Chapter 5. Role of magnetic fields in solar and stellar variability

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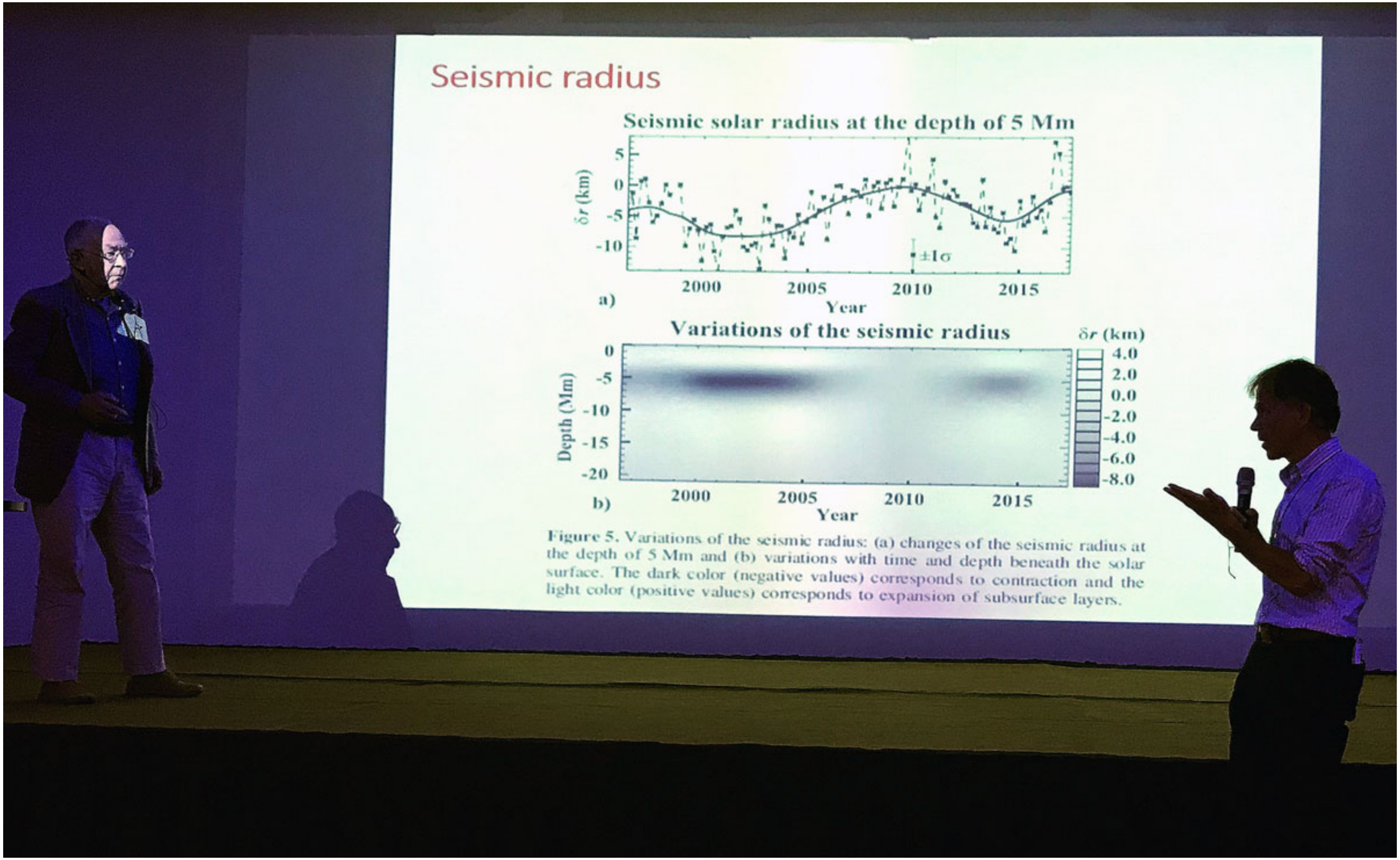

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Possible evidence for a magnetic dynamo in hot Algols

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Abstract. We present the case of hot semi-detached Algols showing photometric cycles longer than the orbital period. The evidence indicating that this long cycle might be due to a magnetic dynamo operating in the rapidly rotating donor star is examined.

Keywords. binaries: spectroscopic, close, stars: evolution.

