CONTINUED PHOTOMETRY OF A VARIABLE HOT SUBDWARF STAR IN NGC 6791

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The subdwarf B (sdB) stars lie at the extreme blue end (Teff~25,000-35,000K) of the horizontal branch, 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. How these stars form is 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. We propose to continue Kepler observations of the unique hot blue star B4 in NGC 6791, one of only a handful of (sdB) stars known to exist in an old open cluster, and the only cluster sdB known to show photometric variability caused by binarity. Our goals are twofold - to observe short-period nonradial pulsations in this star, and to study longer period variations caused by its binarity. 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 sdB stars. At least 75% of sdB stars with Teff and log g similar to B4 show g-mode pulsations. B4 was selected for short-cadence observation for Cycle 2. If it is a pulsator, a second year of photometry will enable us to refine the pulsation periods, reach low-amplitude modes at levels (70ppm) seen in known Kepler sdB pulsators , and perhaps measure changes in the pulsations driven by evolution of the star. A pulsator in an open cluster of known metallicity and age will provide new and unique probes of the pulsation mechanism and interior of these stars. Given its faintness, the multiperiodic variations (45 to 90 minute periods) and the small amplitude of the pulsations, Kepler is the only instrument able to measure these oscillations to the degree of precision needed for asteroseismic analysis. Another year of SC data would allow us to look for smaller amplitude pulsations than one year alone might reveal, perhaps showing multiplet structure that can provide mode identification. This star is already known to be a low-amplitude (2%-9%) variable with a period of less than 1 day. Our second goal is to extend the high signal-to-noise light curve for analysis of the binary system. High-precision Kepler photometry, coupled with ground-based spectroscopy that we will obtain, can measure the orbital properties of the binary, the mass and radius of the companion, and the distance. With a second year of photometry of the binary light curve, we can begin to place interesting limits on a tertiary components through timing variations. Because this star is faint (Kepler magnitude Kp = 18.27), ground-based data have been insufficient to establish the nature of the known variability or determine the properties of the binary system. Ground-based data are insufficient to detect short-period variability from pulsations. Only an extended, uninterrupted time series can address these issues, and at present Kepler is the only instrument capable of providing the needed data. B4 is a uniquely valuable star: a (possibly) nonradially pulsating star, in a close binary system, within a cluster. The binary nature will allow mass and radius determination,and its presence in a cluster secures knowledge of its age, metallicity, and distance. With these known, asteroseismology will be tightly constrained.