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Stellar activity cycles from long-term data by robotic telescopes

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Abstract. All results about stellar activity cycles stem from decades-long systematic observations that were done by small telescopes. Without these equipments we would not know much, *if anything*, about stellar activity cycles, like those we see and observe easily on the nearest star, the Sun.

In the early 80's of the last century systematic photometric monitoring of active stars began with automated photometric telescopes (APTs), some of which continue the observations to date. The Vienna-Potsdam APT now works for about two decades (Strassmeier et al. 1997), similarly to the 4-College Consortium APT (Dukes et al. 1995), while the Catania APT (Rodono et al. 2001) was closed down a few years ago. These small tools with the same setups for decades do not cost much and are relatively cheap to maintain. The longest continuous photometric datasets of a few objects from APTs span now over 30 years, which, together with earlier, manually-obtained data allow to study those activity cycles of stars which are in the order of 10 years or shorter: to be sure in the timescale of a cycle it should be observed repeatedly at least 2-3 times.

The spectroscopic automated telescope STELLA (Strassmeier et al. 2004), built in the first decade of this century, measured already a few dozens of radial velocity curves for long-period binary stars and measured their activity levels (Strassmeier et al. 2012); these results can be gathered only by robotic telescopes. Only with STELLA it is possible to study the decades-long behavior of starspots on active giants with long rotational periods via Doppler Imaging.

As the databases were growing it became clear that stars, just as the Sun, had multiple cycles. It was also found that stellar cycles showed systematic changes and that the cycle lengths correlated with the rotational periods of the stars. Extensive summaries of stellar activity cycles are found in Baliunas et al. (1995) using the Mt. Wilson Ca-index survey, and Oláh et al. (2009) based on automated photometry+manual data from the literature, resulting in the detection of positive correlation between the rotational rates and cycle length(s) in the sense that faster rotating stars have shorter cycle(s). The long-term, $B-V$ and $U-B$ color index changes of active stars were thoroughly studied by Messina (2008). Direct connection between the magnetic behavior and the orbit of a system containing an active star is seldom observed; such examples are presented by Strassmeier et al. (2011) and Oláh et al. (2013).

Based on the data from the DASCH (Digital Access to a Sky Century at Harvard) project, three active K-giants' long-term variability on the timescale

of decades to 100 years have beed discovered by Tang et al. (2010). The ASAS database was used to study the cyclic behavior of field M-dwarf stars by Savanov (2012) who found no correlation between the rotation rates and cycle lengths of these objects, suggesting a different type of dynamo to those that drive the dynamo in the RS CVn systems and related active stars, e.g., in Oláh et al. (2009). Recently, Vida & Oláh (2013) determined cycles on the timescale of a year on fast rotating, late-type dwarf stars measured by the *Kepler* space telescope. However, despite the extremely high precision and time cadence, the Kepler data do not allow to study very long- term phenomena, such as the activity cycles of solar-like stars, due to the limited lifetime of the mission.

One of the most important factors in studying stellar activity cycles is **time**, which cannot be overtaken by any means. It needs systematic, uninterrupted observations for dozens of years, preferably with the same instrument, to avoid systematic effects in the observed long-term variations. Another point is that most of the known magnetically active stars are quite bright objects needing a small telescope to be observed. The construction of automated photometric and spectroscopic telescopes is one of the major, and at the same time low-cost, investments in astronomy. These telescopes and their equipments should be preserved and used as long as possible, replaced when necessary, but never closed down.

Key words: stars – activity – cycles

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