{rot}
HE1215+0227	51738.4628	29.4±13.9	40.0	32.8±6.4	0.04	-0.08		
	51741.4753	33.6 ± 7.1	40.0					
WD1216+036	52069.5569	36.7±1.3		35.4±1.1	1.16	-0.55		
	52080.5550	33.5±1.7						
WD1218-198	51684.6079	-0.2 ± 13.8	40.0	-1.0 ± 9.2	0.00	-0.02		
WD1220-292	51685.6803	-1.6±12.2	40.0	10.0.00	1.16	0.67		
	51684.5611	18.6 ± 0.8		19.3±0.9	1.46	-0.65		
HE1225+0038	51685.6900	22.0±1.8	10.0/15.0	11.2±0.7	0.20	-0.04		
HE1223+0038	51656.6225 51681.6629	11.3±0.7 10.4±1.4	10.0/ 15.0 10.0/ 15.0	11.2±0.7	0.20	-0.04		polyn., G&L, +CaK
	51730.4803	10.4 ± 1.4 11.5 ± 1.0	10.0/ 15.0					
WD1229-012	51684.5779	17.6 ± 0.8	10.0/ 13.0	17.2±0.7	0.12	-0.14		G&L
WD1227 012	51686.5580	16.9 ± 0.7		17.2±0.7	0.12	0.14		Oul
WD1230-308	51684.5871	58.4±3.4		56.1±3.1	1.34	-0.61		
11250 500	51686.5948	46.8±6.9		00112011	1.0 1	0.01		
WD1231-141	51684.5981	6.6±1.4		10.1±1.1	5.19	-1.64		
	51686.6044	13.0±1.3						
HE1233-0519	51737.4654	62.3±8.6	40.0	49.5±4.5	1.80	-0.74		G&L, ¹⁹
	51741.4860	44.7 ± 5.2	40.0					,
WD1233-164	52387.4971	65.4±4.7		61.0±1.6	1.02	-0.22		
	52657.8130	62.0 ± 2.4						
	52658.7388	59.1±2.2						
WD1236-495	52044.5600	74.4±1.9		73.0±1.3	0.43	-0.29		polyn., G&L
	52068.5906	72.1±1.5						
WD1237-028	52080.4824	57.8±3.1		61.7±1.7	1.26	-0.58		polyn., G&L
	52117.5042	63.3±1.9						
WD1241+235	52322.8816	8.9±3.0		8.7±1.8	0.00	-0.01		
WD1241_010	52326.8787	8.7±2.2		0 4 . 0 7	11.04	2.06		
WD1241-010	51684.6160	0.5 ± 0.6		-2.4 ± 0.7	11.94	-3.26		
1101042 - 0122	51686.5644	-5.4 ± 0.6		46 2 . 2 7	0.62	0.26		
HS1243+0132	52393.7289 52656 8442	49.0 ± 3.7		46.2±2.7	0.62	-0.36		
WD1244-125	52656.8442 51687.6284	43.5±3.7 29.2±1.1		27.9±0.9	1.33	-0.60		nolyn
WD1244-123	51730.4725	29.2 ± 1.1 26.4 ± 1.2		21.9±0.9	1.33	-0.00		polyn.
HE1247-1130	52387.5492	$\frac{20.4 \pm 1.2}{18.3 \pm 4.2}$		18.4±3.5	0.00	-0.02		
HE1247-1130	32307.3492	10.J±4.Z	_	10.4±3.3	0.00	-0.02		l

¹⁹ magnetic

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Table B.1: RV measurements, continued.

object	HJD	RV	Δλ	\overline{RV}	χ^2	log p	comments
5	-2400000	$\mathrm{km}\mathrm{s}^{-1}$	Å	$\mathrm{km}\mathrm{s}^{-1}$	10	01	
	52393.7210	18.8 ± 5.9		· #			
EC12489-2750	51738.5636	39.0±3.4	40.0	35.0±3.1	4.47	-1.46	G&L
	51741.4973	16.3 ± 7.4	40.0				
HS1249+0426	52080.5201	22.8±3.3		25.7±2.8	1.55	-0.67	polyn., G&L
	52113.5070	32.8 ± 5.1					
WD1249+160	52326.8886	11.3±1.3		10.9±0.9	0.09	-0.11	
	52328.7291	10.6±1.0					
WD1249+182	52328.8518	-2.4 ± 1.4		-3.5 ± 1.0	0.53	-0.33	polyn.
	52329.8201	-4.4 ± 1.2					1 2
HE1252-0202	51738.5729	23.4±1.9		24.4±1.6	0.34	-0.25	
	51741.5065	25.8 ± 2.4					
WD1254+223	52328.8609	8.1±3.1	40.0	8.3±2.5	0.01	-0.04	G&L
	52329.8809	8.7±3.9	40.0				
WD1257+047	51684.6222	43.5±1.5		41.8±1.1	1.20	-0.56	
	51686.5802	40.2 ± 1.4					
WD1257+032	51939.8754	22.3±1.3		24.2±0.9	1.67	-0.71	20
	51942.8896	25.4±0.9					
WD1257+037	51683.6735	101.7±5.7		100.6±4.2	0.05	-0.08	polyn., G&L, v _{rot}
• • • •	51686.6252	99.2±6.1					r - , -,, - 100
HE1258+0123	51703.5253	41.1±3.5		40.7±2.6	0.01	-0.04	
	51727.6046	40.3±3.6					
WD1300-098	52080.5322	39.3±5.6		36.8±5.1	0.55	-0.34	G&L, ²¹
121200 070	52136.5167	27.0 ± 11.3		00.010.1	0.22	0.51	Gal,
HS1305+0029	52080.5679	37.6±2.3		36.9±1.3	0.07	-0.10	
10100010020	52656.8630	36.7 ± 1.3		50092105	0.07	0.10	
WD1305-017	52658.7638	-4.1 ± 55.4	40.0	12.9±16.3	0.32	-0.07	DAO
121202 017	52684.7734	30.9 ± 29.7	40.0	12.7±10.5	0.52	0.07	
	52684.8071	6.5 ± 20.8	40.0				
HE1307-0059	51739.5103	50.0±2.0		51.4±1.5	0.49	-0.32	
	51742.5189	52.6±1.9		01112110	0.15	0.02	
HS1308+1646	52658.8029	48.0±3.7		46.2±2.6	0.27	-0.22	G&L, v _{rot}
10130011010	52684.7878	44.5±3.6		10.2±2.0	0.27	0.22	
WD1308-301	51687.6460	66.9±0.5		66.4±0.6	0.52	-0.33	G&L
WD1500 501	51703.5561	65.8±0.6		00.4±0.0	0.52	0.55	Gal
HE1310-0337	51736.6041	55.6±7.4	30.0	44.1±4.4	2.12	-0.84	
	51740.5418	38.0 ± 5.4	50.0	→→ ,1 →→ , +	2.12	0.07	
WD1310-305	52378.7125	34.0±1.0		35.1±0.8	1.18	-0.26	G&L
	52659.7641	34.0 ± 1.0 35.2 ± 1.1		JJ.1±0.0	1.10	0.20	Oul
	52658.7452	36.9 ± 1.5					
EC13123-2523	51656.6350	30.6±1.3	30.0	29.0±1.3	3.33	-1.17	G&L
2013123 2323	51659.7365	23.1 ± 2.7	30.0	27.0±1.3	5.55	1.1/	Gul
WD1314-153	52387.5661	108.8 ± 1.2	50.0	107.2±0.8	1.99	-0.43	
131-133	52659.7707	108.8 ± 1.2 107.4 ± 1.1		107.210.0	1.77	0.45	
	52658.7707	107.4 ± 1.1 105.3 ± 1.2					
WD1314-067	51947.7127	26.6 ± 2.9		29.2±1.7	0.64	-0.37	
UU1717-00/	51948.8802	30.4 ± 2.0		<i>∠1.4</i> ⊥1.1	0.04	0.57	
HE1315-1105	51657.5720	30.4 ± 2.0 31.9±1.2	10.0/ 15.0	31.7±1.0	0.04	-0.08	polyn., G&L, +CaK
1121313-1103	51683.6385	31.9 ± 1.2 31.4 ± 1.2	10.0/ 15.0	J1./±1.0	0.04	-0.08	poryn., Oach, +Cak
WD1323-514	52044.5684	-2.5 ± 1.0	10.0/ 13.0	-3.3±0.8	0.39	-0.27	
1525-514				-3.3±0.8	0.39	-0.27	
HE1325-0854	52068.5973 51684.5305	$\frac{-3.8\pm0.8}{0.3\pm0.7}$		0 8 1 0 8	0.45	-0.30	
1121323-0834				0.8 ± 0.8	0.45	-0.50	
HE1326-0041	51686.5484	$\frac{1.7 \pm 1.1}{25.0 \pm 2.3}$		20 1 1 7	2.15	-0.85	
	51738.5839	25.9 ± 2.3		29.1±1.7	2.15	-0.85	
11111111111111	51741.5177	32.2 ± 2.2					

 20 H α core of 2001/01/30 spectrum somewhat corrupted 21 possibly magnetic

Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta\lambda$	\overline{RV}	χ^2	$\log p$		comments
	-2400000	$\rm kms^{-1}$	Å	$\rm kms^{-1}$				
	51742.5301	6.1±0.9						
VD1327-083	52382.7000	40.0±0.3		40.4±0.4	0.29	-0.06		G&L
	52684.7967	40.8±0.3						
IE1220 0525	52658.7768	40.3±0.4	40.0	12.0 - 11.0	2.25	1 1 5		
HE1328-0535	51738.5953	30.6±13.6	40.0	12.0±11.0	3.25	-1.15		
WD1328-152	51741.5280	-24.4 ± 19.0	40.0	15.10	2.21	1.1.0		COL
WD1328-152	51755.5256	-1.8 ± 2.3	30.0	1.5±1.9	3.31	-1.16		G&L
VD1220+026	52087.5228	7.9±3.3	30.0	21.4+0.0	5 27	1.60		
WD1330+036	51684.6300	18.9 ± 1.0		21.4±0.9	5.37	-1.69		
WD1222 220	51687.5609	24.3±1.1		165.14	0.71	1.00		
WD1332-229	51684.6404	13.4 ± 1.9		16.5±1.4	2.71	-1.00		
WD1224.020	51686.6366	19.4±1.8		102 4 . 0 6	1 10	0.50		COL 22
WD1334+039	51755.5175	204.3±17.1		183.4±8.6	1.18	-0.56		G&L, ²²
101004 0701	52136.5070	176.2±10.0		44.0 1.7	0(10	6 51	DD	1
HS1334+0701	52078.5495	-36.1 ± 2.0		-44.8±1.7	26.19	-6.51	DD	polyn.
WD1224 100	52387.7572	-59.4 ± 2.7		510.00	0.00	0.11		
WD1334-160	51703.5671	52.3±1.3		51.9±0.9	0.08	-0.11		
WD1224 (79	51706.5492	51.7±0.9		(5.5.0.0	1.24	0.(1		COL
WD1334-678	51755.5377	64.7 ± 0.9		65.5±0.9	1.34	-0.61		G&L
HE1335-0332	52044.5783	67.9±1.7		5(7)24	1 (7	0.71		
HE1335-0332	51740.5520	49.8±5.3		56.7±3.4	1.67	-0.71		
101220 . 0007	51743.5467	61.5±4.4		71.0.05	0.05	0.00		
HS1338+0807	52080.5960	70.5 ± 5.0		71.8±2.5	0.05	-0.08		
UE1240 0520	52140.4947	72.2±2.8	40.0	247.55	0.00	0.46		
HE1340-0530	51741.5685	19.9 ± 6.7	40.0	24.7±5.5	0.90	-0.46		
WD1242 027	51743.5565	34.5±9.6	40.0	50.2 . 1.7	5 41	1.70		
WD1342-237	51739.5323	54.4 ± 2.1		50.2±1.7	5.41	-1.70		polyn., G&L
WD1344+106	51742.5398	43.9±2.6		10 4 0 7	1.02	-0.78		nalan Cel
WD1344+100	51755.5603	-11.6 ± 0.7		-10.4 ± 0.7	1.92	-0.78		polyn., G&L
WD1240 072	52066.6052	-9.2 ± 0.7		50.0 . 1.5	2.96	0.04		G&L
WD1348-273	52387.5731	61.4 ± 2.0		58.2±1.5	3.86	-0.84		G&L
	52659.8176	53.3 ± 2.3						
WD1240 - 144	52658.7926	60.8±4.0		10.2 . 1.7	220.52	-53.30	DD	CD2
WD1349+144	51947.8050 51948.8908	29.2±2.8 -43.4±2.0		-18.3±1.7	239.52	-55.50	DD	SB2
UD1250 000				542.10	0.42	0.00		1 0.01 23
WD1350-090	51739.5514	53.4±1.3		54.3±1.0	0.43	-0.29		polyn., G&L, ²³
WD1256 022	51742.5478	55.1±1.3		21.0.0.0	2 (1	0.07		1 0.01
WD1356-233	51703.5780	-22.8 ± 1.0		-21.0 ± 0.8	2.61	-0.97		polyn., G&L
WD1401-147	51706.5594	-19.2±1.0		14 (+ 1 7	5.00	1 (1		
WD1401-147	51739.5432	19.3 ± 2.2		14.6±1.7	5.06	-1.61		polyn., G&L
WD1402 077	51742.5626	9.5±2.3	40.0	20.4 - 11.2	0.40	0.21		
WD1403-077	51947.7238	45.8±20.3	40.0	30.4±11.2	0.48	-0.31		
WD1410 + 160	51950.8265	23.7±13.3	40.0	26115	0.12	0.14		
WD1410+168	52387.7646	2.7 ± 2.2		3.6±1.5	0.12	-0.14		
101410.0000	52770.5395	4.1±1.9		((7) 1	0.00	0.00		
HS1410+0809	52387.6042	66.7±4.0		66.7±4.1	0.00	0.00		
WD1411+135	52080.6076	42.4±3.8		46.6±2.1	1.00	-0.50		
VD1412 100	52140.5131	48.3±2.4		10.0.1.0	0.01	0.04		
WD1412-109	52137.5668	20.1 ± 2.3		19.8±1.9	0.01	-0.04		
TE1412 : 0001	52140.5473	19.5±2.9		20.1.1.0	0.10	0.1.4		
HE1413+0021	51738.6274	31.6±1.6		32.1±1.2	0.12	-0.14		
	51741.5480	32.7±1.6		52.0.1.0	4001.00	100	DD	
HE1414-0848	51684.6867	-106.3 ± 2.0		53.2±1.2	4901.98	<-100	DD	SB2, polyn., G&L
	51687.6106	128.9±3.1						
	52080.6207	135.4 ± 3.0						

