Asteroseismic modelling of A- and F-type pulsators*

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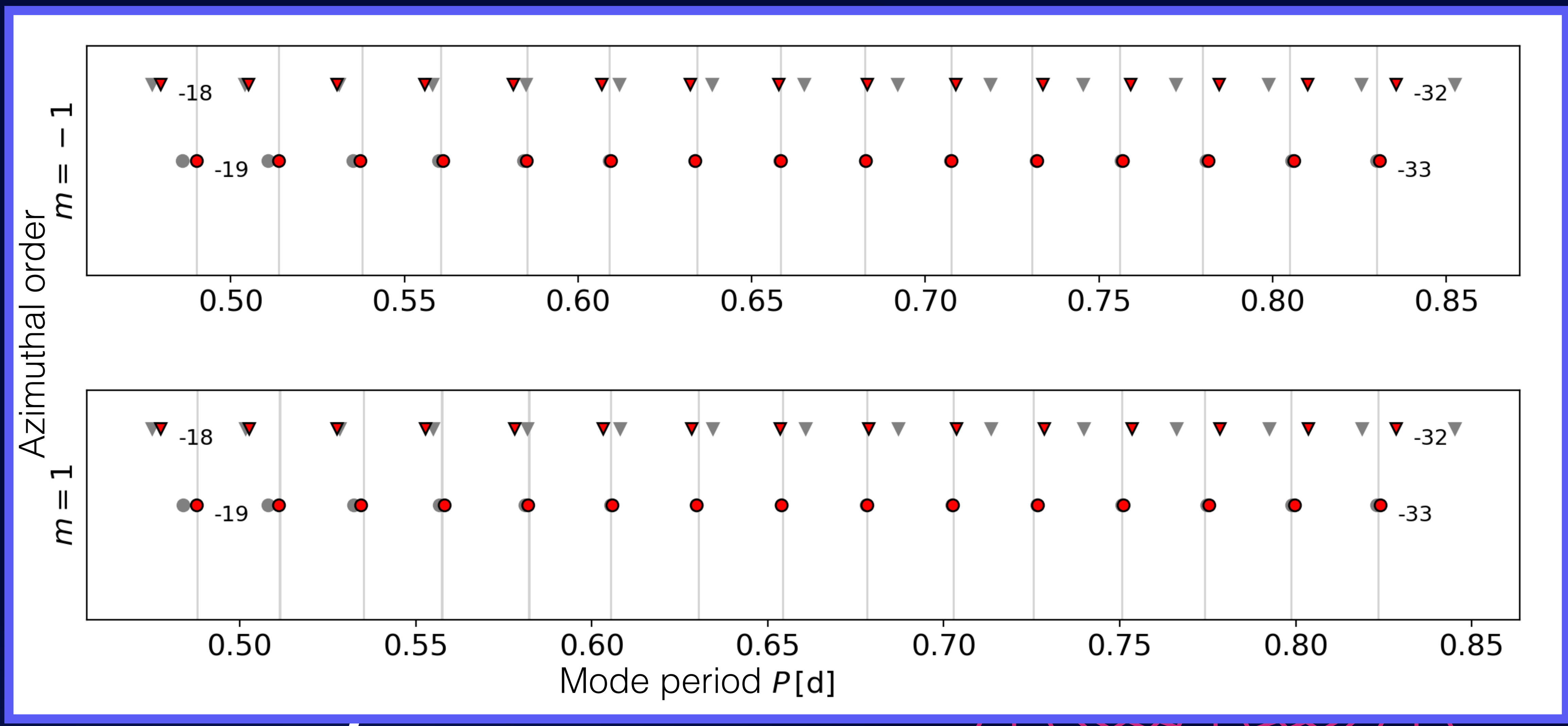
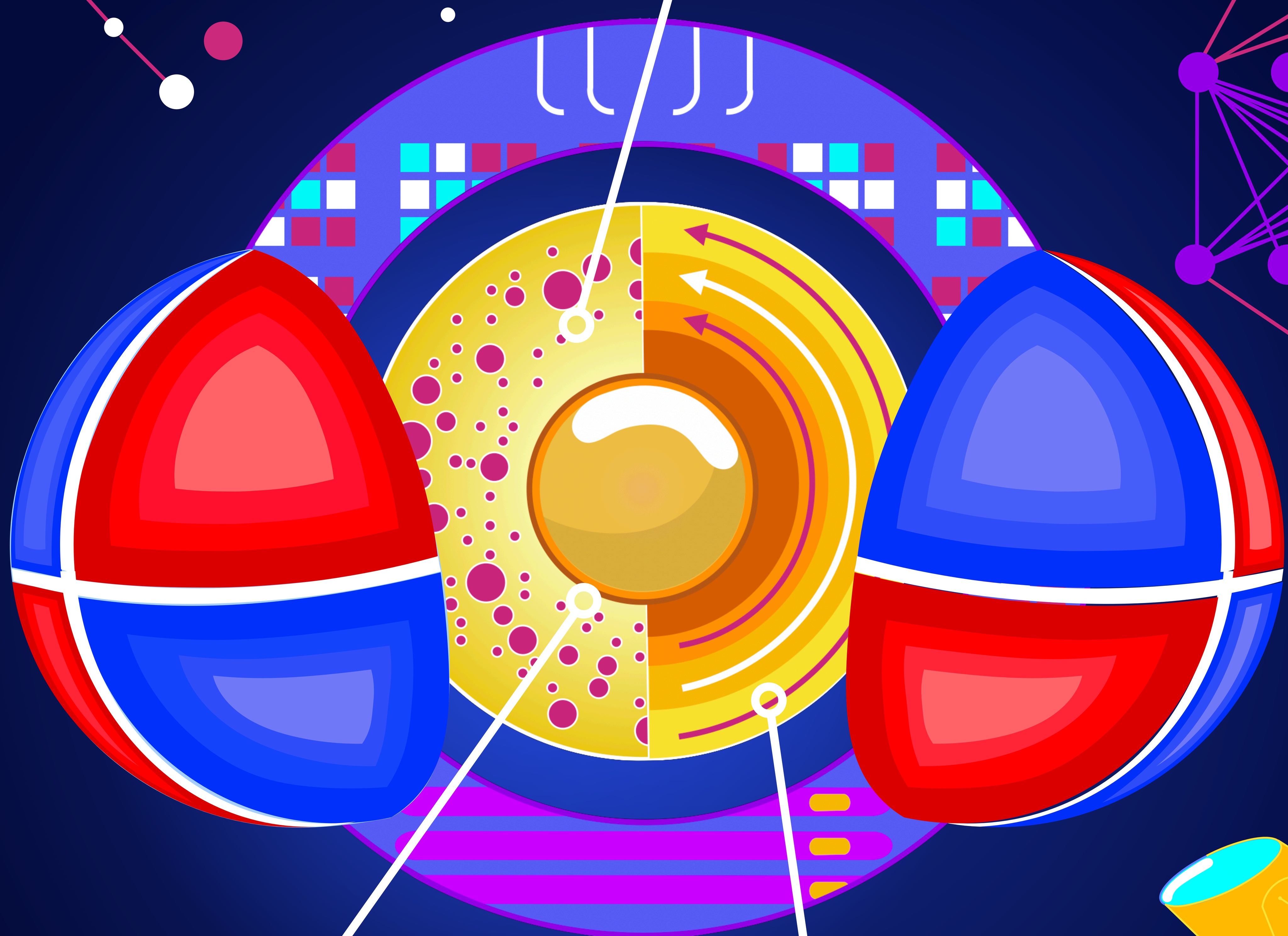
Asteroseismology

