Eclipsing Binaries – Near and Far

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Among Mirek Plavec's most favorite stars are eclipsing binaries that are caught in very rapid stages of binary star evolution in which mass exchange and mass loss are occurring at a fast pace. Because this stage of binary star evolution is brief, these stars are rare in our Galaxy. These rapidly evolving binaries which include such well known stars as β Lyrae, U Cephei and W Serpentis and some symbiotic binaries are complicated systems that often display spectroscopic and brightness changes on time scales shorter than their orbital periods. Generally the spectra of these systems show variable emission and absorption line features and their light curves frequently show features that do not repeat from one orbit to the next. For these reasons it is difficult to secure adequate contemporaneous spectroscopic and photometric observations to define their properties. Moreover, most of these binaries display asymmetric mass flows and have quasi-permanent or transient accretion disks and stellar winds and in some jets to further complicate the picture. For the above reasons, Mirek favorite stars are among the most challenging variable stars to observe and study. In spite of these difficulties Mirek has been relentless in observing and modeling these challenging, but most interesting close binaries. He has unraveled many of their secrets but also has uncovered more mysteries that await solutions. As demonstrated by Mirek's many excellent papers, the study of these stars is exciting and offers important insights into stellar and binary star evolution, accretion processes, mass loss and resultant chemical enrichment of the interstellar medium.

At this meeting honoring Mirek Plavec on the occasion of his 70th birthday, I discuss some observing possibilities that are becoming available for the for study close binaries – not only for studying Mirek's favorite binaries but all types of interacting binaries both nearby and far away. These include interacting binaries that are in the solar neighborhood but also eclipsing binary systems recently discovered by the thousands in nearby galaxies such as the Magellanic Clouds and M31. As a spin-off of photometric microlensing programs such as EROS, OGLE and MACHO, there are now more eclipsing binaries known in the Magellanic Clouds (over 10 000 systems) than found in our Galaxy (about 4000 systems). The large numbers of new systems with well covered light curves significantly increase the sample of binary stars that can be studied. For example, once considered "unique" systems similar to β Lyr and W Ser can be identified and studied from these larger samples of stars. Moreover, a number of uncomplicated, detached eclipsing binaries in the Magellanic Clouds and in the Andromeda Galaxy are proving to be excellent "standard candles" for determination the distances to these galaxies and for calibrating the cosmic distance scale. In addition to the increase in the number of eclipsing binaries available to study, it is now feasible with moderate size telescopes to obtain spectra of nearby stars with spectral resolutions of better than $R = 100\,000$ and with signal to noise values of up to 500:1 to 1000:1. Moreover, as demonstrated from spectroscopic exosolar planet programs of Marcy and Butler and Mayor and Queloz and others it is now practical to measure radial velocities with precision of better than 10 m s^{-1}. While ground based photometry now yields photometric precision of several millimags, recent photometry carried out with HST by Brown and collaborators has yielded light curves of an eclipsing binary star-planet system (HD 209458) with a precision of $\sim$0.1 millimagnitudes. In the near future, photometry from space from a mission like "Kepler" is capable of photometric precision of better than 0.01 millimags. Applying these new techniques to eclipsing binaries can result in many exciting discoveries too numerous to discuss.

Moreover, one of the problems with observing active close binary systems is that their light curves and radial velocity curves do not repeat from cycle to cycle. One solution is to observe these stars continuously and obtain "real time" complete light curves with no need to phase observations obtained weeks or even months apart. Over the last decade it has been possible to conduct continuous observing programs of variable stars using networks of ground based telescopes. The Whole Earth Telescope (WET) is a good example of this approach. In near future continuous observations of southern hemisphere close binaries can be made with telescopes operating in the Antarctic. Also, as demonstrated with the International Ultraviolet Explorer (IUE) satellite, uninterrupted observations from space are ideal for studying many types of active binary systems. In the next few years, several asteroseismology and exosolar planet transit search space missions such as MOST, COROT, RÖMER, Kepler and Eddington will be capable of observing star fields continuously. Although not the primary aim of these missions, continuous observing runs of hundreds (even thousands) of eclipsing binary star systems will be obtained. Perhaps a few of Mirek's favorite stars should be proposed for observations with these satellites or from ground-based telescope networks. In addition to these developments, multiwavelength observations of selected pivotal close binaries can made from X-ray to radio wavelengths from space and from the ground. Coordinated multiwavelength photometric and spectroscopic are powerful methods for the study of close binaries.

Another development is the possibility of observing nearby eclipsing binaries such as β Lyr and Algol with interferometers that will permit the individual components of the binary to be spatially resolved. There are several optical interferometers with angular resolution capabilities of better than 0.5 milliarcseconds. Within the next decade, with planned space interferometric missions designed primarily to detect exosolar planets, it may even be possible to image directly nearby interacting binaries. For example, the planned NASA mission Space Interferometer Mission (SIM), which has an expected angular resolution of $\sim 10^{-6}$ arcseconds ($\sim$1 microarcsecond), should be in operation. With SIM it will be possible to observe the small astrometric motions and determine super-accurate parallaxes of many galactic interacting binaries. SIM is even capable of measuring the orbital motions of long period ($P > 100$ d) binaries in the Magellanic Clouds. Images of selected close binaries and their expected accretion structures should prove very interesting and serve as reality checks on our models derived from radial velocity and light curve studies. With such images we may be able to see how close (or far off) we have been in constructing models for these stars.

Thus, using the powerful new tools and techniques currently available (or that will be available during this decade) unprecedented opportunities await us to study and to finally understand many of Mirek's favorite stars as well as other classes of interacting binaries in our Galaxy and the legions of new binary systems in the Local Group galaxies. We live in exciting times for research in close binaries and it is appropriate that we discuss these opportunities at Mirek's 70th birthday and hope that we can all return to celebrate many more birthdays together.