The next SDSS white dwarf catalog

S J Kleinman\textsuperscript{1}, A Nitta\textsuperscript{1} and D Koester\textsuperscript{2}

\textsuperscript{1}Gemini Observatory, 670 N. A'ohoku Place, Hilo HI 96720
\textsuperscript{2}Institut f"ur Theoretische Physik und Astrophysik, University of Kiel, D-24098 Kiel, Germany
E-mail: skleinman@gemini.edu

Abstract. We have begin work on the next Sloan Digital Sky Survey (SDSS) spectroscopically-identified white dwarf catalog. It will feature white dwarf stars from Data Release 7, the final data release from the SDSS-I and SDSS-II surveys. Besides incorporating the latest spectrophotometry improvements from the SDSS, we have improved our spectroscopic models and expanded our grid. We expect on the order of 5000–6000 additional white dwarf stars not included in the earlier Data Release 4 catalog.

1. Introduction

As many of the presentations at this conference will attest, the Sloan Digital Sky Survey (SDSS: York et al. 2000) has had a huge impact on white dwarf astronomy. Its rich, homogeneous data have produced multiple, large catalogs of white dwarf stars. Using the Early Data Release, Harris et al. (2003) first presented 269 white dwarf stars from 190 square degrees of SDSS data. Using data from the first SDSS Data Release (DR1), data, Kleinman et al. (2004) reported on 2551 white dwarf stars from 2100 sq. degrees of the survey. Whereas these previous catalogs were based on the SDSS spectroscopic data, Harris et al. (2006) presented a luminosity function based on 6000 white dwarf stars from the SDSS DR3, using observed SDSS colors and proper motions to form their sample. Eisenstein et al. (2006) followed the DR1 catalog with another spectroscopic catalog, this time based on DR4 data and including 9316 white dwarf stars from 4783 square degrees of data.

We are now preparing the latest spectroscopic white dwarf catalog based on SDSS Data Release 7 (Abazajian et al. 2008), the final data release from SDSS-I and SDSS-II. DR7 includes all data from the original SDSS and SEGUE-I footprints. Future SDSS data releases will provide even more white dwarf stars from SEGUE-II and possibly other survey components. DR7 covers 8250 sq. degrees on the sky. Spectrophotometric improvements in reductions were made for DR6 (Adelman-McCarthy et al. 2008), with further improvements included in DR7 as well.

Our new catalog will include spectroscopic fits based on our latest atmospheric models from D. Koester and the latest SDSS DR7 reductions. It will be include all new and old objects found in the previous spectroscopic catalogs. That is, we will re-analyze all the white dwarfs presented in the EDR, DR1, and DR4 spectroscopic catalogs and put them on a uniform basis in this new catalog.

2. Sample Selection
Each of the SDSS white dwarf catalogs mentioned above used a different set of sample selection criteria. The DR1 catalog (Kleinman et al., 2004) used a series of different criteria to form a
Figure 1. DR4 (base) vs. DR6 (arrow) reductions for a sample of \( g < 19 \) DAs. The results show the effects of the new DR6 spectrophotometry on our fits. The hotter DAs had their temperatures significantly reduced, making them more in agreement with other fits.

catalog of some 9000 candidate white dwarf stars. The spectra of these candidates were then all looked at by eye and classified as a white dwarf or not. The resulting white dwarf sample was then fit by our spectroscopic fitting code, \textit{autofit}. Eisenstein et al. (2006) used a smaller set of criteria to select candidates from two different SDSS spectroscopic reduction pipelines. They then used \textit{autofit} to fit the spectra of the candidates, automatically triggering human inspection only for objects with uncertain fits, the sample size simply being too cumbersome for easy human inspection of the entire sample. However, by using a second set of reductions not available via the standard SDSS data servers (http://cas.sdss.org), their candidate selection is difficult to reproduce.

