BRIGHTNESS VARIATIONS FROM THE ACCRETION DISK IN CH CYGNI

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The aim of the proposed Kepler program is to determine whether the accretion disks around white dwarfs are fundamentally similar to those around neutron stars and black holes. We will accomplish this goal by generating the first power spectrum of optical brightness fluctuations from an accreting white dwarf to span a large enough range of frequencies to reveal all the features typically seen in the power spectra of X-ray fluctuations from X-ray binaries. Since this broad power spectrum will need to cover time scales ranging from less than a minute to months with an unprecedented level of sensitivity, we will combine long-cadence observations with the Kepler satellite with fast optical photometry from ground-based telescopes. As the accretion disks around white dwarfs primarily emit in the optical, whereas the accretion disks around neutron stars and black holes primarily emit in the X-rays, we will determine the degree to which white-dwarf and X-ray binary disks are similar by comparing the optical power spectrum of a specially selected accreting white dwarf --- CH Cygni--- to the well-studied X-ray power spectra of neutron-star and black-hole X-ray binaries. The accreting white dwarf in the symbiotic binary CH Cygni is ideal for this study because it has a long enough orbital period that there will be no confusion between brightness variations that are due to the behavior of the accretion disk and those that are due to the orbit of the binary. The power spectra of X-ray binaries (in particular low-mass X-ray binaries, or LMXBs) display a characteristic set of features. These features include quasi-periodic oscillations and broad components that can be fitted by Lorentzian functions. As the compact objects in LMXBs have weak or non-existent magnetic fields, these features in the power spectra are not due to magnetic accretion. Instead, they are thought to be related to the accretion disk itself, with possible connections to the dynamical, thermal, and viscous time scales at the inner edge of the disk. They have properties and relationships that hold whether the accreting compact object is a neutron star or stellar-mass black hole, and recent observations suggest that supermassive black holes and white dwarfs might also produce the same pattern of variations. If our Kepler observations confirm that the accretion onto an object for which general relativity is not needed to describe the trajectories of matter and radiation near its surface, such as a white dwarf, has the same variability properties as accretion onto a relativistic object such as a black hole or neutron star, there will be several major implications. The more than two decades of research on LMXB variability will become relevant to accreting white dwarfs, and the myriad studies of disks around white dwarfs in cataclysmic binaries will become relevant to LMXBs. Moreover, models for the X-ray variations from LMXBs that invoke general relativity, as the most popular models do, and the possibility of using the features in LMXB power spectra to probe strong gravity, will be called into question. Observing CH Cygni with Kepler is technically challenging because the source is very bright. However, we have made plans to use a custom aperture to overcome these difficulties. Tackling these technical challenges is worth the effort because achieving our science goal will have broad implications, and Kepler is the only instrument that can obtain a long enough continuous light curve with high enough sensitivity to accomplish this goal.