ABSTRACT FOR THE GENERAL PUBLIC

Observational astronomy today is going through the “Big Data” revolution. More and more instruments and facilities focus on quick and efficient gathering of data for thousands and even millions of targets nearly at the same time. Lets take for example the Vera C. Rubin Observatory (a.k.a. LSST) – the 8.4-m behemoth that will scan the entire available sky in just few nights, producing up to 20 TB of data each night. Other, ongoing projects, although much smaller in scale, also produce immense amount of observations. The general idea is to observe as much as possible, so the data can be used for many more scientific topics, than just those that the specific instrument was designed for. In principle, any researcher with an idea can have the necessary data almost for free.

One of such “all-sky”, “free data” instruments is the *Transiting Exoplanet Survey Satellite* (TESS), a spacecraft designed to detect transiting extrasolar planets by looking for small, periodic dips (transits) in the brightness of the host star. For about 28 days it observes the same, large portion of the sky, recording images every 10 or 30 minutes, as well as brightness measurements (photometry) for some pre-selected targets every 2 minutes, or 20 seconds in some cases. Then it moves to another field of view, and continues observations. Nearly entire sky is covered in two years, with some specific areas being observed continuously for a year straight. This way TESS produces brightness measurements for hundreds of thousands of stars (and other objects!), and makes them freely available for everyone. No wonder that it became very popular among researchers focused on many other kinds of astronomical studies. One of the topics that benefit the most from the TESS mission are eclipsing binaries.

Detached eclipsing binaries (DEBs) are one of the most important objects for stellar astrophysics. They are pairs of stars that formed in the same time from the same cloud of gas and dust, which orbit around themselves in a way that once a while one hides behind the other. In the same time they have no other influence on themselves as through the gravity; in particular there is no transfer of material from one star to the other. Such configuration allows us to measure fundamental stellar properties, such as the sizes of stars, their individual brightnesses, and masses. Especially the last one is very important, as it determines how a star changes during the course of its life. Also, from the DEB’s spectra (after some clever manipulations) we can measure the motion of the stars (so called “radial velocities”, RVs), estimate the shape of the orbit, and say something about the stars atmospheres, like what are their temperatures or chemical compositions. The amount of information we can determine from DEBs, and what we can do with them later, make the DEBs one of the most useful objects in astronomy.

But to actually get those information, and make them truly valuable, we need to reach a certain good level of precision. A rule-of-thumb value is 2% error in stellar mass and radius, but the lower error the better. This is because the more precise data we obtain, the more stringent tests of our knowledge about stars we can make – some phenomena that occur in stellar interiors affect the observable characteristics at the level of 0.5% or lower. For such precise results, one needs super-precise observational data to begin with. Thus the TESS satellite became quite handy, as it currently produces the best available brightness measurements, and for a huge number of stars. But photometry alone is not enough for DEBs. One needs high-resolution spectra, from the most stable spectrographs, to get super-precise RV measurements. Unfortunately, there is no machine (yet) that does it automatically for the entire sky and even comparable number of targets to TESS. Dedicated observations take years, even decades, and huge amount of resources. Establishing a new, single spectroscopic survey just to exploit TESS data would not be possible. Unless, such survey already existed...

The *Comprehensive Research with Échelles on the Most interesting Eclipsing binaries* (CRÉME) project began in 2011 as an RV survey of DEBs from another photometric project (ASAS), aimed to search and thoroughly characterize new examples of rare or otherwise interesting stars in DEBs. With almost 400 targets from the entire sky, regularly monitored over several years, CRÉME allowed to identify a vast number of exciting objects, like very light or very heavy stars, old giants, multiple systems, different kinds of pulsators, etc. (Un)fortunately, it turned out to be of much better quality than its photometric counterpart at that time: the ASAS data (or other data from ground based telescopes) were simply not good enough for the CRÉMEs goals. Only after the launch of TESS the true potential of CRÉME could be seen.

With the combined CRÉME and TESS abilities, we are now ready to push the limits of the DEBs studies, and bring to light hundreds of new and precisely studied cases of rare, exotic, and interesting stars.