Double Periodic Variables (DPVs) are hot semi-detached Algols with β Lyrae type light curves showing a long cycle lasting in average about 33 times the orbital period (Mennickent *et al.* 2003). The more evolved star transfers matter onto the hotter, less-evolved B-type star through Roche-lobe overflow, forming an accretion disc around it. More than 200 DPVs have been found in the Galaxy and Magellanic Clouds. Catalogs of DPVs have been published by Poleski *et al.* (2010), Pawlak *et al.* (2013) and Mennickent (2017). Recently, G. Rojas (M.Sc. thesis, University of Concepción, 2019, Fig. 1) found 34 new Galactic DPVs after a search in the catalog "Eclipsing and ellipsoidal binary systems towards the Galactic Bulge" by Soszyński *et al.* (2016). DPVs are hotter and more luminous than classical Algols. Galactic DPVs include β Lyrae (Guinan 1989) and AU Mon (Lorenzi 1980). Kalv (1979) interpreted the 516-d periodicity of RX Cas as pulsations of the Roche-lobe filling star. Pulsation is also suggested by Guinan (1989) for the B8 II secondary of β Lyrae. Peters (1984) suggests that the long cycles in AU Mon are due to cyclic pulsations of the mass transferring star. The DPVs have been reviewed by Mennickent *et al.* (2016) and Mennickent (2017).

A recent hypothesis for the long cycle involves a magnetic dynamo operating in the donor star through the Applegate mechanism (Schleicher & Mennickent 2017). A modulation of the strength of the wind generated in the stream/disc interaction region has been proposed as the cause for the long cycle. This could happen when the Applegate (1992) mechanism modifies the stellar quadrupole momentum redistributing angular momentum in the binary and producing cyclic mass loss through the inner Lagrangian point linked to changes in the equatorial radius of the donor. Actually, magneto-hydrodynamical simulations reveal changes in the stellar structure due to magnetic cycles and suggest how relevant the stellar rotation can be in rapidly rotating orbitally synchronized binary star components (Navarrete *et al.* 2019). Rapid rotation might generate stellar dynamos even in early A-type giants, as suggested by the presence of chromospheric emission

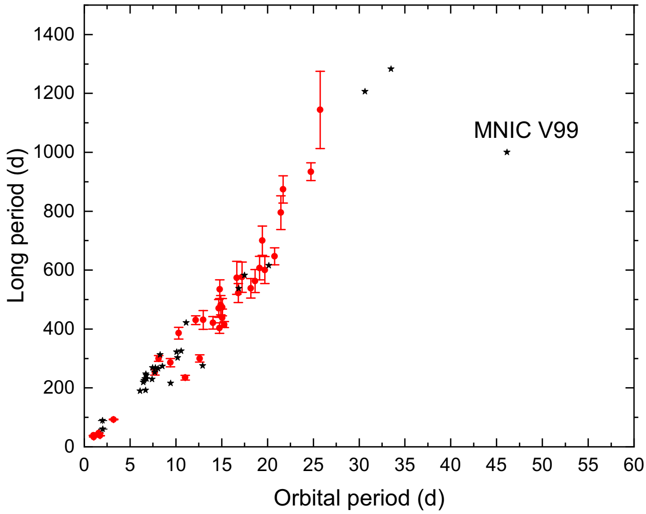

Figure 1. Long versus orbital period for Galactic DPVs. The new DPVs found by Rojas (M.Sc. thesis 2019) are shown by dots while the rest are listed in Mennickent (2017), Rosales & Mennicken (2017, 2018, 2019) and the VSX database (https://www.aavso.org/vsx/). MNIC V99, reported by Nikolay Mishevskiy in VSX, has a period ratio of 21.67, similar to β Lyrae (21.25).

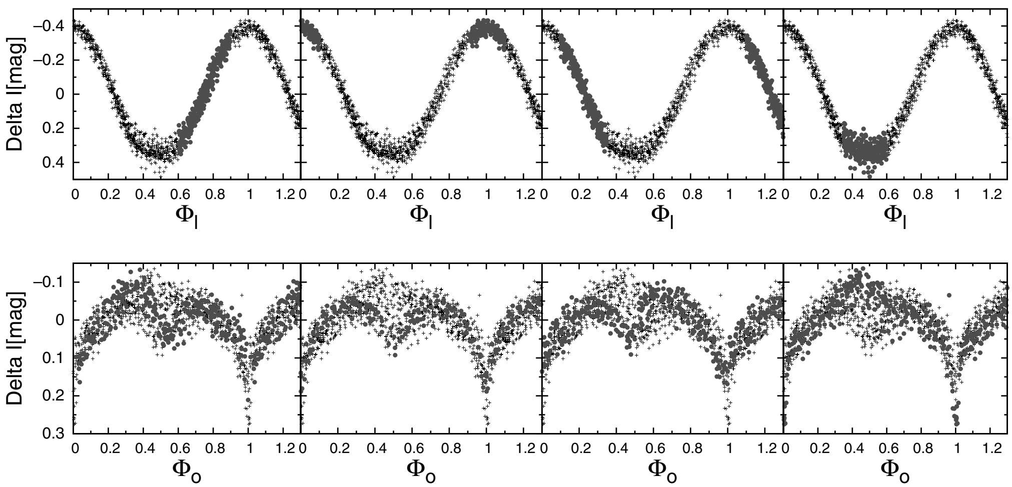

Figure 2. Disentangled long cycle (up) and orbital (down) light curves phased with the respective periods for OGLE-LMC-DPV-097. Crooses show the complete datasets, dots show segments of the data of the long cycle (Garcés *et al.* 2018). The changes in the orbital light curve might reflect structural changes in the accretion disk due to variable mass transfer.

