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WHOLE EARTH TELESCOPE OBSERVATIONS OF THE HELIUM INTERACTING BINARY PG 1346+082 (CR BOOTIS)

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ABSTRACT

We present our analysis of 240 hr of white-light, high-speed photometry of the dwarf nova–like helium variable PG 1346+082 (CR Boo). We identify two frequencies in the low-state power spectrum, at 679.670 ± 0.004 μHz and 669.887 ± 0.008 μHz. The 679.670 μHz variation is coherent over at least a 2 week time span, the first demonstration of a phase-coherent photometric variation in any dwarf nova–like interacting binary white dwarf system. The high-state power spectrum contains a complex fundamental with a frequency similar, but not identical, to the low-state spectrum, and a series of harmonics not detected in low state. We also uncover an unexpected dependence of the high-frequency power's amplitude and frequency structure on overall system magnitude. We discuss these findings in light of the general AM CVn system model, particularly the implications of the high-order harmonics on future studies of disk structure, mass transfer, and disk viscosity.

Subject headings: stars: individual (PG 1346+082) — stars: oscillations — white dwarfs

1. INTRODUCTION

PG 1346+082 (CR Boo) is a member of a special subset of short-period binary systems, the interacting binary white dwarfs (IBWDs). IBWDs, also known as AM CVn stars, after the prototype, contain two white dwarfs of extreme mass ratio in close proximity. The secondary, with an estimated mass ranging from 0.02 to 0.09 $M_{\odot}$, fills its Roche lobe and transfers material to the much more massive primary via an accretion disk (Faulkner, Flannery, & Warner 1972). IBWDs are fascinating laboratories of accretion dynamics. Recent spectroscopic evidence argues that the prototype, AM CVn, contains a stable accretion disk with a 13.4 hr precession period (Patterson, Halpern, & Shambrook 1993). AM CVn stars also provide insight into binary star evolution, while offering an unique opportunity to peer into a stellar core remnant and directly view the by-products of nucleosynthesis (Marsh, Horne, & Rosen 1991). The extremely low secondary mass suggests the donated material originates from a present surface, once deep within the core of the progenitor main-sequence star. Yet spectra of all AM CVn stars are helium-rich, rather than carbon-dominated, indicating that the evolutionary path traversed by these systems precludes the ignition of helium in the core of the secondary progenitor. Helium-core white dwarfs created by single-star evolution could not have yet formed in the age of the Galactic disk (Winget et al. 1987).

In addition, the AM CVn stars offer a possible channel onto the white dwarf cooling track. Recent theoretical and observational work (see Fontaine & Wesemael 1996 for a review) argues that most, if not all, hydrogen-surface white dwarfs (DAs), which comprise 80% of the total white dwarf population, have thick ($\approx 10^{-4}$ $M_{\odot}$) surface layers, and comprise a fairly well-understood channel of white dwarf evolution. The situation is less clear for helium-surface white dwarfs (DBs), which comprise the remaining 20% of the population. Observational evidence suggests a range of helium layer thicknesses, which could be explained through either time-dependent diffusion (Dehner & Kawaler 1995; Provencal et al. 1996) or multiple sources for DBs, such as the subdwarfs, the DAO stars, and the AM CVn systems (Shipman 1996). Evidence abounds for an evolutionary trend between orbital separation and accretion rate among the six AM CVn objects (Table 1) (Provencal 1994). The mass transfer will not stop until the secondary is completely absorbed, leaving a solitary DB (Nather, Robinson, & Stover 1981), perhaps providing a significant fraction of the field DBs we observe today.

The Palomar Green survey (Green, Schmidt, & Liebert 1986) object PG 1346+082 (CR Boo), one of three dwarf nova–like AM CVn systems, undergoes outbursts ranging from a low-state (minimum light) magnitude of ≈ 17.4 (m_b)

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