²² fit without model spectrum
 ²³ magnetic

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Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta\lambda$	\overline{RV}	χ^2	$\log p$		comments
	-2400000	$\rm kms^{-1}$	Å	$\rm kms^{-1}$				
	52137.5343	128.0±1.9						
WD1418-088	51739.5605	-37.1±1.5		-34.1 ± 1.2	4.09	-1.36		G&L, v _{rot}
	51742.5722	-30.9 ± 1.6						
WD1420-244	51684.6506	25.0±2.7		22.7±1.8	0.67	-0.38		
	51687.5902	21.2±2.2						
WD1422+095	51739.5691	-0.4 ± 1.0		-0.5 ± 0.8	0.01	-0.03		polyn., G&L
	51742.5541	-0.6 ± 0.9						
WD1426-276	51730.6705	73.2±1.3		74.7±1.0	1.27	-0.58		
	51731.6164	76.2±1.3						
HE1429-0343	51739.5781	59.2±3.0		58.0±2.7	0.35	-0.26		polyn., G&L
	51742.5825	54.3 ± 5.4						r J y
HS1430+1339	52143.5108	23.3±2.3		18.9±1.8	4.14	-1.38		polyn., G&L
	52140.5360	13.9 ± 2.5						r <i>j j</i>
WD1425-811	52386.6998	30.8±1.1		32.8±0.8	2.23	-0.87		polyn., G&L
WD1425 011	52720.8732	34.0 ± 0.7		52.0±0.0	2.23	0.07		polym., Gul
WD1431+153	52136.5291	<u>11.9±2.0</u>		10.9±1.4	0.21	-0.19		polyn.
	52130.5291	11.9 ± 2.0 10.2 ± 1.7		10.7±1.4	0.21	0.19		Polyn.
HS1432+1441	52142.5121	74.7±1.3		73.2±1.0	1.23	-0.57		
113143271441	52142.5121 52137.5026	74.7 ± 1.3 71.8 ± 1.2		13.2±1.0	1.23	-0.37		
WD1434-223	51684.6615	-73.3 ± 4.5		-73.3±4.6	0.00	0.00		
WD1434-223 HE1441-0047	51684.6615			-73.3 ± 4.0 22.3 ±3.7	0.00			C&L v
пс1441-004/	51738.0008	27.1±5.5 18.4±4.9		22.3±3.1	0.80	-0.43		G&L, <i>v</i> _{rot}
1101447.0454				26107	1 40	0.65		malam C.P.I
HS1447+0454	52078.5930	-1.6 ± 0.7		-2.6 ± 0.7	1.48	-0.65		polyn., G&L
	52137.5456	-3.9 ± 0.8		106.0.00	0.07	0.00		
WD1448+077	51755.5806	-107.2 ± 0.9		-106.8 ± 0.8	0.27	-0.22		
	52078.5403	-106.1 ± 1.2		52.0.1.5	0.06	0.00		
WD1449+168	52393.7762	54.7±3.1		53.9±1.5	0.06	-0.09		
	52387.7490	53.6±1.6						
WD1451+006	51684.6722	1.8 ± 1.6		3.2±1.2	0.65	-0.38		
	51687.6004	4.3±1.5						
WD1457-086	51738.6775	22.3±2.1	10.0/ 15.0	20.4±1.3	0.62	-0.37		G&L, +CaK
	51741.5907	19.4±1.5	10.0/ 15.0					
WD1500-170	51703.6251	-8.1±2.9	30.0	-8.5 ± 2.0	0.02	-0.05		
	51706.5792	-8.8 ± 2.6	30.0					
WD1501+032	51947.8351	-17.2 ± 1.1		-16.5 ± 0.8	0.32	-0.24		
	51950.8464	-15.9 ± 0.9						
WD1503-093	51696.7399	1.0 ± 1.7		-0.3 ± 1.1	0.47	-0.31		G&L
	51701.7063	-1.1 ± 1.3						
WD1507+220	52387.7919	-51.4 ± 1.1		-52.0 ± 0.7	4.21	-0.62		
	52771.5979	-40.9 ± 4.5						
	52799.5451	-52.1 ± 1.7						
	53065.8615	-53.0 ± 0.9						
WD1507+021	52443.5669	34.9 ± 2.4		34.9±2.5	0.00	0.00		
WD1507-105	51696.7505	-17.9 ± 4.4		-16.0±1.1	0.12	-0.14		G&L
	51701.7202	-15.9 ± 0.9						
HE1511-0448	51696.7628	-32.9 ± 18.1	30.0	-82.6±1.4	89.86	-17.85	DD	G&L
	51701.7314	-71.3 ± 2.2	30.0					
	51701.7425	-73.5 ± 4.0	30.0					
	52108.5059	-105.1 ± 2.2	30.0					
	52078.6243	-66.7 ± 3.3	30.0					
WD1511+009	51947.8452	13.2±3.5		15.6±2.5	0.56	-0.34		
	51950.8559	18.2 ± 3.6						
WD1515-164	51703.6359	46.0±1.1		46.2±1.0	0.02	-0.06		
	51706.5904	46.4 ± 1.4			5.02	0.00		
HS1517+0814	52080.6468	46.5±2.2		45.2±1.3	0.25	-0.21		
		44.7 ± 1.4		10.211.0	0.25	0.21		
	3/10480/							
HE1518-0344	52116.4862 51730.6513	27.2±3.8		24.6±3.2	0.87	-0.46		

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Table B.1: RV measurements, continued.

				1			
object	HJD	RV	$\Delta\lambda$	\overline{RV}	χ^2	$\log p$	comments
5	-2400000	$\mathrm{km}\mathrm{s}^{-1}$	Å	$\rm kms^{-1}$,,,	01	
HE1518-0020	51739.6020	32.1±0.9		31.7±1.1	0.73	-0.40	polyn.
	51743.6499	27.9 ± 3.5					r y
HE1522-0410	51738.6884	29.9±2.2		27.1±1.9	5.29	-1.15	polyn., G&L
1111022 0110	51743.6697	34.6 ± 6.7			0.22	1110	
	51755.6030	18.0±3.6					
HS1527+0614	52080.6602	67.7±1.6		63.7±1.1	4.81	-1.55	
1151027 0011	52116.4978	61.4 ± 1.2		00112111		1.00	
WD1527+090	52112.5350	22.7±1.1		24.5±0.9	2.44	-0.93	
	52141.5256	26.2 ± 1.0					
WD1524-749	51739.6435	204.1±1.5		204.9±1.2	0.77	-0.17	
1101021 119	51743.6871	216.4 ± 12.6	30.0	201.921.2	0.77	0.17	
	51755.5938	205.8 ± 1.7	2010				
WD1531+184	52443.5796	31.9±1.6		31.9±1.7	0.00	0.00	
WD1531-022	52112.5272	43.7±1.6		43.8±1.2	0.00	-0.02	polyn., G&L, ²⁴
WD1551 022	52137.5846	43.9 ± 1.4		+J.0±1.2	0.00	0.02	polyn., G&L,
WD1532+033	52089.5361	$\frac{+3.9\pm1.4}{11.2\pm6.9}$	40.0	13.2±5.6	0.14	-0.15	
WD1552+055	52116.5083	16.8 ± 9.2	40.0	15.2±5.0	0.14	-0.15	
WD1537-152	51727.6270	-0.8 ± 1.6	-0.0	2.0±1.2	2.74	-1.01	
WD1557-152	51731.6538	-0.8 ± 1.0 4.5 ± 1.5		2.0±1.2	2.14	-1.01	
WD1539-035	52136.5635	4.5 ± 1.3 45.6±1.3		45.8±1.0	0.04	-0.07	polyn., G&L
WD1559-055	52141.5355	45.0 ± 1.3 46.1 ± 1.3		4J.0±1.0	0.04	-0.07	polyn., G&L
WD1543-366			40.0	07.0 + 2.0	4.02	-1.35	
WD1543-300	51731.6836	75.0 ± 6.0	40.0	87.2±3.8	4.03	-1.35	
WD1544 077	51739.6611	95.5±4.9	40.0	01.1.0.6	2.07	1 1 7	
WD1544-377	51739.6693	22.4 ± 0.5		21.1±0.6	3.27	-1.15	G&L, v _{rot}
WD1547-057	52771.7871	19.4±0.7		47.5.20	0.17	0.17	
WD1547+057	52088.5733	48.6±2.8		47.5±2.0	0.17	-0.17	
WD1547.015	52089.5602	46.4±2.8	40.0	01.4.20.7	0.15	0.16	
WD1547+015	52116.5185	-76.1 ± 25.0	40.0	-81.4 ± 22.7	0.15	-0.16	G&L
WD1540.140	52089.5473	-106.1±53.8	40.0	10 (. 1.0	0.00	0.02	
WD1548+149	51979.7720	18.5±1.7		18.6±1.2	0.00	-0.02	
NUD1550 100	52033.6489	18.7±1.4		10.1.1.5	0.00	0.00	
WD1550+183	52387.8695	9.2±3.2		12.1±1.5	0.60	-0.36	
	52862.5458	12.9±1.5		(0.0.1.1	0.01		
WD1555-089	51740.6666	69.6±1.0		69.9±1.1	0.24	-0.20	
	51743.6785	71.5±2.7			0.53	0.11	
WD1609+135	51701.7588	108.1±0.8		107.4±0.7	0.73	-0.41	polyn., G&L
	51705.7321	106.5±0.9					
WD1609+044	52089.5710	38.9±1.8		37.4±1.3	0.65	-0.38	
	52117.5209	36.1±1.6					
HS1609+1426	52088.5505	-18.3 ± 1.6		-15.9±1.1	1.71	-0.37	
	52088.5844	-14.2 ± 1.7					
	52136.5755	-14.8 ± 2.3					
WD1614+136	52116.5931	1.6 ± 0.8		1.5±0.8	0.03	-0.06	
	52117.5316	1.3±0.9					
WD1614+160	52443.6108	-23.1 ± 0.9		-23.3 ± 0.9	0.02	-0.05	
	52862.5546	-23.5 ± 1.2					
HS1614+1136	52443.6006	18.1±1.6		17.9±1.4	0.02	-0.05	
	52839.6581	17.5 ± 2.4					
WD1614-128	51701.7691	87.4±1.2		86.0±0.9	1.20	-0.56	
	51703.6054	84.7±1.1					
WD1615-154	51701.7757	9.7±1.2		9.0±1.1	0.34	-0.25	
	51703.5985	8.0±1.6					
HS1616+0247	52443.5912	10.4 ± 1.7		10.6±1.3	0.01	-0.04	
	52542.5008	10.8 ± 1.8					
WD1619+123	52490.6177	15.1±1.2		15.3±1.0	0.02	-0.05	
	52839.6684	15.4±1.3					
WD1620-391	52386.7099	43.7 ± 0.4		44.0±0.6	0.28	-0.23	
24			-				

²⁴ possibly composite

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Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta \lambda$	\overline{RV}	χ^2	$\log p$		comments
	-2400000	${\rm km}{\rm s}^{-1}$	Å	${\rm kms^{-1}}$				
	52771.8007	44.4 ± 0.4						
WD1625+093	51705.7430	66.0 ± 2.4		66.8±1.5	0.10	-0.13		polyn., G&L, v _{rot}
	51730.6808	67.3±1.8						
WD1636+057	51705.7553	78.2±1.5		78.3±1.0	0.00	-0.02		polyn., G&L
	51731.6634	78.3±1.0						
WD1640+113	52108.5450	15.5±2.0		14.2±1.2	0.31	-0.24		
	52116.5359	13.6±1.3		22.1.2.1	0.00	0.00		1 0.01
HS1641+1124	52116.6050	33.4±4.4		33.1±2.4	0.00	-0.02		polyn., G&L
1101646 1050	52117.5424	33.1±2.7		12 (+1.5	1.20	0.50		
HS1646+1059	52117.5830	10.7±1.8		12.6±1.5	1.26	-0.58		
HS1648+1300	52137.5955 52116.5561	15.1 ± 2.2 -26.3±1.3		-27.0±1.1	0.31	-0.24		
n31040+1300	52117.5730	-20.3 ± 1.3 -27.8 ± 1.4		-27.0 ± 1.1	0.51	-0.24		
WD1655+215	52521.5373	$\frac{-27.8\pm1.4}{46.6\pm0.8}$		46.1±0.7	0.28	-0.23		polyn., G&L
WD1055+215	52541.4905	45.7 ± 0.6		40.1±0.7	0.28	-0.23		poryn., O&L
HS1705+2228	52521.5239	-42.7 ± 0.9		-43.4±0.9	0.50	-0.32		
10170372220	52538.5146	-44.4 ± 1.2		+J.+±0.9	0.50	0.52		
WD1716+020	52387.8828	-19.3 ± 0.7		-18.8±0.7	0.34	-0.25		G&L
	52815.7186	-19.3 ± 0.7 -18.3 ± 0.7		10.0±0.7	0.34	0.25		Jul
WD1733-544	51730.7009	29.9±1.1		31.7±0.9	2.06	-0.82		polyn., G&L
,, D1/33 JTT	51731.6743	33.3 ± 1.0		51.7±0.7	2.00	0.02		Polyni, Oul
WD1736+052	51688.9114	52.6±1.4		51.4±1.0	4.05	-0.88		polyn., G&L
11211201002	51696.8023	45.1±2.5		51.121.0	1.00	0.00		polym, Call
	51730.6909	52.3±1.2						
WD1755+194	52443.6515	45.2±2.1		45.2±1.7	1.72	-0.37		
	52536.5186	51.2±4.2						
	52720.8940	42.2±2.9						
WD1802+213	52465.7191	51.8±3.1		56.1±2.2	2.02	-0.81		
	52482.7154	60.0 ± 3.0						
WD1821-131	51696.8167	-7.3 ± 2.6		-13.1±1.4	3.84	-1.30		G&L, <i>v</i> _{rot}
	51699.7714	-15.4 ± 1.5						
WD1824+040	51681.7166	35.0±1.3		19.5±0.4	5002.02	<-100	DD	polyn., G&L
	51682.8934	-17.1 ± 0.6						
	52033.8512	-15.7 ± 0.9						
	52078.7260	4.2 ± 0.6						
	52116.5739	18.7 ± 0.5						
	52117.5931	80.6±0.5						
	52139.5153	11.2±1.5						~ ~ ~
WD1826-045	52387.8877	-2.0 ± 0.8		-2.0 ± 1.1	0.00	0.00		G&L
WD1827-106	52387.9019	-38.8 ± 1.6		-38.4±1.3	0.06	-0.09		
UD1024 701	52815.7261	-37.9±2.1		02.2.0.0	0.40	0.21		
WD1834-781	51731.6991	93.0±0.9		92.3±0.8	0.48	-0.31		
WD1940+042	51738.7184	91.5±1.0		22.07	1 5 1	0.66		nolum C P-I
WD1840+042	52387.8932	1.1 ± 0.7		2.2±0.7	1.51	-0.66		polyn., G&L
WD1045.010	52815.7363	$\frac{3.4\pm0.8}{20.7\pm2.2}$		207.15	0.00	0.00		SD2 25
WD1845+019	52033.8574	-30.7 ± 2.3		-30.7 ± 1.5	0.00	-0.00		SB2, ²⁵
WD1944 002	52065.8166	-30.7 ± 1.9	20.0		2.05	1.04		
WD1844-223	51981.8792	14.8±2.5	30.0	11.4±2.1	2.85	-1.04		
WD1057 . 110	52033.8447	5.0 ± 3.5	30.0		2 77	0.00		
WD1857+119	51681.7265	-26.0 ± 3.1		-27.7 ± 1.4	3.77	-0.82		polyn., G&L
	51690.8904 51682.9007	-31.1 ± 1.8 -23.3 ± 2.4						
WD1911+135				17.4±1.0	0.04	-0.07		
vv U1911+133	51681.7336 51682.9090	16.6±3.1 17.5±0.9		1/.4±1.0	0.04	-0.07		
WD1914+094	51689.9170	17.5 ± 0.9 4.4 ± 4.0	30.0	3.5±2.9	0.49	-0.04		
xx 1 / 1 7 1 4 ± U 7 4	51009.91/0			5.5±2.9	0.49	-0.04		
	51690.9000	8.8 ± 16.1	30.0					