For the new catalog, we have chosen to follow an approach similar to that of Eisenstein et al. (2006), but using new outputs now available from the SDSS Catalog Archive Server to replace the second set of data reductions used by Eisenstein et al. (2006). We have coded their main selection criteria in SQL and optionally added constraints requiring the object either to have been targeted for observing based on it being a possible white dwarf star or to have had a reduced spectrum best matched by one of the white dwarf templates now used in the SDSS/SEGUE spectroscopic pipeline. When both sets of criteria were insisted upon, the success rate was very high with nearly 75% of the candidates being well-fit as a white dwarf star by \textit{autofit}. Even more white dwarf stars will eventually be extracted by finishing the human inspections on the uncertain fits. Our candidate selection is still ongoing, but we currently have 3683 white dwarfs stars not included in the DR4 or DR1 catalogs. This sample, however, is based only on DR6 data and does not include any human inspections. Combined with the previous spectroscopic
catalogs, we should eventually have of order 15,000 white dwarf stars, with the latest reductions of their spectra fit with the latest version of our fitting code.

3. Spectrophotometry
For the first time since DR2, the SDSS changed its spectroscopic reductions for DR6 and again for DR7. In particular, wavelengths near the H absorption lines now have more reliable spectrophotometry. Using the new DR6 reductions, most hot DAs moved to lower \( \log g \) and \( T_{\text{eff}} \) as seen in Figure 1. This change should go a long way in solving the trend reported in the DR1 and DR4 catalogs of our hot DA fits being systematically hotter than those from other fits of the same objects. The DB fits changed much less systematically, as expected, as a result of these SDSS reduction changes. DR7 reductions have even more improved spectrophotometry corrections included, but we have not yet fit these reductions. We are confident, though, that these reductions will at least partially improve the comparison between our fits and those in the literature for hot DAs (as reported in both the DR1 and DR4 catalogs as well as Kleinman, 2007).

4. New models
Our fitting code, autofit, has changed very little since DR4, but we have made many improvements to the model grid it uses. First of all, our grid has expanded. We now have a denser sampling of \( \log g \), \( T_{\text{eff}} \). We have also extended the grid to \( \log g = 10 \) in both the DA and DB grids. Figure 2 illustrates the old DR4 and new catalog grids.

Additional changes have been made to the models themselves. The most significant changes include the consistent use of neutral line broadening in the models. For DBs, the results are
Figure 3. Sample new (solid circles) vs. old (hollow circles) DB fits showing the result of our new DB models. The log g values below $T_{\text{eff}} = 16,000$ K are now much more consistent with those above 16,000 K.

clearly seen at $T_{\text{eff}} < 16000$ K, where log g is now much more consistent across this temperature range, as shown in Figure 3.

We also now have an updated grid of DB models with an ML2/$\alpha = 1.25$ convection treatment which seems to better represent convection in DBs (see for example, Beauchamp et al., 1999 and Montgomery, 2007) than do the previously used ML2/$\alpha = 0.6$ models. We have not yet run our fits with this grid, but will do so for the final catalog.

5. Conclusions
We are still in the process of preparing the latest SDSS white dwarf catalog. It will contain unified fits of all the new and previous SDSS white dwarf stars and use the latest DR7 reductions. Our model grid has improved both in its density and its physics. We will explore fitting the DBs with our new ML2/$\alpha = 1.25$ grid. The improved spectrophotometry has already been shown to help our DA temperature determinations in the high $T_{\text{eff}}$ range and the improved model physics should help our fits in the low $T_{\text{eff}}$ regime. The new catalog should feature uniform fits on some 15,000 or so spectroscopically-verified white dwarf stars.

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References
Abazajian K et al. 2008 ApJ Supp submitted
Adelman-McCarthy J et al. 2008 ApJ Supp 175 297
Beauchamp A Wesenael F Bergeron P Fontaine G Saffer R A Liebert J & Brassard P 1999 ApJ 516 887
Eisenstein D E et al. 2006 ApJ Supp 167 40
Harris H et al. 2003 AJ 126 1023
Harris H et al. 2006 AJ 131 571
Kleinman S J et al. 2004 ApJ 607 426
Kleinman S J Eisenstein D J Liebert J & Harris H C 2007 in “Proc. of the 15th European Workshop on White Dwarfs” ASP Conf. Ser. 372 121
Montgomery M H 2005 Communications in Asteroseismology 150 253
York D G et al. 2000 AJ 120 1579