

Preface

Binary stars are essential laboratories in stellar astrophysics. Observations of binary stars allow us to determine fundamental parameters of stars, such as mass, radius and luminosity, to high precision. These measurements are used to calibrate stellar structure and evolution models. Furthermore, stars in binaries can undergo processes not seen in single stars, such as mass transfer, due to which one star can influence the life of the other.

In this book, we present detailed studies of a variety of compact variable stars as well as new theoretical and instrumental tools to aid such studies. The individual systems studied in this thesis are all binary stars that are undergoing or underwent an epoch of mass transfer from one star to the other.

We start with spectroscopic studies of two moderately magnetic cataclysmic variables (intermediate polars) that are among those with the fastest spinning white dwarfs. Our study of the prototype of the intermediate polars, DQ Her, revealed the presence of a spiral density structure in its accretion disc. By folding our spin resolved spectroscopic measurements on the spin period of the white dwarf, we detected spectral line variations that can clearly not be explained by reprocessing of X-rays in the accretion disc, which was long assumed to be the cause of the variability. We detected very different but equally intriguing spin cycle variations in the spectra of the second intermediate polar we have studied; V455 and our findings indicate that accretion curtain emission is probably observed. Our study of V455 and provides a beautiful demonstration of the power of Electron Multiplying CCDs (EMCCDs) to perform high-speed astronomical observations of relatively faint targets.

Next, we present an in-depth study of light curves of two compact binaries obtained with the *Kepler* satellite. These two targets, KPD1946+4340 and KOI-74, are the first binaries that were found to show very significant Doppler beaming signals. We have modelled the light curves, taking into account the effects of reflection, ellipsoidal modulation, microlensing, Doppler beaming and eclipses. Accurate system parameters were determined, while paying special attention to deriving reliable uncertainty estimates. Our study of KPD1946+4340 presents the first comparison of a star's radial velocity amplitude as measured from

spectroscopy and as measured from photometry using the observed Doppler beaming amplitude. We conclude that the photometric and spectroscopic radial velocity amplitudes are in agreement, for both targets, and that Doppler beaming can successfully be used to measure radial velocities. In the case of KOI-74 we have shown how one can derive the mass ratio of selected binaries from photometry alone, by exploiting Doppler beaming and light travel time (Rømer) delay signals.

Finally, we discuss ongoing efforts in the field of asteroseismology of hot subdwarf stars. We present a grid of evolutionary subdwarf B star models that are computed while taking into account diffusion processes. We show that the Fe and Ni enhancements in the pulsation driving regions are higher than previously assumed, and we show the influence on the predicted instability strips for p - and g -mode pulsators. Using the grid of subdwarf structure models, synthetic amplitude ratios of pulsation modes observed in different colour filters are computed. Such amplitude ratios are sensitive to the spherical degree of the pulsation modes and provide valuable observational constraints to asteroseismic studies. The new 3-channel Mercator Advanced Imager for Asteroseismology, MAIA, was developed to provide measurements of pulsation amplitudes in different colour bands. We end this thesis with a status update of the commissioning of this new camera, which was installed at the Mercator telescope in the Spring of 2012.

All efforts presented in this book were the subject of my Ph.D. research, which I conducted at the University of Leuven from September 2009 until May 2013 under the supervision of Prof. Conny Aerts and Dr. Roy Østensen. It was a very rewarding experience to work with great colleagues on such a variety of topics, using state-of-the-art techniques and instrumentation. I hope that, through this diversity, the readers of this book will appreciate the beautiful and sometimes unexpected ways in which binary stars present us with clues to what they look like and how they live.

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Bloemen, S.

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