 25 H α emission from M dwarf/BD (physical?) companion

Table B.1: RV measurements, continued.

object	HJD	RV	Δλ	\overline{RV}	χ^2	log p		comments
001000	-2400000	$km s^{-1}$	Å	$km s^{-1}$	λ	105 P		comments
	52065.8244	1.0±4.5	30.0	KIII 5				
WD1914-598	52033.8749	69.3±1.2	50.0	70.1±0.9	0.34	-0.25		
WD1714 570	52065.8342	70.8 ± 1.1		70.1±0.7	0.54	0.25		
WD1918+110	51687.9081	75.9±1.8		74.8±1.3	0.36	-0.26		
WD19101110	51688.8802	73.9 ± 1.6		71.0±1.5	0.50	0.20		
WD1919+145	52426.9175	49.0±0.5		49.5±0.6	0.39	-0.28		G&L
WD1717+145	52765.9026	50.0 ± 0.4		49.5±0.0	0.57	0.20		GæL
WD1932-136	51687.9186	1.6±1.2		1.8±1.2	0.03	-0.07		
WD1)52 150	51688.8904	2.2 ± 2.1		1.0±1.2	0.05	0.07		
WD1943+163	52465.7391	31.5±3.6		33.0±1.1	0.11	-0.13		
WD1945+105	52482.7348	31.5 ± 5.0 33.1 ± 0.9		55.0±1.1	0.11	-0.13		
WD1948-389	52033.8900	15.5 ± 14.8	40.0	-14.2±7.2	3.08	-1.10		
WD1940-309	52065.8605	-23.3 ± 8.2	40.0	-14.2 ± 1.2	5.08	-1.10		
WD1950-432				20.2 + 7.5	0.20	-0.18		
WD1950-452	52033.8978	-32.0 ± 14.6	40.0 40.0	-39.3 ± 7.5	0.20	-0.18		
WD1952-206	52065.8671	-41.9±8.7	40.0	29.9.07	0.00	0.01		
WD1952-200	51731.7224	38.8±0.7		38.8±0.7	0.00	-0.01		
WD1052 594	51738.7046	38.8±0.9	20.0	2.0.5.1	0.40	0.00		
WD1952-584	52138.5001	-0.1 ± 6.3	30.0	3.0±5.1	0.40	-0.28		
NID 1052 011	52140.5756	8.9±8.7	30.0	52.2.1.1	0.11	0.10		
WD1953-011	51681.7530	51.9 ± 3.2		53.2±1.4	0.11	-0.13		G&L, ²⁶
	51682.9210	53.5±1.4						
WD1953-715	52387.8272	24.9 ± 1.1		24.9±1.0	0.01	-0.03		
	52388.7837	25.0±1.3						
WD1959+059	51705.8690	-9.9 ± 5.5		-6.5 ± 3.0	0.30	-0.24		polyn., G&L
	51731.7293	-5.1 ± 3.6						
WD2004-605	51738.7355	19.5 ± 5.2	40.0	17.4±5.0	0.95	-0.48		
	51743.7136	-2.6 ± 16.5	40.0					
WD2007-219	51738.7112	-21.2 ± 0.7		-20.3 ± 0.8	1.05	-0.51		polyn., G&L
	51761.7859	-19.1 ± 1.0						
WD2007-303	52387.8119	72.9±0.3		73.6±0.5	1.14	-0.54		G&L
	52765.9107	74.3±0.3						
WD2014-575	51738.7420	66.5±0.9		67.6±1.0	2.88	-1.05		
	51743.7253	72.0 ± 2.1						
WD2018-233	52033.9041	1.2 ± 1.7		1.4±1.1	0.02	-0.05		
	52117.6127	1.5 ± 1.1						
WD2020-425	51738.7493	67.6±6.5		-123.7±2.1	563.95	<-100	DD	SB2
	51761.7932	-146.6 ± 2.2						
WD2021-128	52033.9322	43.7±2.7		46.0±1.6	0.58	-0.35		
	52065.8521	47.1±1.8						
WD2029+183	52388.9019	-149.7 ± 1.3		-146.9±1.1	4.51	-1.47		polyn., G&L
	52491.7102	-143.7 ± 1.4						
WD2032+188	52521.5515	-23.1 ± 1.1		-24.0±1.1	1.11	-0.54		27
	52527.5155	-26.7 ± 2.1						
WD2039-202	52387.8173	-2.8 ± 0.4		-2.3±0.5	0.36	-0.26		G&L
	52812.9050	-1.9 ± 0.3						
WD2039-682	52387.8350	57.7±1.1		57.0±1.0	0.40	-0.28		polyn., G&L, v _{rot}
1122007 002	52414.9160	56.1±1.2		0,102110	01.0	0.20		porj, coo2, , 100
HS2046+0044	52521.6321	-5.9 ± 8.4		14.4±3.1	11.70	-2.54		
	52521.6406	5.8 ± 4.6		1	11110			
	52538.5098	30.1 ± 4.8						
WD2046-220	52033.9120	-15.1 ± 1.6		-14.6±1.1	0.09	-0.12		
11 D2070-220	52117.6210	-14.2 ± 1.3		17.0±1.1	0.09	0.12		
WD2051+095	51705.8880	$\frac{-14.2\pm1.3}{15.5\pm1.6}$		16.5±1.1	0.33	-0.25		
WD2031+093	51731.7382	15.3 ± 1.0 17.2 ± 1.2		10.J±1.1	0.55	-0.23		
WD2051-208				161.2 + 2.0	0.02	0.07		nolun Cler 28
WD2031-208	52140.6206	162.0 ± 4.4		161.3±2.9	0.03	-0.07		polyn., G&L, ²⁸

²⁶ possibly magnetic, variable line profile
 ²⁷ one spectrum not fitted -- poor quality
 ²⁸ magnetic

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Table B.1: RV measurements, continued.

					2		
object	HJD	RV	$\Delta \lambda$	\overline{RV}	χ^2	$\log p$	comments
	-2400000	km s ⁻¹	Å	$\rm kms^{-1}$			
1100056 0501	52142.5386	160.7±3.8		10 6 1 0	0.50		
HS2056+0721	52140.6095	42.7±2.8		40.6±1.8	0.52	-0.33	
NID 2056 022	52142.5612	39.1±2.3	10.0	0 1 10 7	0.10	0.12	
WD2056+033	52142.5492	-5.0 ± 14.5	40.0	-9.1 ± 10.7	0.10	-0.13	
1102050 0022	52140.6309	-13.9 ± 15.7	35.0/40.0	10.00	0.04	0.00	
HS2058+0823	52145.5785	-2.3 ± 6.0	30.0	-1.0 ± 3.8	0.04	-0.08	
WD2050 - 101	52141.5514	-0.2 ± 4.9	30.0	46.4.1.0	0.41	0.00	
WD2058+181	52465.7932	-47.0 ± 1.1	20.0	-46.4 ± 1.0	0.41	-0.09	
	52527.5379	-44.6 ± 14.7	30.0				
1102050 - 0200	52538.6254	-45.4 ± 1.4		74.22	1.00	0.50	
HS2059+0208	52521.6507	3.8 ± 3.2		7.4 ± 2.2	1.26	-0.58	
WD2050 - 100	52539.5339	10.2±2.8		7.5.1.5	0.(1	0.26	
WD2059+190	52539.5437	6.3 ± 1.8		7.5±1.5	0.61	-0.36	G&L
1102100 - 1724	52540.5599	9.4±2.3 45.7±3.7	20.0	44.0+2.5	2.26	0.51	
HS2108+1734	52465.7845		30.0	44.9±2.5	2.36	-0.51	
	52527.5498	16.0 ± 14.6	30.0				
WD0105 000	52861.6698	45.8±3.5	30.0	41 1 . 1 4	0.01	0.02	<u><u> </u></u>
WD2105-820	52423.8069	41.1±1.3		41.1±1.4	0.01	-0.03	G&L, $v_{\rm rot}$, ²⁹
WD2115 . 010	52772.8885	40.7±4.5		161.12	0.01	0.42	
WD2115+010	52145.5885	14.5±1.7		16.1±1.3	0.81	-0.43	
WD0115 5(0	52144.6099	17.5±1.6		4.2.0.0	1 7 4	0.72	1 0.01
WD2115-560	52387.8721	2.5 ± 1.2		4.2±0.9	1.74	-0.73	polyn., G&L
WD2120+054	52772.9009	5.7±1.1	20.0	4.0 . 5.5	0.01	0.10	
WD2120+054	52539.5538	-8.2 ± 7.7	30.0	-4.9 ± 5.5	0.21	-0.19	
WD0100 4(7	52540.5707	-1.7 ± 7.8	30.0	04.2 + 1.1	0.00	0.00	
WD2122-467	52423.8161	24.8 ± 2.1		24.3±1.1	0.06	-0.00	
	52479.7642	24.3±2.0 24.2±1.6					
	52482.7441 52531.5638	24.2 ± 1.0 23.5±4.0					
WD2124-224	51739.6787	27.3±5.5	40.0	35.8±3.4	2.22	-0.87	
WD2124-224	51761.8000	40.8 ± 4.2	40.0	55.0±5.4	2.22	-0.87	
HS2130+1215	52540.5904	$\frac{40.8\pm4.2}{6.3\pm6.2}$	30.0	2.1±5.3	0.95	-0.48	
пз2130+1213	52541.5500	-8.5 ± 0.2	30.0	2.1±3.3	0.95	-0.46	
HS2132+0941	52145.6098	-8.3 ± 9.8 -2.9 ± 1.1	30.0	-4.1±0.9	0.98	-0.49	nolun
п52152+0941	52145.0098	-2.9 ± 1.1 -5.4 ± 1.2		-4.1 ± 0.9	0.98	-0.49	polyn.
HE2133-1332	52172.5668	$\frac{-3.4\pm1.2}{7.6\pm0.9}$		9.3±0.7	2.53	-0.95	G&L
11E2135-1352	52142.5815	10.7 ± 0.8		9.5±0.7	2.33	-0.95	OæL
WD2134+218	52465.8060	$\frac{10.7 \pm 0.8}{26.3 \pm 0.8}$		27.0±0.8	0.79	-0.43	
WD2134+210	52527.6108	20.3 ± 0.8 28.4±1.2		27.0±0.8	0.79	-0.43	
WD2136+229	52465.8213	-48.4 ± 0.9		-47.4±0.9	1.01	-0.50	polyn., G&L
WD2130+229	52535.5780	-46.1 ± 1.1		-47.4±0.9	1.01	-0.50	poryn., O&L
HE2135-4055	51681.9070	67.6±0.8		66.8±0.7	0.67	-0.39	polyn., G&L, ³⁰
ПЕ2133-4033	52772.9085	67.0 ± 0.8 66.0 ± 0.8		00.8±0.7	0.07	-0.59	polyli., G&L,
WD2137-379	51685.9061	-7.9 ± 2.7		-12.4±1.6	2.33	-0.90	
WD2137-379	51686.9041	-14.7 ± 1.9		-12.4 ± 1.0	2.33	-0.90	
HS2138+0910	52145.6206	-14.7 ± 1.9 -25.0 ± 1.4		-24.2±1.0	0.28	-0.22	polyn., G&L
1132130+0910	52145.6206 52141.5817	-23.0 ± 1.4 -23.6 ± 1.1		-24.2±1.0	0.28	-0.22	poryn., O&L
WD2139+115	51701.8743	$\frac{-23.0\pm1.1}{19.3\pm1.3}$		18.7±1.2	0.33	-0.25	
WD2139+113	51704.9340	19.3 ± 1.3 17.3 ± 2.2		10./±1.2	0.35	-0.23	
HE2140-1825	52078.8893	$\frac{17.3\pm2.2}{6.3\pm1.1}$		6.6±0.8	0.05	-0.09	
пе2140-1823	52078.8893 52141.5928	6.3 ± 1.1 6.8 ± 0.8		0.0±0.8	0.05	-0.09	
WD2146-433	52069.9243	$\frac{0.8\pm0.8}{28.4\pm9.6}$	30.0	25.9±3.7	0.05	-0.08	G&L
WD2140-433	52138.5643	28.4 ± 9.6 25.5 ± 4.0	30.0 30.0	23.9±3.1	0.05	-0.08	Gal
HS2148+1631	52540.6005	$\frac{23.3\pm4.0}{3.2\pm1.4}$	50.0	5.0±1.2	1.99	-0.80	
1152140+1031	52541.5637	3.2 ± 1.4 7.6 ± 1.7		J.U±1.2	1.99	-0.00	
HE2148-3857	51685.9153	45.7 ± 3.4		46.5±2.6	0.06	-0.09	
1122170-3037	51005.7155	→ <i>J</i> .7 ± <i>J</i> . †		TU.J12.U	0.00	-0.02	I

