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Analysis of the hydrogen-rich magnetic White Dwarfs in the SDSS

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Abstract. We have calculated optical spectra of hydrogen-rich (DA) white dwarfs with magnetic field strengths between 1 MG and 1000 MG for temperatures between 7000 K and 50000 K. Through a least-squares minimization scheme, we have analyzed the spectra of 114 magnetic DAs from the Sloan Digital Survey (SDSS; 95 previously published plus 14 newly discovered within SDSS).

Keywords. Stars: white dwarfs – magnetic fields

1. Introduction

White dwarfs with magnetic fields between 10^4 and 10^9 G are thought to represent more than 10% of the total population of white dwarfs (Liebert *et al.* 2003). In this work we present the re-analysis of the 95 DA Magnetic White Dwarfs (MWDs) discovered by Schmidt *et al.* (2003) and Vanlandingham *et al.* (2005), plus the analysis of 19 additional objects from SDSS up to Data Release 6 (9583 deg²; <http://www.sdss.org/dr6/>).

Schmidt *et al.* (2003) and Vanlandingham *et al.* (2005) determined the field strengths and the inclinations of magnetic dipoles by comparing the observed spectra visually with model spectra calculated using a simplified radiation transfer code (Latter *et al.* 1987). Their and our results are compared on Fig. 1.

2. Analysis

The magnetic field geometry of the MWDs was determined with a modified version of the code developed by Euchner *et al.* (2002). This code calculates the total flux (and circular polarization) spectra for an arbitrary magnetic field topology by adding up appropriately weighted model spectra for a large number of surface elements. Magnetic field geometries are accounted for by a centered or an offset dipoles in this work. The model parameters are the magnetic dipole field strength B_d , the effective temperature T_{eff} , the inclination of the dipole axis i , and an offset along the magnetic dipole axis z_{off} , if offset dipoles are used. The observed spectra are fitted using an evolutionary algorithm (Rechenberg 1994) with a least-squares quality function and all of our fits resulted in reduced χ^2 values between 0.8 and 3.0 except for some high-field objects.

3. Discussion

In many cases offset dipole models resulted in significantly better fits than the models with centered dipoles. In particular some MWDs with high field strengths (> 50 MG), where the spectra become very sensitive to the details of the magnetic field geometry, are not accounted for by our simple models.

SDSS has nearly tripled the number of MWDs; therefore the completeness of the total known MWD population is strongly affected by the selection biases of SDSS (priority selection of the spectroscopic targeting; Stoughton *et al.* 2002).

High-field MWDs are thought to be remnants of magnetic Ap and Bp stars. If flux conservation is assumed, population synthesis models predict the majority of MWDs' polar field strengths to be in the interval 50–500 MG (Wickramasinghe & Ferrario 2005). On the other hand in our sample objects with magnetic field strengths lower than 50 MG are more numerous than the objects with higher magnetic field strengths (see Fig. 2), partly due to the selection biases. Nevertheless our result is consistent with previous ones and supports the hypothesis that magnetic fossil fields from Ap/Bp stars alone are not sufficient to produce the observed number of MWDs (Wickramasinghe & Ferrario 2005). Possible progenitor populations are A and B stars with magnetic field strengths below 100 G or magnetic F stars (Schmidt *et al.* 2003), which both are currently unobserved.

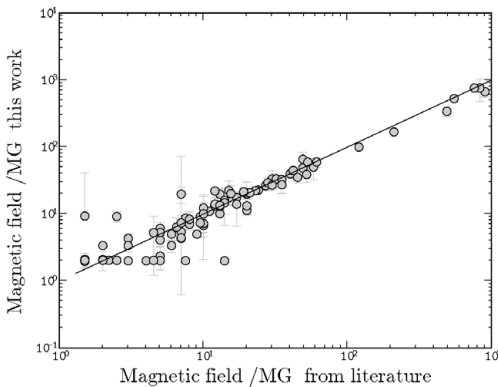


Figure 1. Comparison of dipole magnetic field fit values in this work versus Schmidt *et al.* (2003), Vanlandingham *et al.* (2005).

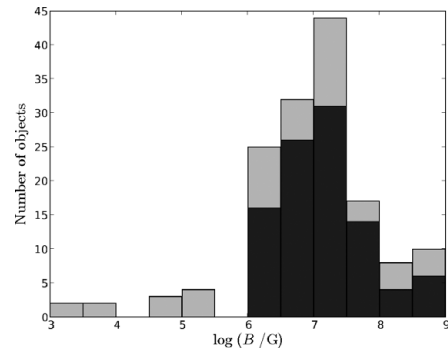


Figure 2. Histogram of magnetic white dwarfs in equal intervals of $\log B$. Gray columns represent the number of all DA MWDs and black shades represent the contribution of SDSS to DA MWDs.

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