

Unravelling the mysteries of AF-type stars

Prepared by Victoria Antoci, Peter De Cat and Gerald Handler

The region in the HR-diagram where the classical instability strip intersects with the main-sequence hosts AF-type stars that are affected by a rich variety of phenomena:

- Stars with a peculiar chemical composition (CP stars), like Ap SrCrEu stars (magnetic stars with H-line types between A3 and F0 which are overabundant in Sr, Cr and Eu), Am stars (non-magnetic stars with H-line types between A0 and F1 which are overabundant in Fe-peak elements) and λ Bootis stars (non-magnetic stars with H-line types between A0 and F0 showing underabundances of Fe-peak elements but solar C/N/O/S abundances).
- Stars with pulsations, like δ Scuti (δ Sct) stars (main-sequence/giant mid-to-late A-stars with low-overtone pressure modes, probing the outer layers, with typical periods of 0.5-6 hours and excited by the κ mechanism acting on the the He II ionisation zone), γ Doradus (γ Dor) stars (main-sequence early F-type stars with high-overtone gravity-modes, probing the inner layers, with typical periods of 0.5-3 days and excited by a flux blocking mechanism at the bottom of the outer convection zone) and rapidly oscillating Ap (roAp) stars (Ap SrCrEu stars with very high-overtone pressure-modes with typical periods of 5-15 minutes; the excitation mechanism is not fully understood). Stochastic driving of pulsation modes can also occur for stars with a(n efficient) convective envelope (the cool edge of this region).
- Stars in binary or multiple systems. As their components share a common origin (they were formed from the same parent cloud), multiplicity provides additional constraints on the age and the overall chemical composition. Moreover, in close systems, tidal interactions affect their pulsations and, indirectly, their photospheric chemical composition.

Hybrid pulsators exhibiting different types of pulsation modes simultaneously are the most interesting asteroseismic targets as different internal regions can be probed at the same time. The observations of the nominal *Kepler* mission have shown that δ Sct/ γ Dor hybrids are a common phenomenon rather than an exception (Grigahcène et al. 2010, ApJ, 713, L192; Uytterhoeven et al. 2011, A&A, 534, A125). From a theoretical point of view, the flux blocking mechanism can operate only if the outer convective envelope has a depth between 3 and 9% of the stellar radius. Uytterhoeven et al. (2011), however, show that γ Dor stars as well as the *candidate* δ Sct/ γ Dor hybrids are populating the entire instability strip. Recent studies seem to confirm these findings (Tkachenko et al. 2012, MNRAS 422, 2960; Tkachenko et al. 2013, MNRAS, 431, 3685; Hareter 2012, AN 333, 1048; Balona 2014, MNRAS 437, 1476). If the flux blocking theory is correct, all these stars should have convective envelopes of a considerable depth, certainly a surprise in the hot part of the instability strip. However, a recent study of candidate γ Dor *Kepler* stars suggests that they are confined in the common part of the γ Dor and δ Sct instability strips (Tkachenko et al., 2013, A&A 556, A52). Also a clear upwards correlation is found between $v \sin i$ and the frequencies of independent pulsation modes, confirming the theoretical prediction of Bouabid et al. (2013, MNRAS, 429, 2500) that rotation shifts the frequency spectrum of g-modes to higher values.

For a better understanding of the different phenomena at play, we request a K2-survey of A0-to F5-type stars in LC mode. We give priority to bright objects with known parallax as ground-based follow-up spectroscopy is needed to complement the morphology of the variability to reach our goal, i.e. the stars labeled as *high priority* targets in the accompanying excel file (high priority: #52 on silicon, #62 close to silicon; low priority: #23 on silicon, #29 close to silicon).