²⁹ possibly magnetic or rapidly rotating
 ³⁰ bad model fit for temperature

Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta\lambda$	\overline{RV}	χ^2	$\log p$		comments
	-2400000	${\rm km}{\rm s}^{-1}$	Å	$\rm kms^{-1}$. –		
	51686.8938	47.4±3.9						
WD2149+021	52540.6630	28.3±0.4		28.2±0.5	0.02	-0.05		G&L
	52861.8031	28.1±0.3						
WD2150+021	52540.6126	57.7 ± 17.1	40.0	54.2±11.1	0.04	-0.08		
	52541.5843	51.6±14.6	40.0					
WD2152-045	52172.5390	22.0±10.3	30.0	12.1±1.4	2.05	-0.45		
	52540.6700	9.6±1.9						
	52813.9033	14.1±1.9		40.1.1.6	0.40	0.01		
WD2151-307	51739.6851	50.0±1.7		49.1±1.6	0.49	-0.31		
WD0150 540	51761.8089	46.4±3.3	40.0	28.0.2.4	5 12	1 1 1		
WD2152-548	51739.6912	-25.9 ± 4.7	40.0 40.0	-28.9 ± 3.4	5.13	-1.11		
	51743.7666	-43.0 ± 6.2	40.0					
WD2153-419	51761.8136	-14.9 ± 7.7		112+02	0.20	-0.23		C & I
WD2155-419	51696.8595 51699.7474	19.6±14.3 7.1±10.3	40.0 40.0	11.3±8.3	0.30	-0.23		G&L
WD2154-061	52172.5490	$\frac{7.1\pm10.3}{51.0\pm8.8}$	40.0	47.2±7.3	0.35	-0.26		
WD2134-001	52540.6858	31.0 ± 0.0 38.7±13.2	40.0	47.2±7.5	0.55	-0.20		
HE2155-3150	52078.8999	$\frac{38.7\pm13.2}{33.6\pm2.1}$	40.0	32.0±1.3	0.47	-0.31		<u> </u>
162155-5150	52138.5872	33.0 ± 2.1 31.1 ± 1.5		52.0±1.5	0.47	-0.31		
WD2157+161	52540.6224	-6.0 ± 1.6		-9.1±1.0	2.93	-0.64		
	52541.6021	-10.9 ± 1.7		2.1±1.0	2.75	0.04		
	52870.7390	-10.9 ± 1.7 -10.5 ± 1.5						
HE2159-1649	51885.5213	32.5±1.7		37.1±1.0	7.49	-1.63		
111112137 1047	51891.5256	45.7±3.5		57.1±1.0	7.47	1.05		
	52141.6240	38.3±1.2						
WD2159-414	51705.8995	-88.5±14.6	40.0	-72.1±6.2	0.89	-0.46		
	51708.8509	-68.5 ± 6.8	40.0	/2/12012	0.07	0110		
WD2200-136	51885.5317	159.7±1.5		75.4±1.1	2991.48	<-100	DD	SB2
	52540.7062	1.0 ± 1.7						
	52172.6033	127.6 ± 5.3						
	52540.6967	8.3 ± 2.4						
WD2159-754	51884.5341	141.8 ± 1.0		141.3±0.8	0.16	-0.16		G&L
	52142.6261	141.0 ± 0.8						
HE2203-0101	52540.6335	29.0 ± 1.1		26.7±1.0	4.27	-1.41		
	52141.6349	23.5 ± 1.4						
WD2204+070	51701.8636	37.2 ± 1.8		39.5±1.4	1.98	-0.43		
	51704.9233	40.3 ± 2.6						
	52142.6409	43.5±2.8						
WD2205-139	51885.5404	46.0±2.2		49.1±1.2	4.04	-0.59		
	52540.7279	46.9±2.1						
	52172.6137	48.3 ± 5.3						
WD0007 + 1 40	52541.6140	52.8±1.7		267,12	1 70	074		C %-I
WD2207+142	51690.9132	24.9 ± 1.5		26.7±1.3	1.78	-0.74		G&L
HE2209-1444	51696.8388 51885.5488	29.6±2.0 81.6±1.7		72.0±1.8	171.53	-38.47	DD	SB2 CPI
пс2209-1444	51885.5488 52172.6360	81.6 ± 1.7 -23.4±5.8		/2.0±1.8	1/1.53	-38.4/	עע	SB2, G&L
HS2210+2323	52541.6239	$\frac{-23.4\pm3.8}{50.1\pm2.1}$		50.2±1.6	0.01	-0.03		
19221072923	52542.5192	50.1 ± 2.1 50.4 ± 2.3		JU.2±1.0	0.01	-0.03		
WD2211-495	51739.6977	$\frac{50.4\pm2.5}{25.8\pm0.5}$	30.0	26.0±0.7	0.22	-0.20		G&L
MD2211=49J	51743.7728	25.8 ± 0.3 26.9±1.4	30.0	20.0±0.7	0.22	-0.20		JAL
HS2216+1551	52542.5294	-57.9 ± 3.6	50.0	23.5±2.3	450.49	-99.25	DD	SB2
19221071331	52543.6272	-37.9 ± 3.0 71.9±2.8		23.3£2.3	730.47	19.43	עע	502
HE2218-2706	52162.5351	-37.9 ± 1.5		-34.4 ± 0.8	3.62	-1.24		
112210-2700	52102.5551	-37.9 ± 1.3 -33.2 ± 0.7		-J+.4±0.0	5.02	-1.24		
HE2220-0633	52541.6768	$\frac{-33.2\pm0.7}{46.0\pm0.9}$		45.7±1.0	0.24	-0.21		
		40.0 ± 0.9 44.6 ± 1.9		73.711.0	0.24	0.21		
0000	57144 6780							
HS2220+2146B	52144.6289 52542.5809	37.7±2.3		37.6±1.7	0.00	-0.01		

Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta \lambda$	\overline{RV}	χ^2	$\log p$	comments
	-2400000	$\rm kms^{-1}$	Å	$\rm kms^{-1}$			
HS2220+2146A	52542.5753	25.9±3.4		28.3±2.2	0.51	-0.32	
10000	52543.6397	30.0±2.8		20 5 2 4	0.4.5	0.02	
WD2220+133	51884.5480	30.8 ± 4.5		30.5±2.4	0.15	-0.03	
	52172.6482	40.0 ± 19.3					
150001 1(00	52883.7377	30.2±2.8		45.0 - 1.2	0.25	0.25	
HE2221-1630	52434.9024	44.7 ± 1.8		45.8±1.3	0.35	-0.25	polyn., G&L
HS2225+2158	52144.6391 52542.6019	46.8 ± 1.8 17.4 ±2.3		20.7±1.7	2.16	-0.85	
152225+2156	52542.0019	17.4 ± 2.3 23.9±2.3		20.7±1.7	2.10	-0.85	
WD2226+061	51696.8863	<u>25.9±2.5</u> <u>35.3±3.1</u>		36.2±1.1	0.05	-0.09	
VD2220+001	51701.8340	36.3 ± 1.0		J0.2±1.1	0.05	-0.09	
WD2226-449	52146.6723	55.8±0.5		55.9±0.5	0.23	-0.05	G&L
WD2220-449	52140.6725	55.6 ± 0.5		55.9±0.5	0.25	-0.05	GæL
	52423.9030	56.3 ± 0.5					
IS2229+2335	52542.6112	-14.6 ± 1.5		-11.9±1.1	3.12	-1.11	
13222972333	52543.6562	-9.4 ± 1.4		-11.9±1.1	5.12	-1.11	
HE2230-1230	52079.9102	13.3 ± 1.8		14.3±1.4	0.35	-0.26	
122230-1230	52144.6621	15.5 ± 1.8 15.5 ± 2.0		14.5±1.4	0.55	-0.20	
HE2231-2647	52162.5437	-17.0 ± 1.6		-16.6±1.1	0.30	-0.06	
.11/2/201 /04/	52162.5437	-17.0 ± 1.0 -17.7 ± 2.1		10.0±1.1	0.50	0.00	
	52396.9065	-17.7 ± 2.1 -15.8 ± 1.5					
HS2233+0008	52542.6199	$\frac{-13.8\pm1.3}{41.7\pm0.9}$		42.1±0.8	0.13	-0.15	
192299 10000	52543.6649	42.5 ± 1.0		72.110.0	0.15	0.15	
WD2235+082	51884.5591	39.1±4.7	40.0	27.7±2.4	4.74	-0.72	G&L
VD22331002	52153.5777	26.0 ± 5.0	40.0	27.7±2.4	7./7	0.72	GæL
	52153.5896	23.2 ± 4.0	40.0				
	52172.6689	21.9 ± 5.9	40.0				
HE2238-0433	52172.7058	62.5 ± 14.4	10.0	45.7±3.9	0.87	-0.19	
1112230 0133	52542.6322	43.4 ± 7.1		15.7±5.9	0.07	0.19	
	52804.9072	44.8 ± 4.8					
HS2240+1234B	52541.7294	37.0±1.5		37.4±1.0	0.04	-0.08	
152210112312	52542.6506	37.6 ± 1.2		57.121.0	0.01	0.00	
HS2240+1234A	52541.7164	40.1±1.7		38.8±1.5	0.80	-0.43	
	52542.6596	36.6±2.3		00102110	0.00	0110	
WD2240-045	51696.8981	-70.6±5.3	40.0	-75.1±3.9	0.90	-0.46	G&L
	51701.8527	-80.3 ± 5.7	40.0	/0112010	0170	0110	
WD2240-017	51705.9082	32.1±1.6		31.2±1.5	0.59	-0.05	
	51736.6808	28.6 ± 4.8					
	51736.6885	31.7±7.2					
	52856.7489	28.7±3.6					
WD2241-325	52437.9168	2.3±4.7	30.0	1.7±3.8	0.03	-0.06	
	52479.7742	0.7 ± 6.1	30.0				
HS2244+2103	52543.6836	28.8±3.1		28.6±2.1	0.00	-0.02	
	52544.5849	28.4±2.6					
HS2244+0305	52541.7407	23.6±24.9	40.0	-31.7±18.6	6.54	-1.98	G&L
	52542.6710	-101.4±27.9	40.0				
HE2246-0658	52172.7133	67.3±13.1		49.9±3.0	1.48	-0.32	
	52541.7486	48.4±3.1					
	52803.9317	59.7±13.4					
WD2248-504	52423.9109	12.4±2.2		14.5±1.9	1.89	-0.77	
	52416.9152	20.3±3.7					
HE2251-6218	52153.5505	23.0±1.8		24.3±1.4	0.62	-0.37	
	52154.5156	26.0±2.0					
VD2253-081	51737.7520	1.8±1.6		1.4±1.3	4.40	-0.95	polyn., G&L
	51742.7655	20.1±7.3					
	52823.9128	-0.7 ± 2.0					
VD2253+054	51761.8331	35.1±2.9		36.4±2.0	1.70	-0.20	polyn., G&L, v _{rot}
	51762.6777	42.5±8.2		i i			

Table B.1: RV measurements, continued.

					2		
object	HJD	RV	$\Delta \lambda$	\overline{RV}	χ^2	$\log p$	comments
	-2400000	km s ⁻¹	Å	$\mathrm{km}\mathrm{s}^{-1}$			
	52856.7626	40.3 ± 3.6					
	52862.7332	31.9±4.3					
WD2254+126	51705.9157	22.2±2.3		23.0±1.3	0.13	-0.03	G&L
	51737.7311	23.0 ± 2.1					
	51740.7086	23.8±2.2					
HS2259+1419	52543.6936	-28.2 ± 1.1		-28.0 ± 0.9	0.03	-0.07	G&L
	52542.6901	-27.8 ± 1.2					
WD2303+017	52172.7344	13.5±16.8	40.0	41.6±3.0	3.30	-0.46	
	52531.5554	38.2 ± 9.4	40.0				
	52856.7721	41.2 ± 3.3	40.0				
	52862.7228	57.2 ± 9.4	40.0				
WD2303+242	52542.6998	13.1±1.8		10.6±1.4	1.91	-0.78	G&L
	52543.7029	8.2 ± 1.8					
WD2306+130	52172.7456	33.4±1.2		33.7±0.8	0.05	-0.08	G&L
	52542.7097	33.9 ± 0.8					
WD2306+124	51762.6499	36.4±2.6		39.1±1.3	0.78	-0.42	
	51802.5972	39.9±1.3					
WD2308+050	52542.7299	15.9±9.1	30.0	26.6±3.7	0.97	-0.49	
	52543.7333	28.7 ± 4.0	30.0	_0.0_0.0	0.27	···/	
WD2309+105	51762.6581	-16.9 ± 7.6	40.0	-16.8±2.4	0.00	-0.00	G&L
	51802.6075	-16.8 ± 2.4	40.0	10.0±2.7	0.00	0.00	
WD2311-260	51708.8620	17.1±21.1	40.0	47.2±5.5	1.28	-0.59	G&L
WD2511 200	51737.7421	49.4 ± 5.6	40.0	+7.2±3.3	1.20	0.57	GœL
WD2312-356	52154.5539	17.5 ± 1.8	40.0	20.5±0.6	1.99	-0.13	
WD2512-550	52163.6750	17.5 ± 1.3 19.5 ± 1.7		20.3±0.0	1.99	-0.15	
	52531.5852	19.3 ± 1.7 21.2±0.8					
	52165.5311	21.2 ± 0.8 20.6 ± 0.9					
	52172.7562	20.0 ± 0.9 21.2±1.1					
WD2314+064	52543.7427	27.5 ± 1.2		27.2±1.2	0.10	-0.13	
WD2314+004		27.5 ± 1.2 26.4±2.1		27.2±1.2	0.10	-0.13	
HE2315-0511	52544.6053		20.0	27.2 + 5.6	1.05	1.05	
HE2313-0311	51736.6975	72.3 ± 32.2	30.0	27.2±5.6	4.85	-1.05	
	51736.7055	49.9±11.1	30.0				
	51742.7954	17.4±6.6	30.0	10.0.1.1	0.05		<u> </u>
WD2318+126	52543.7630	-11.9 ± 1.6		-12.3 ± 1.1	0.05	-0.09	G&L
	52544.6237	-12.6 ± 1.4				0.10	
WD2318-226	51762.6681	48.1±15.3	30.0	43.2±3.7	0.06	-0.10	
	51802.6741	42.9±3.7	30.0				
WD2321-549	52212.7310	-13.0 ± 33.5	40.0	7.9 ± 6.1	0.24	-0.20	G&L
	52531.5735	8.6 ± 6.2	40.0				
WD2322+206	52543.7737	5.9 ± 1.1		5.0±0.9	0.52	-0.33	polyn., G&L
	52544.6333	4.2±1.0					
WD2322-181	51738.7684	24.7±1.5		24.6±1.1	0.00	-0.02	
	51741.7477	24.6±1.4					
WD2324+060	52543.8142	-6.3 ± 0.9		-7.2 ± 0.7	0.75	-0.41	
	52544.6724	-8.0 ± 0.8					
WD2326+049	51762.6852	43.9±0.7	10.0/15.0	41.6±0.7	6.38	-1.94	polyn., G&L, +CaK
	51804.6758	39.5±0.6	10.0/15.0				· · · · · ·
WD2328+107	52544.6821	44.8±1.2		44.3±0.9	0.17	-0.17	
	52547.6266	43.8 ± 1.1				•	
WD2329-332	51740.7261	35.0±2.5		36.0±1.9	0.20	-0.18	
, _, _, _	51743.8226	37.2 ± 2.7					
	52544.6920	-77.7±2.2		-55.7±1.7	122.70	-27.79	DD
WD2330-212	52547.5962	-27.3 ± 2.5		55.1 ±1.1	122.10	21.17	
WD2330-212			40.0	21.9±1.9	0.36	-0.26	G&L
		23 4+2 6	40.0				
	51739.7628	23.4 ± 2.6 20.4+2.6	40.0	21.9±1.9	0.50	0.20	Gal
WD2331-475	51739.7628 51743.7885	20.4 ± 2.6	40.0 40.0				
WD2330-212 WD2331-475 WD2333-165	51739.7628			69.0±0.6	0.24	-0.20	polyn.

