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Metal Abundances in the Hottest Known DO White Dwarf (KPD 0005+5106)

Daniel Wassermann*, Klaus Werner*, Thomas Rauch* and Jeffrey W. Kruk†

*Institute for Astronomy and Astrophysics, Kepler Center for Astro and Particle Physics, Eberhard Karls University, D-72076 Tübingen, Germany
†NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

Abstract. We performed a new analysis of UV and optical spectra of KPD 0005+5106. We find $T_{\rm eff} = 200\,000 \pm 20\,000$ K, $\log g = 6.7 \pm 0.3$, $M = 0.64\,{\rm M}_\odot$ and $\log L/{\rm L}_\odot = 3.7$. The mass fractions of the metals are in the range $0.7 - 4.3$ times solar. This abundance pattern is probably unaffected by gravitational settling and radiative levitation, hence, its origin lies in previous evolutionary stages. We speculate about a link of KPD 0005+5106 to the RCrB stars and its possible outcome of a double-degenerate merger event.

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INTRODUCTION

The hot DO KPD 0005+5106 was discovered by Downes et al. [4] and has attracted particular attention because it displays sharp emission lines in optical spectra. Our first NLTE model-atmosphere analysis [9] showed that KPD 0005+5106 is the hottest known DO white dwarf ($T_{\rm eff} = 120\,000$ K). More recently, the discovery of Ne VIII and Ca X lines in FUSE spectra suggested $T_{\rm eff} \approx 200\,000$ K and preliminary modeling showed that this high $T_{\rm eff}$ also improves the model fit to the He II line spectrum [10, 11]. This solved a problem connected with a number of emission features that were previously identified as O VIII lines. These would require extremely high temperatures ($\approx 10^6$ K) so that their origin was attributed to shock fronts in a stellar wind. Instead, it turned out that these features are Ne VIII lines that form in the extremely hot photosphere.

In view of these findings, we performed a new analysis in order to derive temperature, gravity and metal abundances.

RESULTS AND CONCLUSIONS

The analysis was performed with our NLTE model atmosphere code, which computes line blanketed, static, plane-parallel atmospheres in radiative equilibrium.

In the FUSE spectra, we discovered lines from extremely high ionized silicon, sulphur, and iron (Si VII, S VII, Fe X) that were never found before in any stellar photosphere. Our analysis of these lines and those from helium and several other metals gives $T_{\rm eff} = 200\,000 \pm 20\,000$ K. Figs. 1–4 display some model fits to observed line profiles.