Searching for anti-solar differentially rotating stars - An application to the *Kepler* field

Over the last decades, anti-solar differential rotation profiles have been found in numerical simulations of convective envelopes of low-mass stars. These profiles are characterized by a slow equator and fast poles (reversed with respect to the Sun), and occur in simulations for high Rossby numbers. At the same time, anti-solar differential rotation profiles have been reported in evolved stars, but never unambiguously observed for solar-type stars on the main-sequence.
As the Sun ages and spins down, its effective Rossby number increases, which could induce a transition toward an anti-solar regime before the end of the main-sequence. Such a rotational transition would have an impact on the large-scale dynamo process and magnetic activity. The detection of anti-solar rotation for main-sequence stars would therefore improve our understanding of the magneto-rotational evolution of solar-type stars. In particular, this transition could be at the origin of the weakened angular momentum loss that might be observed for old solar-like stars.

In this context, we use the *Kepler* survey in order to identify main-sequence stellar targets that might exhibit an anti-solar differential rotation profile. To do that, we develop a new theoretical formula, motivated by numerical simulations, in order to estimate the fluid Rossby numbers of solar-like stars from observable quantities. In this development, we take into account structural, metallic and evolutionary aspects. We quantify the fluid Rossby number of 50,656 *Kepler* targets using the most recent catalog of rotational periods (Santos et al. 2021).

After checking individually each selected target, we obtain a catalog of 22 candidates likely in a state of anti-solar differential rotation. We conclude that promising cool main-sequence stellar candidates for anti-solar differential rotation already exist in the *Kepler* field, even though their number is small. Future characterization of these stars would increase our understanding of the mechanisms impacting magnetic and rotational evolution of old solar-type stars at high Rossby number.