Table B.1: RV measurements, continued.

object	HJD	RV	$\Delta \lambda$	\overline{RV}	χ^2	$\log p$		comments
	-2400000	$\rm km~s^{-1}$	Å	$\rm kms^{-1}$				
	51803.6089	48.6±1.8						
HE2334–1355	52544.7020	20.2±2.0		19.0±1.5	0.36	-0.26		
	52547.6063	17.9 ± 2.1						
WD2336-187	51738.7794	11.6±3.1		-3.6±2.8	70.03	-16.23	DD	SB2, polyn., G&L
	51741.7681	-66.1 ± 6.3						
WD2336+063	52544.7122	38.9±0.8		39.0±0.8	0.01	-0.04		
	52547.6169	39.1±1.0						
MCT2343-1740	51802.6292	51.7±15.0		27.8±3.6	1.57	-0.68		
	51803.5741	26.4±3.6						
HE2345-4810	52162.6064	54.0±1.9		43.1±1.8	67.25	-15.62	DD	
	52466.9007	10.0 ± 3.5						
MCT2345-3940	51802.6167	1.6±2.3		4.6±1.4	1.48	-0.65		
	51803.5613	6.2 ± 1.6						
WD2347+128	51802.6883	-2.2 ± 2.4		0.7±1.6	1.33	-0.60		polyn., G&L
	51804.6838	2.8 ± 2.0						I - J -
WD2347-192	51802.6409	32.7±4.2		31.1±2.7	0.14	-0.15		
	51761.8427	30.0 ± 3.5						
HE2347-4608	52532.6073	48.2±1.2		48.7±1.0	0.17	-0.16		
1111111111111111	52542.8092	49.3±1.3		1017 = 110	0117	0110		
WD2348-244	51762.7212	67.2±1.5		65.8±1.1	0.76	-0.42		polyn., G&L, v _{rot}
	51802.6514	64.6 ± 1.4		00.0111	0.70	0.12		
MCT2349-3627	51802.7047	23.1±36.0	40.0	16.9±18.6	0.02	-0.06		
	51804.6325	14.6 ± 21.7	40.0	100/21010	0.02	0.00		
WD2349-283	51762.7350	36.2 ± 1.0		35.2±0.8	0.76	-0.42		
1102317 203	51802.6635	34.3 ± 0.9		<i>33.2</i> ±0.0	0.70	0.12		
WD2350-248	51761.8516	62.0±2.6		62.7±2.1	0.09	-0.12		
1122330 210	51803.5874	63.7 ± 3.3		02.7 ±2.1	0.07	0.12		
WD2350-083	52530.8368	56.1±1.4		58.3±1.1	2.57	-0.96		
WD2550 005	52466.9202	60.7 ± 1.5		50.5±1.1	2.57	0.70		
WD2351-368	51739.7706	-7.7 ± 1.6		-7.0±1.3	0.24	-0.21		G&L, v _{rot}
	51743.7962	-6.1 ± 1.8		7.0±1.0	0.2 r	5.21		
MCT2352-1249	51802.7167	-1.8 ± 44.8	40.0	-2.1±14.3	0.11	-0.02		
	51804.6436	-18.5 ± 40.4	40.0	2.1 ± 17.3	0.11	0.02		
	52822.9232	0.6 ± 16.3	40.0					
WD2353+026	52466.8883	2.2±3.2	40.0	0.3±2.8	0.77	-0.42		G&L
	52530.6840	-5.2 ± 5.5	40.0	0.5±2.0	0.77	0.12		
WD2354-151	51761.8220	18.3±2.6	30.0	18.8±2.2	0.06	-0.09		
102337 131	51803.5982	19.8 ± 3.8	30.0	10.0±2.2	0.00	0.07		
HE2356-4513	52163.6309	55.5±1.4	50.0	53.3±0.7	1.66	-0.19		
1122330 4313	52466.8676	52.8 ± 1.2		55.5±0.1	1.00	0.17		
	52466.8740	52.8 ± 1.2 51.6 ± 3.7						
	52500.9107	51.0 ± 3.7 52.6 ± 0.9						
	52500.7107	52.0±0.7						

Appendix C: Fundamental parameters

Table C.2 lists the fundamental parameters surface temperature and gravity adopted for our targets. Most of these values are taken from Koester et al. (2009) who determined temperatures and gravities of sample stars by fitting the Balmer lines of the SPY spectra. The table lists effective temperatures and gravities, with the 3D atmosphere corrections of Tremblay et al. (2013a) for DAs with a convective envelope. White dwarf masses were estimated from interpolation in the white dwarf cooling tracks of Panei et al. (2007), Renedo et al. (2010) and Althaus et al. (2005).

Koester et al. (2009) did not derive parameters for some DAs of the sample for various reasons, including a few cases of objects overlooked. For some other cases we decided to replace the values as discussed below. Notes and references have been included in Column 5 of Table C.2 and explained in Table C.1, whenever values different from those given by Koester et al. (2009) were included.

Double-lined binaries: Light of both components is seen in the spectra of double-lined binaries. A deconvolution of both components was attempted using FITSB2 and the same DA model grid as used by Koester et al. (2009). An interative procedure was carried out starting with a simple by-eye estimate of the RVs in the spectra, followed by a fit of temperatures and gravities of both components. These were then used for improved estimates of RVs from the cores of H α and H β as described in 3.2. The latter two steps were repeated until the iteration came to a standstill. The relative contributions of both components were determined using mass-radius relations from the cooling tracks above. The fundamental parameters listed in Tables C.2 and B.1 correspond to the primary (i.e. the brighter component).

The fundamental parameters listed for the primaries are tentative and should be replaced by results from full orbital solutions once these are available. They were derived for the purpose of assessing the status of the primary as low-mass He core or C/O core white dwarf.

Magnetic white dwarfs: Magnetic white dwarfs included in this study have fields strong enough to induce a detectable Zeeman splitting in the cores of the Balmer lines, but the lines do not show distortion beyond that. A detailed analysis of the field structure was beyond the scope of this article and we adopted a crude approximation to derive fundamental parameters. Model spectra from standard model atmospheres were co-added after applying shifts. The π component was assumed unshifted and a symmetric shift was applied to the two σ components. Geometric effects were only taken into account by adjusting the relative strength of the π and σ components. This approach is oversimplistic and ignores subtle effects of radiation transfer and field geometry, but our main aim was to get still useful estimates of fundamental parameters, even if of somewhat limited accuracy.

Grids were constructed for a range of splits. For a given magnetic white dwarf best fit values of temperature and gravity were derived for each grid. Values corresponding to the Zeeman split yielding the smallest value of χ^2 were adopted. While we deem the accuracy of the fundamental parameters sufficient to assess the nature (high or low mass) of the white dwarfs, investigators with a specific interest in these stars are advised to carry out a more sophisticated analysis.

Table C.1: References and explanations for Table C.2

ambiguous	Koester et al. (2009) reported a cool and a hot solution. The solution yielding the smallest χ^2 is included.
BL02 GBD12, phot	Bergeron & Liebert (2002) Giammichele et al. (2012), T_{eff} and $\log g$ derived from photometric spectral energy distribution and trigonometric parallax.
GBR11	Gianninas et al. (2011), fit of Balmer lines
KNV05	Koester et al. (2005a), helium-rich DABZ
KV12	Kawka & Vennes (2012), fit of Balmer lines
LBSS93	Liebert et al. (1993), binary of magnetic and non-magnetic WD
magnetic	magnetic DAs, Zeeman splitting of the line cores. See text for details on the fit proce- dure.
new	white dwarf not included in the Koester et al. (2009) analysis. Analysed using the same model grid.
new/NLTE	hot DAO white dwarfs, analysed using the grid of NLTE model atmospheres de-
primary	scribed in Napiwotzki (1999). Parameters of the primary from a simul- taneous fit of primary and secondary. See
WB94	text. Wesemael et al. (1994), fit of primary and secondary parameters using lines and spec-
HNLE97	tral energy distribution Heber et al. (1997a): genuine DAB, helium line profile variations
K09	Koester et al. (2009): visual double
FK97	Finley & Koester (1997): visual double
J98	Jordan et al. (1998): visual double

Cool white dwarfs: It has been known for some time that the accuracy of surface gravity measurements from Balmer lines alone decreases considerably for white dwarfs at temperatures below $\approx 6500 \text{ K}$ (see, e.g., Fig. 2 of Kawka & Vennes 2012). Higher accuracy can be achieved, if parallax measurements are available. We replaced spectroscopy-only values by the parallax based photometric values of Giammichele et al. (2012), if available. Spectroscopic-only fundamental parameters were not included when assessing the number of single and binary white dwarfs in the mass ranges in Table 3 and the discussion (Sect. 5). This is indicated by the lack of a mass entry in Table C.2. All white dwarfs are included in the numbers for the full sample.

object	Gaia DR2 ID	T _{eff} K	$\log g$ cm s ⁻¹	M M_{\odot}	References/remarks
WD2359-434	4994877094997259264	8253	8.01	0.604	magnetic
WD2359-324	2313582750735435776	22478	7.74	0.514	mugnette
WD0000-186	2414099622710507904	15264	7.85	0.535	
HS0002+1635	2772855182928578560	25878	7.86	0.568	
WD0005-163	2416481783371550976	11860	7.60	0.435	ambiguous
WD0011+000	2545505281002947200	9423	7.77	0.492	unitiguous
WD0013-241	2336189396997071616	18529	7.90	0.568	
WD0016-258	2323704339384503040	10874	7.80	0.507	
WD0016-220	2361264618662161920	13622	7.75	0.496	
WD0017+061	2747611250653031040	28149	7.75	0.526	
WD0018-339	2315346161227820032	20626	7.84	0.548	
WD0024-556	4920057871348614272	10112	8.46	0.876	
WD0027-636	4900807999725863296	58129	7.77	0.603	
WD0028-474	4978793541987799040	20453	7.83	0.54	primary
WD0029-181	2364272573237917952	13966	7.81	0.519	r S
HE0031-5525	4921390960477978112	11839	7.71	0.477	
MCT0031-3107	2317553529604662016	40698	7.78	0.568	
HE0032-2744	2343355051714253056	23947	7.81	0.543	
WD0032-317	2317319612801004416	36965	7.19	0.422	
WD0032-175	2364319061964016512	9602	7.82	0.509	
WD0032-177	2364311331022888704	17210	7.82	0.526	
WD0033+016	2544456862306151680	10642	8.55	0.936	
MCT0033-3440	5005361213245945856	15890	8.18	0.717	
WD0037-006	2542961560852591744	13922	7.78	0.505	primary
HE0043-0318	2529237113117694336	14086	7.73	0.49	1 5
WD0047-524	4922382445088509312	18811	7.73	0.503	
HS0047+1903	2788992130973584640	17135	7.82	0.529	
WD0048-544	4921090656364298368	17870	7.98	0.605	
WD0048+202	2789398778477164672	20363	7.89	0.569	
HE0049-0940	2473843786029439104	13823	7.69	0.477	
WD0050-332	5006486048001153792	35570	7.87	0.596	
HS0051+1145	2774977549607430528	20963	7.93	0.589	magnetic
WD0052-147	2372473658671416960	25950	8.22	0.756	-
WD0053-117	2472557872820632320	6543	6.97		
WD0058-044	2525337076653338240	17209	8.02	0.627	magnetic
WD0101+048	2552121179905893888	8399	7.77	0.488	
WD0102-185	2357946464368276224	21969	7.64	0.484	
WD0102-142	2468060664104501376	19945	7.86	0.553	
HE0103-3253	5027351170924256512	13698	7.82	0.519	
WD0103-278	5034051079388141696	14410	7.79	0.511	
MCT0105-1634	2359382697136585728	28212	7.83	0.563	
WD0106-358	5014009353235167744	29198	7.86	0.576	
HE0106-3253	5026963661794939520	17234	8.00	0.616	
WD0107-192	2354670057156360576	14304	7.79	0.51	
WD0108+143	2591091789004351104	9193	8.26	0.752	
WD0110-139	2456122476087944960	24692	7.99	0.627	
MCT0110-1617	2358739727648116608	34621	7.75	0.542	
MCT0111-3806	4988781711771040128	71306	7.19	0.497	
WD0112-195	2354521726165844096	36364	7.66	0.518	
WD0114-605	4716787269774839936	24692	7.75	0.521	
WD0114-034	2483669331171909120	19460	7.77	0.516	
WD0124-257	5037128131397095168	23042	7.79	0.53	
WD0126+101	2585189473147457408	8551	7.37	0.338	
WD0127-050	2480731779699826176	16718	7.78	0.514	
WD0128-387	5009694457291031168	13404	8.41	0.854	primary, WB94
WD0129-205	5043926824108837376	19950	7.88	0.566	
HS0129+1041	2585306399337120128	16738	7.92	0.573	
HS0130+0156	2558916466707621504	41083	7.74	0.556	
HE0130-2721	5035978214033613824	21880	7.90	0.578	

Table C.2: Gaia DR2 IDs, effective temperatures, gravities and masses for the SPY DA white dwarfs.

Table C.2: Gaia DR2 IDs, effective te	

object	Gaia DR2 ID	$T_{\rm eff}$	$\log g$	М	References/remarks
LIE0101 - 0140	055070(00000000000000000000000000000000	K	$cm s^{-1}$	M _☉	
HE0131+0149	2558736322894795648	15228	7.75	0.498	
WD0133-116	2457759374023232768	12556	7.79	0.506	nrimary
WD0135-052 MCT0136-2010	2480523216087975040 5139880551029408768	6914 8893	7.19 8.43	0.857	primary primary
MCT0130-2010 MCT0138-4014	4960499042889705344	21698	8.43 7.90	0.837	primary
WD0137-291	5023333658515040128	21098	7.90	0.576	
WD0137-231 WD0138-236	5039292447021548416	36897	7.63	0.513	
WD0138-230 WD0140-392	4962193390308361728	21811	7.92	0.515	
WD0140 352 WD0143+216	98092934167683072	9195	8.07	0.638	
WD0145-221	5135466183642594304	11933	7.92	0.566	
WD0145-257	5037875455706805504	25915	7.86	0.568	
HS0145+1737	91690164426711040	18125	7.89	0.566	
HE0145-0610	2467788122659245696	8616	7.77	0.489	
HS0146+1847	95297185335797120	11500	(8.00)	0.102	KNV05, logg assumed
HE0150+0045	2510891108771852416	12993	7.68	0.471	ni (v ob, logg ussuniou
WD0151+017	2511623211717232640	12811	7.78	0.504	
HE0152-5009	4940662032058418944	13373	7.63	0.454	
WD0155+069	2567944320460595840	22007	7.67	0.492	
WD0158-227	5134814168951616000	67081	7.46	0.541	
HE0201-0513	2491046298280035584	24626	7.64	0.49	
HS0200+2449	105299786211260160	23281	7.86	0.563	
WD0203-138	5149462073310745344	48529	8.00	0.675	
WD0204-233	5122528470836031232	13425	7.74	0.491	
HE0204-3821	4964509614631078272	14038	7.79	0.512	
HE0204-4213	4957085334163504512	22575	7.90	0.58	
WD0204-306	5020119579868434944	5640	(8.00)		KV12, logg assumed
WD0205-365	4968128554074903808	61240	7.74	0.601	
WD0205-304	5020146620982523008	17209	7.76	0.508	
HE0205-2945	5020319141229055360	11769	7.54	0.413	primary
WD0208-263	5118133276183878400	33720	7.76	0.547	
HS0209+0832	2521867808229983744	37070	7.92	0.621	NEW, HNLE97
HE0210-2012	5125057897336633344	17612	7.80	0.521	
HE0211-2824	5116584064300345984	14469	7.95	0.585	
WD0212-231	5123291871208145792	26827	7.94	0.608	
HS0213+1145	72992389375581440	17518	7.79	0.517	
WD0216+143	75783121685634816	26637	7.79	0.54	
HE0219-4049	4951125156507440384	15373	7.89	0.558	
HE0221-2642	5118624311204821504	32008	7.72	0.525	
WD0220+222	99915890086770176	15630	7.89	0.558	
HE0221-0535	2488754366292015744	24747	7.95	0.609	
HE0222-2336	5120365044270095232	31816	7.87	0.588	
HE0222–2630 HS0223+1211	5118634309888681600	23198	7.91	0.586	
HE0225-1912	74336778563550464	14721	7.30	0.35	numony
HE0225+0010	5131327656235273088 2501224305619721984	20488 13778	7.84 7.81	0.545 0.515	primary
WD0226-329	5063539946887524864	22294	7.81	0.515	
WD0220-329 WD0227+050	2516322146457318144	19341	7.76	0.507	
WD0229-481	4939012317940174464	59082	7.71	0.513	
WD0229-481 WD0230-144	5146358426863612160	59082 5477	8.13	0.662	GBD12, phot
WD0230-144 WD0231-054	2488960249844340352	17306	8.13 8.45	0.878	OBD12, pilot
HS0237+1034	2488900249844540552 24968088000745216	17300	8.43 8.10	0.878	primary
WD0239+1094	25405350031335296	(6926)	(7.39)	0.07	magnetic
HS0241+1411	32880762085326336	13932	7.76	0.498	mugnetie
WD0242-174	5132580858972702976	20663	7.85	0.498	
WD0242-174 WD0243+155	33554517899463040	17611	7.96	0.596	
WD0243-026	2495751967528809216	6770	8.18	0.698	GBD12, phot
HE0245-0008	2498564582697028864	18813	7.98	0.608	GDD12, pilot
HE0245-0008	4740913887782857216	15949	7.83	0.529	
WD0250-026	5187346124402986752	15315	7.80	0.515	
	10.0.0121102/00/02	10010	,.00	5.515	

