A Novel Class of Spotted/Pulsating Binaries: Models and Analysis

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We propose K2 long cadence observations of 10 Algol-type systems in Fields 4 and 5 to study a new class of short-period interacting binaries that we discovered during Kepler Cycles 1-4. Kepler observations revealed that several systems with Algol-like light curves display unequal brightness at their quadrature phases and that the quadrature brightness ratio varies from > 1 to <1 on a time scale of about 100-400 days. We call these binaries L/T (Leading/Trailing hemisphere) variables. This behavior has never been reported in Algol light curves from ground-based photometry. Some of the L/T systems show delta Scuti-like pulsations on the primary. From the new observations of Algols in K2 Fields 4 and 5, we will investigate the prevalence of the L/T phenomenon in short-period systems and look for the behavior in longer-period Algols in which the gas stream misses the primary star. The L/T phenomenon is likely a result of star spot activity. If the L/T variations are due to hot accretion spots, the L/T phenomenon is a diagnostic of stream behavior (either from normal hydrodynamic flow resulting in shock heating in a direct-impact scenario or impact from a magnetically-controlled stream from the secondary). If the L/T changes are the result of variations in size and distribution of cool spots on the secondary, we gain information on the surface magnetic activity on the mass loser. We propose short cadence observations of the well-known totally-eclipsing system S Cancri from which we can study flare and spot variability on the secondary and variability in its extended atmosphere that is visible just before/just after totality. Pulsation frequencies and behavior will be extracted from the data to compare with Kepler observations of L/T variables. The K2 light curves will be modeled with the newest version of the Wilson-Devinney (WD) program (Wilson 2012) that includes the treatment of variable/migrating star spots. Stellar and spot parameters are determined. K2 provides the continuous photometric coverage of high precision that allows one to identify L/T binaries and study the L/T phenomenon, as the variations are less than 3% of the quadrature flux. A continuous train of eclipse data over many orbital cycles is needed to characterize the variability, including degree of the flux variations and its phase dependence. The project will yield information on the detailed physics of mass transfer, especially the roles of accretion hot spots and magnetic fields, and also test the new WD program (that will be made available to the community) for future applications by others working with the K2 database.