Precise White Dwarf Masses and Radii from Eclipsing White Dwarf-Main-Sequence Binaries

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The number of eclipsing white dwarf / low-mass M dwarf binaries has increased rapidly in the last few years thanks mainly to surveys such as the SDSS. We now know of 20 eclipsing Post Common Envelope binaries (PCEBs) 13 of which have been discovered within the past two years. These systems are the result of a dramatic "common envelope" phase in their past during which the two stars loose angular momentum and mass orbiting within a single envelope of material, resulting in the tightly bound systems we see today. The deep primary eclipses caused by the low-mass star passing in front of the white dwarf, help constrain the basic parameters of the system. However, a primary eclipse alone cannot independently determine the radii of both the stars and the orbital inclination. In order to break this degeneracy we require an additional observation. A measurement of the depth of the secondary eclipse gives the ratio of the two stars radii which, combined with the primary eclipse data, allows us to independently determine both scaled stellar radii (R/a, where a is the orbital separation) and the inclination. If this data is combined with phase resolved spectroscopy that measures the radial velocity amplitudes of both stars, then it is possible to determine both the mass and radius of both stars independent of any stellar models or mass-radius relations. We have recently applied this approach to an eclipsing PCEB and measured the masses and radii of both the white dwarf and low-mass M dwarf with a precision that rivals or exceeds the best measurements of either of these types of star. By combining UVES spectroscopy and ULTRACAM photometry, the mass and radius of white dwarf in the PCEB NN Ser are now amongst the most precise for a white dwarf, precise enough to fix the hydrogen layer fractional mass at 10^{-4}. We are now attempting to detect the secondary eclipses in a number of similar systems and determine the system parameters in a similar way. The end result of this work will be a set of white dwarfs with accurate and precise masses and radii helping to improve existing mass-radius relations and constrain theories of white dwarf structure. Here we present our work on the system NN Ser and our latest work on detecting the secondary eclipses in other systems.