object	Gaia DR2 ID	$T_{\rm eff}$	log g	М	References/remarks
object	Gala DK2 ID	K reft	$cm s^{-1}$	M_{\odot}	Kererences/remarks
WD0250-007	2497895053130247040	7968	7.63	0.43	
WD0252-350	5049628376014475648	16934	7.37	0.379	
WD0255-705	4645960583300470656	10485	7.82	0.512	
HE0255-1100	5160899536860481664	20827	7.84	0.545	
HE0256-1802	5152564272353619072	26212	7.76	0.524	
HE0257-2104	5079634765595460736	17362	7.69	0.486	
WD0257+080	8578256576520320	6410	7.30		magnetic
HE0300-2313	5078074837769743744	22369	8.39	0.847	
WD0302+027	1068931460633216	35270	7.77	0.554	
HE0303-2041	5103714555575829888	9959	7.87	0.53	
HE0305-1145	5159714332045197568	26822	7.81	0.55	
WD0307+149	31047257726638592	21413	7.91	0.581	
HS0307+0746	13611477211053824	10084	7.81	0.507	
WD0310-688	4646535078125821568	16329	7.91	0.568	
HE0308-2305	5075443981321647744	23565	8.54	0.94	
WD0308+188	59077760488621184	18450	7.72	0.5	
HS0309+1001	15255418893384320	18786	7.72	0.5	
WD0315-332	5054287144220982144	49926	7.47	0.5	
HS0315+0858	14141304376849280	18783 12720	7.87	0.557	
HE0315-0118	3262674487682440448	9638	7.74 7.83	0.491 0.514	primary
HE0317-2120 WD0317+196	5100053078775660160 59370127502651264	17735	7.83	0.514	
WD0318-021	3262366899304566272	15125	7.70	0.314	
WD0320-539	4734298439852277376	32588	7.77	0.485	
HE0320–1917	5104856776357892480	13248	7.17	0.311	
HE0324-2234	5098930339964725248	16905	7.84	0.539	
HE0324-0646	5168944835239726080	15740	7.87	0.546	
HE0324-1942	5101782335688104960	23811	8.27	0.78	primary
HE0325-4033	4849811172961336960	16737	7.70	0.486	printary
HS0325+2142	61497407625478272	14027	7.93	0.572	
WD0326-273	5060587895604134400	9158	7.44	0.364	
WD0328+008	3264857636738890624	34476	7.92	0.614	
HE0330-4736	4833967725801565696	13437	7.95	0.585	
HS0329+1121	13469296613857152	17376	7.86	0.545	
WD0330-009	3263351202729621376	34044	7.74	0.538	
HS0331+2240	67620897117741440	21452	7.78	0.523	
HE0333-2201	5088334621288740992	16046	8.19	0.722	
HE0336-0741	3243842361760113408	15854	7.77	0.507	
WD0336+040	3274761620869767168	8696	7.57	0.409	
HS0337+0939	12254267546754176	12843	7.88	0.547	ambiguous
HE0338-3025	5055975238166788352	9911	7.87	0.53	
WD0339-035	3249740657527506048	12758	7.86	0.535	ambiguous
WD0341+021	3270918350990573184	22153	7.27	0.378	
WD0343-007	3251501727261970432	62994	7.68	0.585	
WD0344+073	3277341526122556160	10453	7.50	0.389	
HS0344+0944	3302674308386137856	15321	8.23	0.741	
HE0344-1207	5114767980330242688	11497	7.91	0.559	
HS0345+1324	37976345646670464	25064	8.18	0.731	
WD0346-011	3251244858154433536	40455	9.31	1.293	
HS0346+0755	3277482882085624192 4835585377987834752	16796 19951	7.72 8.07	$0.494 \\ 0.658$	
HE0348-4445 HE0348-2404		19951	8.07 7.94	0.658	
HE0348-2404 HE0349-2537	5083966055431334912 5083478078426926976	20974	7.94 7.91	0.582	
WD0352+049	3083478078426926976 3273625554777257472	20974 37253	7.91 8.61	0.578	
WD0352+049 WD0352+052	3273645105468368000	10095	7.71	0.922	
WD0352+032 WD0352+018	3258317294901181440	22107	7.80	0.47	
WD0352+018 WD0352+096	3302846072717868416	14465	8.18	0.331	
HE0358-5127	4828757999190736128	23376	7.93	0.593	
WD0357+081	3301319572621418368	5478	8.04	0.609	GBD12, phot
	2001017072021110000	21/0	0.01	0.007	, phot

Table C.2: Gaia DR2 IDs, effective temperatures, gravities and masses, continued.

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Table C 2. Cais DD2 IDa offections ton		a a sa di sa a a al
Table C.2: Gaia DR2 IDs, effective ter	nderatures, gravities and masses.	continuea.
	iperatures, gravities and inasses,	• • • • • • • • • • • • • • •

object	Gaia DR2 ID	T _{eff} K	$\log g$ cm s ⁻¹	$M m M_{\odot}$	References/remarks
IS0400+1451	39305036729495936	14623	8.25	0.754	
IS0401+1454	39124751182907520	12903	7.88	0.535	ambiguous
IE0403-4129	4842194473663089920	22702	7.94	0.597	
IE0404-1852	5095932968188685696	19218	7.67	0.483	
VD0406+169	45980377978968064	16049	8.24	0.748	
VD0407+179	46896958359881728	14421	7.77	0.504	
VD0408-041	3251748915515143296	15414	7.86	0.541	
IE0409-5154	4780544792270137088	26315	7.83	0.556	
HE0410-1137	3189613692364776576	12934	7.73	0.485	primary
VD0410+117	3304090857318319232	21074	7.84	0.549	
HS0412+0632	3297249936488848384	13694	7.78	0.507	
HE0414-4039	4841115341656167552	20941	7.93	0.592	
VD0416-550	4778802753534553472	30547	7.12	0.379	
HE0416-3852	4844370755067765504	19324	7.96	0.598	
HE0416-1034	3191249387709577088	24845	7.92	0.592	
IE0417–3033	4884691594508544128	19103	7.85	0.546	
HE0418-5326	4779427928974390272	27090	7.87	0.577	
IE0418-1021	3191269144559159936	23385	8.29	0.789	
VD0421+162	3313606340183243136	19616	8.03	0.634	
HE0423-2822	4892048018790150656	10966	7.85	0.525	
IE0423-2822 IS0424+0141	3279793505770723584	44174	7.68	0.525	
IE0425-2015	4899868157803497984	19801	8.12	0.683	
VD0425+168	3313714023603261568	24000	8.04	0.649	
4E0426 - 1011		18386	8.04 7.85	0.548	
	3179499250541535744				
VD0426+106	3305972018634634880	10009	8.13 7.99	0.674	
HE0426-0455	3202808828330265088	14129		0.604	
VD0431+126	3306722607119077120	21374	7.97	0.609	
IE0436–1633	3171373722173234048	14092	7.96	0.588	
VD0437+152	3309687027907272576	18711	7.25	0.356	
VD0440-038	3201709827802584576	68468	8.42	0.914	
VD0446-789	4622856957782901504	23627	7.69	0.501	
IE0452-3429	4873109308958466432	14825	7.81	0.519	
IE0452-3444	4873054711334208256	21206	7.84	0.548	
VD0453-295	4876689387538123008	16360	7.44	0.399	primary, WB94
HE0455-5315	4782942513595999872	24432	7.55	0.467	
VD0455-282	4880286371109059712	54386	7.68	0.567	
HE0456-2347	2960529070328892928	23645	7.79	0.534	
IS0503+0154	3229005792373924224	54563	7.54	0.526	
HE0507-1855	2975647836248304256	20421	8.27	0.775	
IS0507+0434B	3238868171156736768	11663	7.89	0.545	J98; WD0507+045A
IS0507+0434A	3238868098140387840	20838	7.90	0.574	J98; WD0507+045B
HE0508-2343	2959967254246803328	16811	7.74	0.5	
VD0509-007	3215427579684548864	31910	7.29	0.429	
VD0510-418	4812859061053900928	50490	7.68	0.557	
VD0511+079	3242153305741855744	6158	7.18		
HE0516-1804	2981590730954538112	13287	7.73	0.486	
VD0518-105	3014049448078210304	32008	8.82	1.099	
HE0532-5605	4766810380210581632	11381	8.23	0.737	
VD0548+000	3218753701142724992	44684	7.82	0.594	
VD0549+158	3348071631670500736	32959	7.73	0.531	
VD0556+172	3350123251647482624	18825	8.09	0.67	
VD0558+165	3348917053032143616	16807	8.18	0.717	
VD0603-483	5554202096021588992	34731	7.84	0.581	
VD0612+177	3370342445848382080	25624	7.81	0.548	
VD0621-376	5575007845317435648	57806	7.27	0.475	
	3117320802840630400	6443	7.20		
VIJU028-UZU	5117520002010050100			0.040	
VD0628-020 VD0630-050	3103530586268279936	42451	834	$() \times 4^{\prime}$	
VD0628-020 VD0630-050 VD0642-285	3103530586268279936 2918665577420228480	42451 9104	8.34 7.54	0.842 0.397	

Table C.2: Gaia	DR2 IDs, effective tempera	atures, gravities and masses,	continued.

object	Gaia DR2 ID	T _{eff} K	$\log g$ cm s ⁻¹	M M_{\odot}	References/remarks
WD0659-063	3052844272764398208	6046	6.95	TAT [©]	
WD0710+216	3367112974037883904	10167	7.73	0.479	
WD0715-703	5267418883330985856	44915	7.67	0.541	
WD0721-276	5612710511362093184	36520	7.70	0.53	
WD0721 270 WD0732-427	5536077746353130240	14995	8.00	0.611	
WD0752-676	5273943488410008832	5735	8.23	0.726	GBD12, phot
WD0752 070 WD0810-728	5220896587855584384	30598	7.84	0.573	ODD12, pilot
HS0820+2503	679177201586401280	33367	7.66	0.573	
WD0830-535	5321056462156468480	30050	7.76	0.515	
WD0838+035	3080056219172355840	38342	7.72	0.54	
WD0839-327	5639391810273308416	9174	7.56	0.34	
		25852	7.64	0.403	
WD0839+231	665392383790872192		7.85		
WD0852+192	660409908193185024	15130		0.536	
WD0858+160	610478649930041856	16064	7.77	0.51	
WD0859-039	5762406957886626816	23731	7.79	0.533	
WD0908+171	607984785759304192	17640	7.83	0.534	
WD0911-076	5744058376561655168	18175	7.85	0.547	
WD0916+064	585877867532382592	43048	7.37	0.482	FILOS
PG0922+162B	630770819920096768	25783	9.04	1.2	FK97
PG0922+162A	630770819920096640	23537	8.23	0.754	FK97
WD0922+183	632366829767058816	24532	8.16	0.717	
WD0928-713	5219215228420645248	8401	7.84	0.514	
HS0926+0828	588078329602228992	12250	7.83	0.519	ambiguous
HS0929+0839	588063421770438400	15707	7.77	0.509	
HS0931+0712	3852811476713249536	36719	7.16	0.412	
HS0933+0028	3840288524603932800	32219	8.10	0.698	
HS0937+0130	3846451454781376512	19717	8.31	0.8	
WD0937-103	5740410334419524864	17562	8.50	0.913	
WD0939-153	5685624040829463552	13900	7.77	0.503	
HS0940+1129	612988182140954240	15176	7.84	0.531	ambiguous
HS0943+1401	614643325098055680	16863	8.28	0.773	
HS0944+1913	627412945768300800	17444	7.88	0.559	
WD0945+245	643183348419998336	14500	8.5	0.909	primary, LBSS93
HS0949+0935	3878937457832171776	18357	7.69	0.49	
HS0949+0823	3877952432852336128	14755	7.81	0.518	
WD0950+077	3853660510143027200	15623	7.89	0.558	
WD0951-155	5686109578292348032	17973	7.83	0.534	
WD0954+134	614972658894818688	16462	7.68	0.479	
WD0955+247	642685200933153408	8456	7.75	0.482	
WD0956+045	3849176633005242624	18228	7.78	0.516	
WD0956+020	3834721387994870784	16495	7.81	0.521	
PG0959-085	3770623807170338304	101256	6.86	0.525	NEW/NLTE
WD1000-001	3833194887898568320	20253	7.80	0.529	
WD1003-023	3829366074878263168	20614	7.89	0.569	
HS1003+0726	3874412413432647680	9436	7.76	0.486	
WD1010+043	3860744010725801856	28617	7.90	0.594	
HE1012-0049	3830680854561582464	23204	8.07	0.667	
HS1013+0321	3859871342090899328	11781	7.83	0.521	
WD1013-010	3830623164560911872	8080	7.32	0.32	
WD1015-216	5666295485406677632	30937	7.89	0.593	
WD1015+076	3875365174618907264	27375	7.73	0.519	
WD1015+161	3888723386196630784	19948	7.92	0.585	
WD1017-138	3753200224361795968	31798	7.84	0.575	
WD1017+125	3883615188318129536	21386	7.88	0.565	
WD1017+125 WD1019+129	3883746133280920448	18412	7.88	0.562	
WD1019+129 WD1020-207	5667957225433304192	19920	7.93	0.585	
WD1020=207 WD1022+050	3860381618565361024	19920	7.95	0.368	
WD1022+030 WD1023+009	3831358664825312384	37817	7.65	0.508	
WD1025+009 WD1026+023	3855631797052747136	12653	7.87	0.519	
WD1020+023	3033031797032747130	12033	1.01	0.339	

