THESIS ABSTRACT

Eclipsing Binary Stars in Open Clusters

By John K Taylor

The study of detached eclipsing binaries allows accurate absolute masses, radii and luminosities to be measured for two stars of the same chemical composition, distance and age. These data can be used to test theoretical stellar models, investigate the properties of peculiar stars, and calculate the distance to the binary using empirical methods. Detached eclipsing binaries in open clusters allow a more careful test of theoretical models, which must simultaneously match the properties of the eclipsing system and the morphology of the cluster colour-magnitude diagram. In addition, an accurate distance and a precise age and metal abundance may be found for the cluster from the properties of the eclipsing system, avoiding the difficulties inherent in obtaining these properties from matching isochrones to the cluster stars in a colour-magnitude diagram.

Absolute dimensions have been found for V615 Per and V618 Per, which are eclipsing members of the young open cluster h Persei (NGC 869). The fractional metal abundance of the cluster has been found to be $Z \approx 0.01$ by comparing the properties of V615 Per and V618 Per to the predictions of theoretical stellar evolutionary models, in disagreement with assumptions of a solar chemical composition in previous works.

Accurate absolute dimensions (masses to 1.4%, radii to 1.1% and effective temperatures to within 800 K) have been measured for V453 Cygni, a member of the young open cluster NGC 6871. The current generation of theoretical stellar models can match these properties for an age of 10.0 ± 0.2 Myr and a solar chemical composition. The models also successfully predict the the central concentration of mass of the primary star derived from a study of the apsidal motion of the system. A Monte Carlo simulation technique has been implemented to determine robust uncertainties in the results of the photometric analysis of detached eclipsing binaries.

The B-type subgiant eclipsing system V621 Per, a member of the open cluster χ Persei (NGC 884) has been studied. The absolute dimensions of the system have not

been measured as the secondary star is not detectable in our spectroscopic observations, but have been inferred from a comparison with theoretical models. The secondary star should be detectable in very high-quality spectra, in which case further study of this system will be very rewarding.

Absolute dimensions have been determined for HD 23642, a member of the Pleiades. A new method of measuring the distance to detached eclipsing binaries has been introduced, based on calibrations between surface brightness and effective temperature. This method gives a distance of 139 ± 4 pc to the Pleiades, in good agreement with several recent distance measurements but not with the controversial distance of 120 ± 3 pc found using parallax measurements from the *Hipparcos* satellite. Both the new distance determination method and well-established techniques using bolometric corrections perform better at near-infrared wavelengths, where surface brightness depends less strongly on effective temperature and the effects of interstellar extinction are smaller, than in the optical.

The metallic-lined eclipsing binary WW Aur has been studied using extensive new spectroscopy and published light curves. The masses and radii have been found to accuracies of 0.4% and 0.6% respectively, using entirely empirical methods. The effective temperatures of both stars have been found using a method which is almost fundamental. The predictions of theoretical models can only match the properties of WW Aur by adopting a large metal abundance of $Z = 0.060 \pm 0.005$.

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John Taylor publishes under the name of John Southworth. The full thesis is available electronically at http://www.astro.keele.ac.uk/∼jkt/pubs.html#thesis, along with several other resources useful in the study of eclipsing binary stars.