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WIND STRUCTURE OF THE WOLF-RAYET STAR EZ CMA=HD 50896

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RESUMEN

Presentamos los resultados del análisis de la línea de N V 4604 observada en espectros de la estrella Wolf-Rayet HD 50896 obtenidos en 1991, 1999, 2005 y 2009. Mostramos que la variabilidad de esta línea es consistente con un modelo en el que la opacidad del viento sufre cambios cíclicos con un periodo de 3.76 d o bien con un modelo de un viento con estructura cuadrupolar donde cada sector tiene una opacidad distinta.

ABSTRACT

The Wolf-Rayet star HD 50896 (EZ CMa=WR6) is well-known for the emission-line profile variability that occurs on a 3.7-day timescale. In particular, the shape of the N V 4604-21 doublet changes from a P Cygni profile to one in which no blue-shifted absorption component is present. In this paper we use spectroscopic observations obtained in 1991, 1999, 2005 and 2009 to glean physical conditions within the stellar wind that may give rise to these changes. We find that variations in the opacity at a distance $r/R_{\rm max} \sim 0.3$–0.5 of the stellar surface can produce the observed effects. Here, $R_{\rm max}$ is the extent of the N V line-forming region. The results are consistent either with a scenario in which the opacity of the inner wind region of HD 50896 undergoes cyclical variations over the 3.76 d period or with a quadrupolar wind distribution in which the sectors having different opacities rotate in and out of our line-of-sight on this periodic timescale.

Key Words: stars: individual (EZ CMa = HD 50896) — stars: winds, outflows — stars: Wolf-Rayet

1. INTRODUCTION

Classical Wolf-Rayet (WR) stars (van der Hucht et al. 1981) are the evolved remnants of massive O-type stars and are believed to be the last stable evolutionary phase of a star before it explodes as a supernova or, possibly, a "collapsar" (Crowther 2007). The WR stars are often found in binary systems in which the companion is also a massive O-type star. Van den Heuvel (1976) noted that after the more massive star in a massive binary system has become a supernova, leaving a neutron star or black hole remnant, its companion should eventually become a WR star. Hence, a number of *WR+cc* systems should be observable at any given time. The WN5-type star HD 50896 (EZ CMa=WR6; van der Hucht et al. 1981) was the first WR star to be proposed to fit this evolutionary scenario. Firmani et al. (1979, 1980) detected periodic ($P = 3.76$ d) emission-line profile variability which, when combined with the fact that HD 50896 is surrounded by a ring nebula (S308) and that it lies high above the galactic plane[4], led them to conclude that HD 50896 is a binary system with a low-mass companion. Shortly thereafter, linear polarization (McLean 1980) and photometric (Cherepashchuk 1981) observations confirmed the $P = 3.76$ day periodicity. Subsequent period determinations by Lamontange, Moffat, & Lamarre (1986) and Georgiev et al. (1999) gave, respectively $P = 3.766 \pm 0.001$ d and $P = 3.765 \pm 0.001$ d.

Two criteria were used by Firmani et al. (1979, 1980) to determine the original period: (a) the shape of the He II 4686 line profiles, particularly the lo-

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[4]Suggesting it is a "runaway" system as a consequence of the supernova "kick".