Table C.2: Gaia DR2 IDs, effective tem	peratures, gravities and masses, continue	ed.
	peratures, gravines and masses, commu	

$\begin{array}{c c c c c c c c c c c c c c c c c c c $	$\begin{array}{c} M_{\odot} \\ 0.561 \\ 0.516 \\ 0.395 \\ 0.496 \\ 0.778 \\ 0.539 \\ 0.515 \\ 0.501 \\ 0.523 \\ 0.59 \\ 1.004 \\ 0.379 \\ 0.451 \\ 0.681 \\ 0.503 \\ 0.37 \end{array}$	
WD1031+0633862040300575181184213177.76WD1036+0853868927607051816320229247.32HS1043+02583809362934711715712139237.75WD1049-1583557394009663078912200378.28WD1053-5505353122722363361920146217.86WD1053-2905453248339973753216106697.83WD1053-0923759722119317000448226207.69HS1053+08443865978987449159168165567.81WD1056-3845393763111644515968279747.90WD1058-1293564376149017654272238928.65HS1102+09343866880552624195584169617.37WD1102-183355284526133995520080767.68HS1102+00323804239558419007744129598.13WD1105-0483788194488314248832159957.75HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	$\begin{array}{c} 0.516\\ 0.395\\ 0.496\\ 0.778\\ 0.539\\ 0.515\\ 0.501\\ 0.523\\ 0.59\\ 1.004\\ 0.379\\ 0.451\\ 0.681\\ 0.503 \end{array}$	
WD1036+0853868927607051816320229247.32HS1043+02583809362934711715712139237.75WD1049-1583557394009663078912200378.28WD1053-5505353122722363361920146217.86WD1053-2905453248339973753216106697.83WD1053-0923759722119317000448226207.69HS1053+08443865978987449159168165567.81WD1056-3845393763111644515968279747.90WD1058-1293564376149017654272238928.65HS1102+09343866880552624195584169617.37WD1102-183355284526133995520080767.68HS1102+00323804239558419007744129598.13WD1105-0483788194488314248832159957.75HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	$\begin{array}{c} 0.395\\ 0.496\\ 0.778\\ 0.539\\ 0.515\\ 0.501\\ 0.523\\ 0.59\\ 1.004\\ 0.379\\ 0.451\\ 0.681\\ 0.503 \end{array}$	
$\begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$	$\begin{array}{c} 0.496\\ 0.778\\ 0.539\\ 0.515\\ 0.501\\ 0.523\\ 0.59\\ 1.004\\ 0.379\\ 0.451\\ 0.681\\ 0.503 \end{array}$	
WD1049-1583557394009663078912200378.28WD1053-5505353122722363361920146217.86WD1053-2905453248339973753216106697.83WD1053-0923759722119317000448226207.69HS1053+08443865978987449159168165567.81WD1056-3845393763111644515968279747.90WD1058-1293564376149017654272238928.65HS1102+09343866880552624195584169617.37WD1102-183355284526133995520080767.68HS1102+00323804239558419007744129598.13WD1105-0483788194488314248832159957.75HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	$\begin{array}{c} 0.778\\ 0.539\\ 0.515\\ 0.501\\ 0.523\\ 0.59\\ 1.004\\ 0.379\\ 0.451\\ 0.681\\ 0.503 \end{array}$	
WD1053-5505353122722363361920146217.86WD1053-2905453248339973753216106697.83WD1053-0923759722119317000448226207.69HS1053+08443865978987449159168165567.81WD1056-3845393763111644515968279747.90WD1058-1293564376149017654272238928.65HS1102+09343866880552624195584169617.37WD102-183355284526133995520080767.68HS1102+00323804239558419007744129598.13WD1105-0483788194488314248832159957.75HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	$\begin{array}{c} 0.539\\ 0.515\\ 0.501\\ 0.523\\ 0.59\\ 1.004\\ 0.379\\ 0.451\\ 0.681\\ 0.503\\ \end{array}$	
WD1053-2905453248339973753216106697.83WD1053-0923759722119317000448226207.69HS1053+08443865978987449159168165567.81WD1056-3845393763111644515968279747.90WD1058-1293564376149017654272238928.65HS1102+09343866880552624195584169617.37WD102-183355284526133995520080767.68HS1102+00323804239558419007744129598.13WD1105-0483788194488314248832159957.75HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	$\begin{array}{c} 0.515\\ 0.501\\ 0.523\\ 0.59\\ 1.004\\ 0.379\\ 0.451\\ 0.681\\ 0.503\\ \end{array}$	
WD1053-0923759722119317000448226207.69HS1053+08443865978987449159168165567.81WD1056-3845393763111644515968279747.90WD1058-1293564376149017654272238928.65HS1102+09343866880552624195584169617.37WD102-183355284526133995520080767.68HS1102+00323804239558419007744129598.13WD1105-0483788194488314248832159957.75HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	$\begin{array}{c} 0.501 \\ 0.523 \\ 0.59 \\ 1.004 \\ 0.379 \\ 0.451 \\ 0.681 \\ 0.503 \end{array}$	
WD1056-3845393763111644515968279747.90WD1058-1293564376149017654272238928.65HS1102+09343866880552624195584169617.37WD1102-183355284526133995520080767.68HS1102+00323804239558419007744129598.13WD1105-0483788194488314248832159957.75HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	0.59 1.004 0.379 0.451 0.681 0.503	
WD1058-1293564376149017654272238928.65HS1102+09343866880552624195584169617.37WD1102-183355284526133995520080767.68HS1102+00323804239558419007744129598.13WD1105-0483788194488314248832159957.75HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	1.004 0.379 0.451 0.681 0.503	
HS1102+09343866880552624195584169617.37WD1102-183355284526133995520080767.68HS1102+00323804239558419007744129598.13WD1105-0483788194488314248832159957.75HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	0.379 0.451 0.681 0.503	
WD1102-183355284526133995520080767.68HS1102+00323804239558419007744129598.13WD1105-0483788194488314248832159957.75HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	0.451 0.681 0.503	
HS1102+00323804239558419007744129598.13WD1105-0483788194488314248832159957.75HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	0.681 0.503	
WD1105-0483788194488314248832159957.75HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	0.503	
HE1106-09423758930363570138880725056.47HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12		
HS1115+03213811876594386673408142677.71WD1115+1663970767638191849984220908.12	0.37	
WD1115+166 3970767638191849984 22090 8.12		NEW/NLTE
	0.483	
WD1116+026 3810933247769901696 12354 7.90	0.69	primary, BL02
	0.557	
HE1117-0222 3790471336376946304 14709 7.98	0.599	
WD1121+216 3978879594463069312 7434 8.19	0.705	GBD12, phot
WD1122-324 5402827451143222912 21671 7.86	0.556	
WD1123+189 3977128961497893760 58126 7.50	0.524	
HE1124+0144 3798659326454564224 16246 7.74	0.5	
WD1124-293 3482983495102507904 9353 7.83	0.514	
WD1124-018 3796545519645331584 23942 7.63	0.486	
WD1125-025 3787451081014802304 31755 8.16	0.729	
WD1125+175 3973707423046985984 61213 7.49	0.531	
WD1126-2223541237717085787008120067.88WD1129+0713910382871911470848145997.83	0.545 0.526	
WD1129+0713910382871911470848145997.83WD1129+1553966519331420622080177398.03	0.520	
WD1129+135 5900319331420022080 17739 8.05 WD1130-125 3586028453547223552 14436 8.32	0.052	
HS1136+1359 3918029283792258304 23921 7.83	0.795	
HS1136+0326 3800633813114930688 14087 7.90	0.55	
WD1141+077 3910122047137575424 62493 7.55	0.551	
WD1144-246 3491591640356263424 30500 7.16	0.39	
HS1144+1517 3924401920043360896 15385 7.77	0.508	
	0.545	
WD1147+255 4005438916307756928 9863 7.78	0.497	
WD1149+057 3897445571422443904 11108 7.85	0.527	
WD1150-153 3571559292842744960 12369 7.93	0.569	
HE1152-1244 3574739561506431104 13467 7.75	0.494	
WD1152-287 3480134832273157760 20620 7.63	0.476	
HS1153+1416 3923263135234800768 15553 7.79	0.512	
WD1155-243 3491050989871968768 14011 7.88	0.549	
WD1159-098 3575770010060921728 9232 8.27	0.756	
WD1201-001 3698872156539379968 19853 8.29	0.789	
WD1201-049 3597350571454888448 57260 7.62	0.556	GBR11
WD1202-232 3489719481290397696 8618 7.80	0.499	
WD1204-322 3466326581136347520 21263 8.00	0.623	
WD1204-136 3570694595665791232 10988 7.97	0.584	
HS1204+0159 3891718417216600448 24756 7.75	0.521	
WD1207-157 3569231970322760448 16885 7.78 WD1210+140 2020848710770658880 22127 (02	0.512	
WD1210+140 3920848710779658880 32127 6.92 WD1214+022 3701200326205270528 6205 6.84	0.334	
WD1214+032 3701290326205270528 6295 6.84 HE1215+0227 3701048502366477824 50601 7.50	0 555	
HE1215+0227 3701048502366477824 59691 7.59	0.555	
WD1216+0363701701509194344576144047.77WD1218-1983514997902152549632350137.91	0.504 0.611	
WD1218-198 5514997902152549052 55015 7.91 WD1220-292 3474544434120772736 17702 7.89	0.563	

Table C.2: Gaia	DR2 IDs, effective tempera	atures, gravities and masses,	continued.

object	Gaia DR2 ID	T _{eff} K	$\log g$ cm s ⁻¹	$M m M_{\odot}$	References/remarks
HE1225+0038	3696778892558087552	9340	7.83	0.512	
WD1229-012	3695495693769418112	19540	7.50	0.433	
WD1230-308	3470463802872604032	22764	8.28	0.784	
WD1231-141	3528008496258850560	17217	7.92	0.578	
HE1233-0519	3679712857186869504	15854	8.34	0.812	magnetic
WD1233-164	3523347735187987072	24892	8.21	0.745	-
WD1236-495	6127333286605955072	11444	8.52	0.917	
WD1237-028	3682835848166848896	9885	8.15	0.683	
WD1241+235	3956176053739681664	26982	7.77	0.533	
WD1241-010	3683519503881169920	23459	7.38	0.414	
HS1243+0132	3702195464793095936	21644	7.82	0.539	
WD1244-125	3528847870307147136	14011	7.90	0.557	
HE1247-1130	3529574716212596736	28110	7.84	0.565	
EC12489-2750	3495397496775173248	61045	7.63	0.567	
HS1249+0426	3705386281897262848	11539	7.85	0.528	
WD1249+160	3931446491043126784	25792	7.21	0.379	
WD1249+182	3940955205038857728	19911	7.73	0.504	
HE1252-0202	3682458814461982592	15934	7.81	0.52	
WD1254+223	3944400490365194368	39537	7.59	0.51	
WD1257+047	3705070756419217408	21759	7.95	0.6	
WD1257+032	3692337037379978112	17579	7.81	0.526	
WD1257+037	3704392873140270336	5616	8.19	0.7	GBD12, phot
HE1258+0123	3690323316193465344	11387	7.77	0.497	
WD1300-098	3626022634955198592	15327	8.14	0.691	
HS1305+0029	3690709554012428416	14725	7.85	0.534	
WD1305-017	3685650597933742592	48200	7.83	0.603	NEW/NLTE
HE1307-0059	3685854179383579136	18191	7.91	0.572	
HS1308+1646	3936999437080327040	10732	7.99	0.598	
WD1308-301	6182607385393358848	14422	7.90	0.559	
HE1310-0337	3636072278607729920	18943	7.83	0.535	
WD1310-305	6182345731690327808	20353	7.82	0.536	
EC13123-2523	6192859060011793536	75463	7.68	0.612	
WD1314-153	3607725941130742528	16152	7.72 7.85	0.492 0.54	
WD1314-067 HE1315-1105	3628421666247974016 3623233040812235904	16832 9047	7.83	0.513	
WD1323–514	6070021243006871040	19357	7.83	0.513	
HE1325-0854	3629976620502866944	17021	7.81	0.523	
HE1326-0041	3638786388700921472	18671	7.84	0.542	
WD1326-236	6194788080147917824	14029	7.91	0.563	
WD1327-083	3630035787972473600	14699	7.79	0.512	
HE1328-0535	3631829778632099328	36420	7.87	0.597	
WD1328-152	3604813197389660288	61253	7.72	0.593	
WD1330+036	3712812452150011648	17408	7.83	0.534	
WD1332-229	6195269769319451904	20264	7.86	0.555	
WD1334+039	-	4971	7.94	0.55	GBD12, phot
HS1334+0701	3718352444565698432	16891	7.27	0.353	, F
WD1334-160	3603920565746668032	18653	8.32	0.8	
WD1334-678	5850533227210203520	8761	7.67	0.451	
HE1335-0332	3634151534873010176	20188	8.47	0.896	
HS1338+0807	3724583445679765632	24440	7.65	0.493	
HE1340-0530	3632418223511334016	32936	7.91	0.606	
WD1342-237	6191268135405788544	11061	7.88	0.542	
WD1344+106	3725570772761744384	7059	8.09	0.644	GBD12, phot
WD1348-273	6177238676273826304	9787	7.78	0.495	· 1
WD1349+144	3728966476985207936	19917	7.86	0.553	primary
WD1350-090	3618657732410663808	9261	7.94	0.565	magnetic
	6275184065428686464	9447	7.83	0.516	-
WD1356-233	0273104003420000404	2117	1100	0.00 - 0	
WD1356-233 WD1401-147	6301064404482150912	11955	7.94	0.573	

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Table C.2: Gaia DR2 IDs, effect	ive temperatures,	gravities and ma	sses, continued.

