

Abstract

The multiplicity of stars is a well-established phenomenon. But still, the theory of formation, evolution, and stability of multiple-star systems is a field that has a lot of unanswered questions. One of the least studied aspects in one of the simplest multiplicities is the evolution of hierarchical triple systems. Triple systems have been used as an explanation for the formation of close binaries, blue stragglers, planetary nebulae, and also the merger of several black holes. But most of these systems have long outer periods and their dynamic effects can have timescales of years and decades. Therefore studying them in detail can be a time-consuming process.

Meanwhile, there is a subset of these triples called the Compact Hierarchical Triple (CHT), which offers more potential for observational astrophysics. These are triple systems with an outer orbit period of fewer than 1000 days. CHT were once considered to be rare but with new observations from photometric space missions, we are discovering more of these systems. CHTs lay in the domain where we can see most, if not all, of the different dynamical interactions that occur in a triple star system. The dynamic processes in CHTs can be observed in time scales less than a human lifetime. Since most of the triples known previously have wide orbits, these systems are one of the remaining candidates to explore the full scale of triple systems. Therefore CHTs can act as probes to multiple-star formation, dynamics and evolution. The orbital separations of these systems are similar to planetary systems. Understanding CHTs can thus act as a stepping stone for understanding planetary formation and evolution. Till now, the number of CHT candidates is less than 700. Only 43 have been completely characterised. Therefore, we need to (i) detect more CHTs to improve the sample, and (ii) characterise the stellar, orbital and atmospheric parameters to understand the configurations of these systems.

Detached Eclipsing Binaries (DEB) are known as the source of the most accurate stellar parameters. We can reach accuracy up to less than 1% with high-quality observations. Such accurate stellar parameters are difficult to obtain with other methods. If a CHT has a DEB as their inner binary, we have an added advantage of obtaining very accurate stellar parameters of not only the binary but of the tertiary as well. In this thesis, we detect and also obtain an accurate picture of the orbits, geometry, metallicity, age, and evolutionary status of a sample of CHTs.

We search for CHT with the method of eclipse timing variations (ETV) using observations from the *Solaris* photometric survey. A radial velocity search, using doubled-lined and triple-lined DEB, is carried out using high-resolution spectroscopy. We supplement the spectroscopy with high-precision *TESS* photometry for our sample of CHT. Using complex contemporary techniques in modern astronomy, we obtain stellar, orbital, and atmospheric parameters of all three stars in a CHT. Light curve modelling, radial velocity modelling, spectral disentangling, and spectral analysis are all carried out to get a set

of independent and consistent set of parameters. Using these parameters we probe the evolution, dynamics and distribution of the parameters, with a goal of constraining the formation theories of these rare systems.

In this thesis, we report the detection of nine low-mass CHTs. 6 CHTs are analysed in detail to give the first detailed spectroscopic analyses of these CHTs. In our detailed analyses, we find the ages of the CHTs as well as the evolutionary states of all stars in the system. There exist around 43 CHTs in the literature with the same detail in analyses as our work provides. We add our systems to this sample to visualise distributions of different parameters and study their implication on the current CHT formation and evolution theories. Apart from contributing to studies of CHTs, we add 6 DEBs to the collection of accurate parameters of eclipsing binaries. While this is a small addition to a small sample, the work sets the foundation for future studies of CHTs and multiples using upcoming high-resolution spectrographs and precision space telescopes.