in some DPVs and the increase of the dynamo number during mass transfer episodes (e.g. Mennickent, Schleicher & San Martin-Perez 2018, San Martín-Pérez *et al.* 2019). In cases of synchronous rotation Schleicher & Mennickent (2017) arrive to a theoretical expression that fits relatively well the observed DPV cycle lengths. The scenario of a magnetic dynamo might explain remarkable changes observed in the orbital light curve of OGLE-LMC-DPV-097, OGLE-BLG-ECL-157529 and some other DPVs during the long cycle (Garcés *et al.* 2018, Garcés M.Sc. thesis, University of Concepción, 2019, Mennickent *et al.* 2020, Fig. 2 and Fig. 3). Future studies should try to get direct evidence of magnetic fields in these systems, for example through spectropolarimetric

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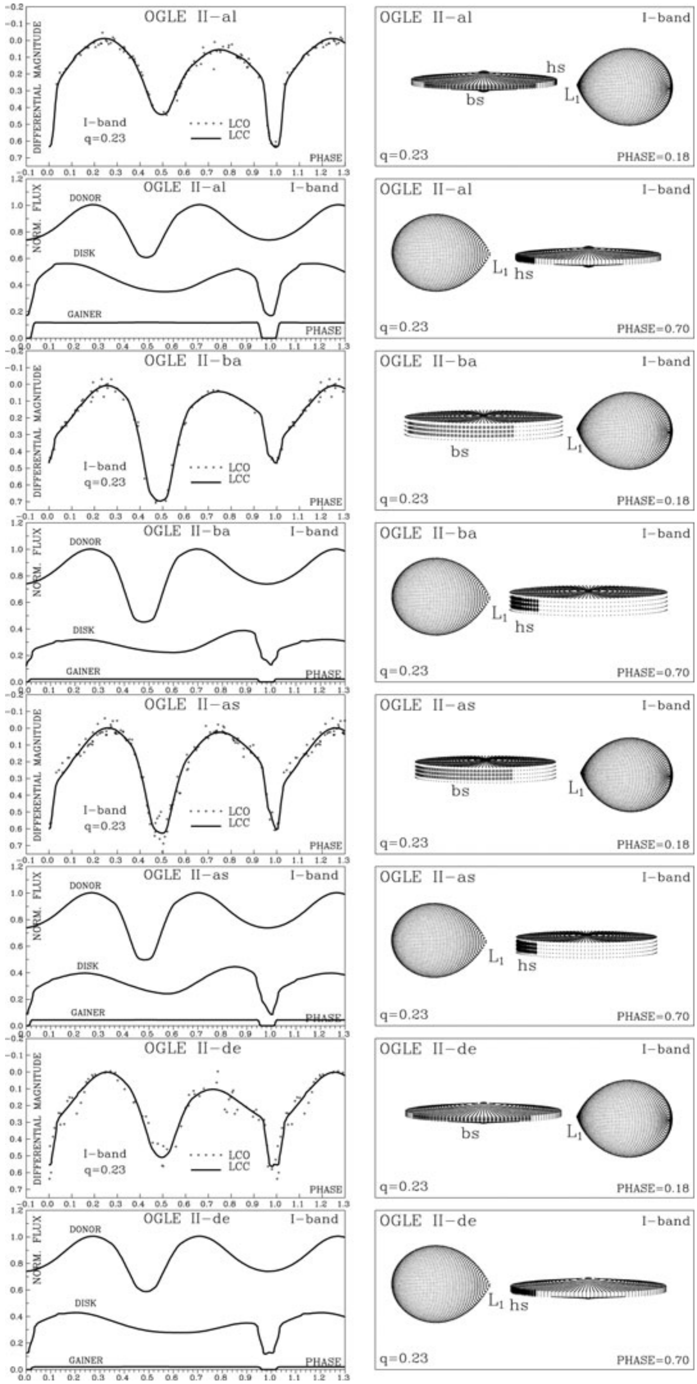

Figure 3. Orbital light curve models for OGLE-BLG-ECL-157529 at the high stage (al), low stage (ba), ascending branch (as) and descending branch (de) of the long cycle (Mennickent *et al.* 2020).

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techniques. Actually, magnetic fields have been inferred in β Lyrae from the analysis of polarized light; these fields could produce magnetically driven streams onto the accretion disk (Skulskij 1982, 2018). Still is not clear if magnetic fields are present in DPVs in general, and why some semi-detached binaries containing B-type components do not show long-term photometric modulations (e.g. Koubský *et al.* 2019).

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