object	Gaia DR2 ID	$T_{ m eff}$ K	$\log g$ cm s ⁻¹	$M \over { m M}_{\odot}$	References/remarks
WD1410+168	1233014608793947776	21323	7.76	0.515	
HS1410+0809	3674476639217656576	16217	8.37	0.83	
WD1411+135	1227001444126009728	18562	8.11	0.677	
WD1412-109	6304590503913422464	26226	7.81	0.549	
HE1413+0021	3653928308787745792	14544	8.11	0.673	
HE1414-0848	3638957019161984640	11133	7.84	0.522	primary
WD1418-088	6329136310728635776	8024	7.75	0.478	1 5
WD1420-244	6272562623549966208	20917	8.16	0.71	
WD1422+095	1176717792385803136	12905	7.84	0.528	
WD1426-276	6223132497775520512	18087	7.66	0.479	
HE1429-0343	3642258577702062720	11320	7.85	0.527	
HS1430+1339	1179764607826002688	9962	8.05	0.627	
WD1425-811	5772718006135360128	12305	7.83	0.521	
WD1431+153	1228266814506156928	14003	7.88	0.549	
HS1432+1441	1227992486355023616	16204	7.75	0.501	
WD1434-223	6278550873112595968	27690	7.37	0.431	
HE1441-0047	3650552739370519680	15775	8.03	0.626	
HS1447+0454	1158347014670132864	13991	7.82	0.519	
WD1448+077	1161215296909017728	14921	7.69	0.477	
WD1449+168	1188119762325721600	22346	7.79	0.526	
WD1451+006	3651184550535258496	25483	7.89	0.582	
WD1457-086	6332172027974304512	21448	7.92	0.584	
WD1500-170	6305900675097580800	31757	7.93	0.611	
WD1501+032	1154004081179409920	14741	7.93	0.576	
WD1503-093	6319913126159509888	13111	7.94	0.578	
WD1507+220	1261751715280478848	19872	7.75	0.509	
WD1507+021	4420242631507777920	20222	7.80	0.525	
WD1507-105	6318882711964895872	10031	7.40	0.356	
HE1511-0448	6335184655474717312	50899	7.45	0.497	
WD1511+009	4419865155422033280	28041	7.82	0.557	
WD1515-164	6259147585259050496	14248	7.97	0.593	
HS1517+0814	1163912467652160896	14494	7.76	0.501	
HE1518-0344	4413820521529120640	28493	7.81	0.552	
HE1518-0020	4415725940820061824	15392	7.82	0.523	
HE1522-0410	4401558183740868480	10320	7.86	0.531	
HS1527+0614	4429106481934491136	14925	7.77	0.505	
WD1527+090	1165354855109711232	21197	7.85	0.551	
WD1524-749	5792402116129561984	23091	7.74	0.515	
WD1531+184	1209640499120458752	13910	7.76	0.5	
WD1531-022	4403768373911022080	19234	8.35	0.824	
WD1532+033	4427107020039299968	61907	7.76	0.608	
WD1537-152	6265082680310200448	16954	7.94	0.586	
WD1539-035	4402583302239225600	9826	7.98	0.587	
WD1543-366	6009760034351291904	42701	8.97	1.176	
WD1544-377	6009537829925128064	10525	7.83	0.517	
WD1547+057	4426435871273922560	24355	8.36	0.831	
WD1547+015	4423116892346484480	76588	7.50	0.57	
WD1548+149	1192764133804981376	21452	7.86	0.557	
WD1550+183	1202826348825240832	14860	8.25	0.753	
WD1555-089	4347700805681797120	14531	7.94	0.582	
WD1609+135	4458207634145130368	9227	8.29	0.77	
WD1609+044	4437271867601913472	29593	7.79	0.548	
HS1609+1426	4464512882357505280	14387	7.82	0.522	
WD1614+136	4463466804419970304	22015	7.21	0.362	
WD1614+160	4465105351622152704	17961	7.82	0.528	
HS1614+1136	4454017257893306496	14137	7.98	0.599	
WD1614-128	4330093466990008448	16293	7.75	0.502	
WD1615-154	4328293291578459392	29465	8.03	0.656	
HS1616+0247	4436059415517432064	18468	7.96	0.597	

Table C.2: Gaia DR	2 IDs, effective temperatures	, gravities and masse	s, continued.

object	Gaia DR2 ID	$T_{\rm eff}$	log g	М	References/remarks
·		Κ	${ m cms^{-1}}$	${\rm M}_{\odot}$	references/refinances
WD1619+123	4460086458999242368	16853	7.68	0.483	
WD1620-391	6018034958869558912	24677	7.93	0.596	
WD1625+093	4452521234885949184	6410	7.40		
WD1636+057	4435778215414219520	8442	8.18	0.7	
WD1640+113	4447202622266019072	19718	7.85	0.551	
HS1641+1124	4447022061837071744	12323	7.87	0.537	
HS1646+1059	4447685097411960064	19890	7.78	0.52	
HS1648+1300	4449098970582483712	18693	7.79	0.519	
WD1655+215	4565048312887877888	9173	7.76	0.488	
HS1705+2228	4568179481487112832	15702	7.75	0.5	
WD1716+020	4387171623850187648	13787	7.64	0.458	
WD1733-544	5921433963191695872	6187	7.18		
WD1736+052	4485626636646013696	8830	7.80	0.501	
WD1755+194	4551645369227445888	24439	7.80	0.54	
WD1802+213	4576304838064664064	16787	7.64	0.47	
WD1821-131	4152557420406043264	6505	8.75		GBR11
WD1824+040	4284122782775063552	14787	7.46	0.398	
WD1826-045	4257461275049675008	9035	7.72	0.47	
WD1827-106	4154963942133386880	13726	7.56	0.428	ambiguous
WD1834-781	6364918198670588928	17723	7.77	0.513	8
WD1840+042	4280632829779587072	8766	7.86	0.523	
WD1845+019	4279269469712040832	29941	7.92	0.602	primary
WD1844-223	4078868662206175744	32443	7.99	0.64	r y
WD1857+119	4313658585693385984	9821	7.74	0.483	
WD1911+135	4320094439580536320	14004	7.86	0.539	
WD1914+094	4309015794737134080	32525	7.85	0.579	
WD1914-598	6446197877766956800	19756	7.84	0.543	
WD1918+110	4309653752003973760	19268	7.81	0.529	
WD1919+145	4319908862597055232	15252	8.01	0.616	
WD1932-136	4183272552601606400	16931	7.73	0.497	
WD1943+163	1820678800523761152	19763	7.79	0.523	
WD1948-389	6690659513515872000	37199	7.75	0.55	
WD1940-309 WD1950-432	6685284241684914688	40835	7.60	0.515	
WD1950-452 WD1952-206	6865430941202657408	13814	7.81	0.515	
WD1952-200	6447181214823340800	33509	7.75	0.541	
WD1952-584 WD1953-011	4235280071072332672	7868	8.23	0.731	GBD12, phot
WD1953-715	6422236358302245248	19267	8.23 7.87	0.559	OBD12, pilot
WD1959+059	4248931504366754304	19207	7.87	0.523	
WD2004-605	6443328221136801920	40994	8.39	0.323	
WD2004-003 WD2007-219	6853784501721502720	40994 9739	8.39 7.81	0.873	
WD2007-219 WD2007-303		15436			
	6749419923164242816 6468623688724871808		7.80	0.518 0.602	
WD2014-575 WD2018-233		26804 15585	7.93	0.602	
	6849796229451135104		7.81		
WD2020-425	6679362959252072832	34004	8.30	0.813	primary
WD2021-128	6876934409805839872	20753	7.82	0.538	
WD2029+183	1815528000815020288	13719	7.64	0.457	
WD2032+188	1815657193425348096	18199	7.36	0.381	
WD2039-202	6857939315643803776	19738	7.79	0.521	
WD2039-682	6424566979354709248	16943	8.34	0.81	
HS2046+0044	4228449385142100480	127096	8.15	0.718	
WD2046-220	6808699474099687808	23413	7.83	0.548	
WD2051+095	1750545141328217984	15274	7.79	0.513	
WD2051-208	6857295585945072128	16139	9.47	1.337	magnetic
HS2056+0721	1737897841324840832	27289	8.32	0.815	
WD2056+033	1731395432637342336	51835	7.70	0.565	
HS2058+0823	1738071701601163264	36844	7.78	0.56	
WD2058+181	1765090584946772736	17349	7.75	0.506	
HS2059+0208	1730310347805122816	18641	7.84	0.542	
WD2059+190	1789361097242243584	6237	6.90		

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Table C.2: Gaia DR2 IDs, effective tem	peratures, gravities and masses.	continued.

object	Gaia DR2 ID	T _{eff} K	$\log g$ cm s ⁻¹	M ${ m M}_{\odot}$	References/remarks
HS2108+1734	1788040794231829376	28812	8.31	0.81	
WD2105-820	6348672845649310464	10263	7.88	0.538	magnetic
WD2115+010	2691277330022787712	25815	7.75	0.523	-
WD2115-560	6462911897617050240	9575	7.75	0.483	
WD2120+054	1738521539295354240	35559	7.68	0.521	
WD2122-467	6575491133702739584	16334	8.05	0.643	
WD2124-224	6828157565735439232	47780	7.71	0.56	
HS2130+1215	1769941011771984768	32995	7.74	0.534	
HS2132+0941	1742342784582615936	13480	7.70	0.476	
HE2133-1332	6842831888437047680	9810	7.53	0.4	
WD2134+218	1793946026371051648	18001	7.86	0.551	
WD2136+229	1794118516552814336	10040	7.80	0.503	
HE2135-4055	6578616598584224640	19211	7.96	0.6	
WD2137-379	6585878288771383296	21013	7.86	0.555	
HS2138+0910	1741417790361772160	9228	7.61	0.429	
WD2139+115	1766702297192943488 6836795672680406272	15551 13984	7.79 7.75	0.515 0.496	
HE2140–1825 WD2146–433	6565941703417200128	62792	7.73	0.490	
HS2148+1631	1772852278044283904	16776	7.23	0.48	
HE2148-3857	6585056369469080448	26758	8.02	0.644	
WD2149+021	2693940725141960192	17926	7.86	0.55	
WD2150+021	2693914886618675456	40874	7.66	0.525	
WD2152-045	2670147461020069632	19837	7.38	0.397	
WD2151-307	6616313457820826496	28580	8.27	0.789	
WD2152-548	6461145119869641728	45171	7.88	0.617	
WD2153-419	6572442909513784576	46503	7.94	0.645	
WD2154-061	2668622270889053568	36259	7.74	0.545	
HE2155-3150	6615959586875261056	16302	7.83	0.532	
WD2157+161	1775640227215432320	19188	7.89	0.566	
HE2159-1649	6826770115204739072	19486	7.84	0.544	
WD2159-414	6571754443436630272	54343	7.71	0.575	
WD2200-136	2612442135856683648	25261	7.52	0.462	primary
WD2159-754	6358158435541361792	8903	8.36	0.815	
HE2203-0101	2677321641247692032	18047	7.87	0.555	
WD2204+070	2721868041314138240	24454	7.95	0.607	
WD2205-139	2612155476855186176	25231	8.25	0.768	
WD2207+142	2735175263041913088	7255	7.49	0.369	
HE2209–1444 HS2210+2323	2600033326799287296 1879147564661258240	8471 23233	7.62	0.429	primary
WD2211-495	6560067493827212544	62336	8.24 7.54	0.76 0.548	
HS2216+1551	2735823425146356224	19163	8.04	0.638	primary
HE2218-2706	6621832284637642240	15039	7.79	0.514	primary
HE2220-0633	2625750938132516224	15523	7.88	0.555	
HS2220+2146B	1874954645786146304	14601	8.24	0.755	K09
HS2220+2146A	1874954641491354624	18743	8.08	0.653	K09
WD2220+133	2734319087081051264	22583	8.30	0.795	
HE2221-1630	2595728287804350720	9889	7.89	0.545	
HS2225+2158	1874832084599745920	25989	7.86	0.567	
WD2226+061	2709363196787375488	16429	7.66	0.472	
WD2226-449	6520516480027596288	13974	7.74	0.493	
HS2229+2335	1875647956587976576	19300	7.90	0.571	
HE2230-1230	2601689466188247808	20949	7.81	0.532	
HE2231-2647	6621374578563035776	21592	7.70	0.5	
HS2233+0008	2654170736729886976	24529	7.99	0.626	
WD2235+082	2716039358376761088	36519	7.73	0.542	
HE2238-0433	2625067484281097856	17542	8.18	0.716	
HS2240+1234B	2731502443233585280	15636	7.86	0.542	J98, WD2240+125A
HS2240+1234A	2731501687319341568	14022	7.99	0.601	J98, WD2240+125B
WD2240-045	2625078449333017856	44102	7.72	0.556	

object	Gaia DR2 ID	$T_{\rm eff}$	$\log g$	М	References/remarks
		Κ	$\mathrm{cm}\mathrm{s}^{-1}$	${ m M}_{\odot}$	
WD2240-017	2652784694950778624	9090	7.78	0.493	
WD2241-325	6603807092875065728	32316	7.95	0.621	
HS2244+2103	2836176779127265792	24113	7.89	0.578	
HS2244+0305	2656542452030717952	60460	7.54	0.542	
HE2246-0658	2611423167751076224	11512	7.99	0.601	
WD2248-504	6514042654346344704	16336	7.74	0.498	
HE2251-6218	6394778525002127104	18033	7.83	0.534	
WD2253-081	2610488514148351360	6233	6.85		
WD2253+054	2711324446359728384	6244	8.64		GBR11
WD2254+126	2719012579552367488	11893	7.85	0.529	
HS2259+1419	2816082757452460416	13057	7.77	0.502	ambiguous
WD2303+017	2658537614663492352	40977	7.67	0.528	-
WD2303+242	2842650153836732928	11261	7.83	0.517	
WD2306+130	2814942392095501952	13955	7.81	0.516	
WD2306+124	2811882073278282496	20360	7.99	0.619	

36062

57007

51160

15122

17981

33451

13965

29851

43583

13026

21683

16261

11658

22390

20457

26442

51573

13791

10602

30498

7810

17012

21827

29352

19197

10933

26272

17738

11567

44455

17427

28867

18529

14438

40294

61740

34984

17418

7.61

7.82

7.77

7.82

7.88

7.72

7.80

7.89 7.78

7.79

7.90

7.83

7.90

7.78

7.91

7.44

7.88

7.84

7.79

7.29

7.46

8.03

7.88

7.32

7.87

7.79

7.94

7.30

7.86

7.88

7.73

8.38

7.79

7.87

7.95

7.59

7.20

7.86

0.507

0.617

0.589

0.522

0.556

0.529

0.512

0.591

0.577

0.508

0.577 0.529

0.552

0.523

0.581

0.445

0.629

0.529

0.503

0.421

0.362

0.629

0.569

0.425

0.555

0.501

0.606

0.366

0.534

0.615

0.499

0.849

0.544

0.52

0.64

0.558

0.414

0.548

primary

WD2308+050

WD2309+105

WD2311-260

WD2312-356

WD2314+064

HE2315-0511

WD2318+126

WD2318-226

WD2321-549

WD2322+206

WD2322-181

WD2324+060

WD2326+049

WD2328+107

WD2329-332

WD2330-212

WD2331-475

WD2333-165

WD2333-049

HE2334-1355

WD2336-187

WD2336+063

HE2345-4810

WD2347+128

WD2347-192

HE2347-4608

WD2348-244

WD2349-283

WD2350-248

WD2350-083

WD2351-368

WD2353+026

WD2354-151

HE2356-4513

MCT2352-1249

MCT2349-3627

MCT2343-1740

MCT2345-3940

2662658107503521536

2810585920868186240

2379935013296113664

6554999363696189056

2664365374183501312

2633791288709297792

2811363550466857344

2385336982642954496

6499376994593401344

2825795087259417984

2393546245693497728

2661500871515095680

2660358032257156736

2762605088857836288

2325117757286653440

2388953031573382784

6528109879126984960

2395444208921491456

2633120655335891968 2432056468657830784

2393875961742886656

2756675044691990272

2394370123500185344

6524412152806190336

6534665545408513792

2769930207121379968

2390888829168611968

6530721803358467968

2338349628107880192

2311200968031379584

2334079090586541440

2338275136195124864

2442099751463686528

2310942857676734848

2421871039614828672

2739782629080048000

2419140746085234688

6530974072557448064

Table C.2: Gaia DR2 IDs, effective temperatures, gravities and masses, continued.