

ACCRETION-DISK FLUCTUATIONS DURING MULTIPLE STATES OF CH CYGNI

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The proposed Kepler observations aim to determine the degree to which the physics of white-dwarf accretion disks is the same as that of neutron-star and black-hole disks in X-ray binaries. In particular, we seek to answer the question: does the pattern of brightness variations from a white-dwarf accretion disk change in the same way as that of X-ray binaries when the disks make an extreme change of state? Of all the sources with accretion disks and jets, the comparison among white dwarfs, neutron stars, and stellar-mass black holes is especially illuminating. Although all these compact objects have similar masses, general relativity is needed to describe the trajectories of matter and light in X-ray binaries, whereas in accreting white dwarfs, it is not. So, the juxtaposition of the timing behavior of these systems provides a way to identify both the fundamental underpinnings of disk accretion and the effects of general relativity. To achieve our scientific goal, we will perform short-cadence observations of CH Cyg with Kepler throughout Cycle 4. CH Cyg is a symbiotic star that contains a white dwarf accreting from a red-giant companion. During the 12 months of Cycle 4, we expect CH Cyg to be in a high state, in which the disk is luminous. Prior Kepler short-cadence observations (during Cycles 2 and 3) have already characterized the rapid variations from CH Cyg in the low state; these previous Kepler observations revealed never-before-seen quasi-periodic oscillations (QPOs) and a break in the power density spectrum. If CH Cyg is truly analogous to an X-ray binary, the QPO should shift to higher frequencies in the high state, and the break should shift to lower frequencies if, for example, the geometrical height of the inner disk decreases. CH Cyg is the ideal target for this study because it produces bipolar jets as in X-ray binaries, its orbital period is so long that orbital motion will not interfere with the detection of brightness fluctuations from the disk, and the disk is large enough that any features in the power density spectrum on time scales of minutes to days will reflect dynamical, viscous, or thermal time scales rather than the size of the disk. CH Cyg is also the only source of its type --- an accretion-powered symbiotic star --- in the Kepler field of view, and because it is a dedicated-mask target, the proposed observations do not count against the short-cadence pixel budget. If our Kepler observations confirm the hypothesis that the accretion disks in symbiotic stars and X-ray binaries have the same type of flux variations, there will be far-reaching implications. 1) We will have confirmed the suggestion that the physics behind the features in the power density spectrum must be the same for white dwarfs, neutron stars, and black holes. 2) Models for the QPOs in X-ray binaries that invoke general relativity, and the possibility of using the features in the power spectrum to probe strong gravity, will be called into question. 3) The more than 2 decades of research on X-ray binary variability will become relevant to accreting white dwarfs, and copious research on cataclysmic-variable disks will become relevant to X-ray binaries. Due to the combination of its sensitivity and its capacity for long-duration observations, Kepler is the only instrument that can carry out this project.