PHOTOMETRY OF A VARIABLE HOT SUBDWARF STAR IN NGC 6791

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We propose a one year observation of the unique hot blue star B4 in NGC 6791, one of only a handful of subdwarf B (sdB) stars known to exist in an old open cluster, and the only cluster sdB known to show photometric variability caused by binarity. The goal of these observations are twofold - we expect to observe nonradial pulsations in this star, and plan to study longer period variations caused by its binarity. The primary goal is to confirm our expectation that B4 should show nonradial pulsations, since its temperature and gravity place it within the instability region for g-mode sdB pulsators, where pulsations are seen in about 75% of the stars (Green et al. 2003). The discovery of a pulsator in a well-studied open cluster of known age and metallicity would provide new and unique probes of the pulsation mechanism for the pulsating sdB stars. Because of the faintness of the star, the time scale of the variations (periods of approximately 45 to 90 minutes) and the expected small amplitude of the pulsations, Kepler is the only instrument able to measure these oscillations to the degree of precision needed for asteroseismic analysis. Our secondary goal is based on the fact that this star is already known to be a low-amplitude (2%-9%) variable with a period of 0.8 (or 0.4) days, The proposed observations will provide a high signal-to-noise light curve for analysis of the binary system. From photometry alone, we will be able to constrain the orbital properties of the binary, and the mass and radius of the companion. Subdwarf B (sdB) stars belong to a class of stars that represent the post-helium core flash evolution of low mass stars. They lie at the extreme blue end of the horizontal branch (Teff ~ 25,000 - 35,000K), and are the remnant cores of stars that have experienced the core helium flash while on the RGB. They have extremely thin (and inert) hydrogen shells surrounding a core undergoing helium fusion. The mechanism(s) that produce these stars is/are currently unknown, though leading scenarios include mass transfer in a binary system. Single-star mechanisms have also been proposed and remain viable given the limitations of observables in these stars. Asteroseismic probes of this star, coupled with the additional constraints of cluster membership and the properties of the binary system, should provide important clues about the formation mechanism of the extremely hot subdwarf stars. Because this star is relatively faint (V=17.88, Kepler magnitude 18.27), published ground-based data are insufficient to establish the nature of the known variability or determine the properties of the binary system. Furthermore, ground-based data are insufficient to detect the shorter period variability expected for any pulsations. Only with an extended, uninterrupted time series can we answer these questions, and the Kepler spacecraft is the only instrument capable of providing the needed data. If it shows pulsation, B4 will be a uniquely valuable star - a nonradially pulsating star, in a close binary system, within a cluster. The binary nature will allow mass and perhaps radius determination, the presence in a cluster secures knowledge of its distance, age, and metallicity, and with these constraints the asteroseismology will be tightly constrained.