ASTROPHYSICS

Application of machine-learning to the study of eclipsing binary stars.
supervisor: doc. Mgr. Štefan Parimucha, PhD. (stefan.parimucha@upjs.sk)
study form: full time
Annotation: Eclipsing binary stars are variable stars whose light curve analysis allows us to determine the basic parameters of the components, such as their effective temperatures, radii, luminosity, and in combination with radial velocities also the masses and mutual distances of the components. These variable stars are one of the most commonly discovered types of variable stars. Archived data from satellite (KEPLER, TESS, GAIA) as well as from ground-based projects (SuperWASP, ASASS…) contain tens of thousands of eclipsing binary stars. It is assumed that planned large-scale surveys such as PLATO and/or Vera C. Rubin Observatory (LSST) will discover several millions of eclipsing binaries. Their analysis using up-to-date conventional methods is practically impossible. One of the possible ways of their study is the application of machine-learning methods to large data sets and the determination of parameter boundaries from their light curves.
References:
Gimenez A. et al., 2007, Close Binaries in the 21st Century: New Opportunities and Challenges, Springer Hearty J., 2016, Advanced Machine Learning With Python, Packt Publishing Kallrath J., Milone E.F, 2009, Eclipsing Binary Stars: Modeling and Analysis, Springer Prsa A, 2017, Modeling and Analysis of Eclipsing Binary Stars, IOP Publishing Unpingco J., 2016, Python for Probability, Statistics, and Machine Learning, Springer

Multifrequency study of the activity of symbiotic binaries.
supervisor: doc. Mgr. Rudolf Gális, PhD. (rudolf.galis@upjs.sk)
study form: full time
Annotation: Symbiotic systems belong to a group of interacting binaries, in which the physical mechanisms related to the mass transfer and accretion are responsible for observable activity of these eruptive variable stars. Our previous investigation showed that a long-term monitoring of the objects during the whole cycle of their activity in a broad spectral range is necessary for better understanding of these physical processes. The main goal of the PhD thesis is study of behaviour of accretion disks, impacts, jets and other phenomena related to the mass transfer in different phases of activity in the symbiotic systems that have recently manifested Z-type outbursts (e.g. AX Per, AG Dra and Z And) using own photometric and spectroscopic observational data and modelling of their light curves and spectra.
References:
Kenyon, S. J., 1986, The symbiotic stars, Cambridge University Press, Cambridge Hellier, C.: 2001, Cataclysmic Variable Stars - How and Why they Vary, Springer, Chichester Warner, B.: 1995, Cataclysmic Variable Stars, Cambridge University Press, Cambridge

Short-period cutoff of contact binaries.
supervisor: RNDr. Theodor Pribulla, CSc. (pribulla@ta3.sk)
study form: full time, Astronomical institute of the Slovak Academy of Sciences
Annotation: Contact binary stars show an orbital period cut-off at about 0.20 days. Systems with shorter orbital periods are not observed. This observational fact has still not been satisfactorily explained and the number of objects with orbital periods shorter than 0.22 days

is only about 25. This is related to another observational fact: contact binaries with spectral types later than K are not observed. It is not clear, if the period cut-off is an observational bias (these systems are intrinsically faint) or it is a real effect caused by the internal structure change between the K and M spectral types (fully convective interior for stars later than about M5). A possible explanation can be slow evolution of low-mass stars. Hence, such systems could not have yet evolved in the Universe.

References:

Benacquista, M., 2012, An Introduction to the Evolution of Single and Binary Stars, Springer

Claret, A., Gimenez, A., 2001, Binary Stars. Selected Topics on Observations and Physical Processes, Springer

Hilditch, R.W., 2001, An Introduction to Close Binary Stars, Cambridge University Press

Rucinski, S.M., 1992, Can Full Convection Explain the Observed Short-Period Limit of the W UMa-Type Binaries?, Astronomical Journal, 103, p960-966

Rucinski, S.M., 2007, The short-period end of the contact binary period distribution based on the All-Sky Automated Survey, MNRAS 382, p393-396

Zhang, X.D., Qian, S.B., 2020, Orbital period cut-off of W UMa-type contact binaries, MNRAS 497, 3493- 3503