Accurate modelling of intermediate-mass stars is needed to improve our understanding of the mechanism(s) behind angular momentum and chemical element transportation in stars. Using gravity (g) modes excited in γ Doradus stars (main-sequence, A/F type), we can probe the conditions near the convective core, and measure properties such as stellar mass and age [e.g. 1,2,3].



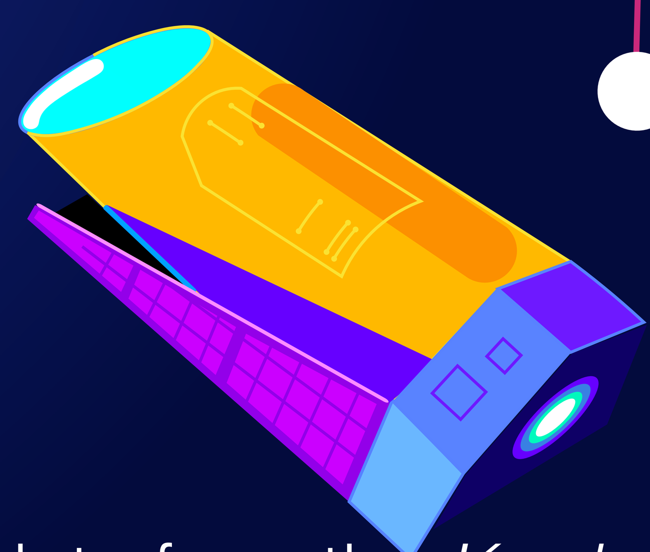
Core-boundary mixing (CBM)

G mode modelling is a high-dimensional problem, and therefore we have trained a neural network to predict the mode periods given a mass, age, CBM, metallicity, and rotation frequency. We applied our network for Computing Pulsation Periods and Photospheric Observables (C-3PO), and derived masses, ages, and core-boundary mixing levels for a sample of 37 F-type pulsators. In the plot below, the measured CBM (exponential core overshoot) is shown as a function of mass, colour-coded by rotation frequency [5]. The grey points were taken from Deheuvels et al. (2016).

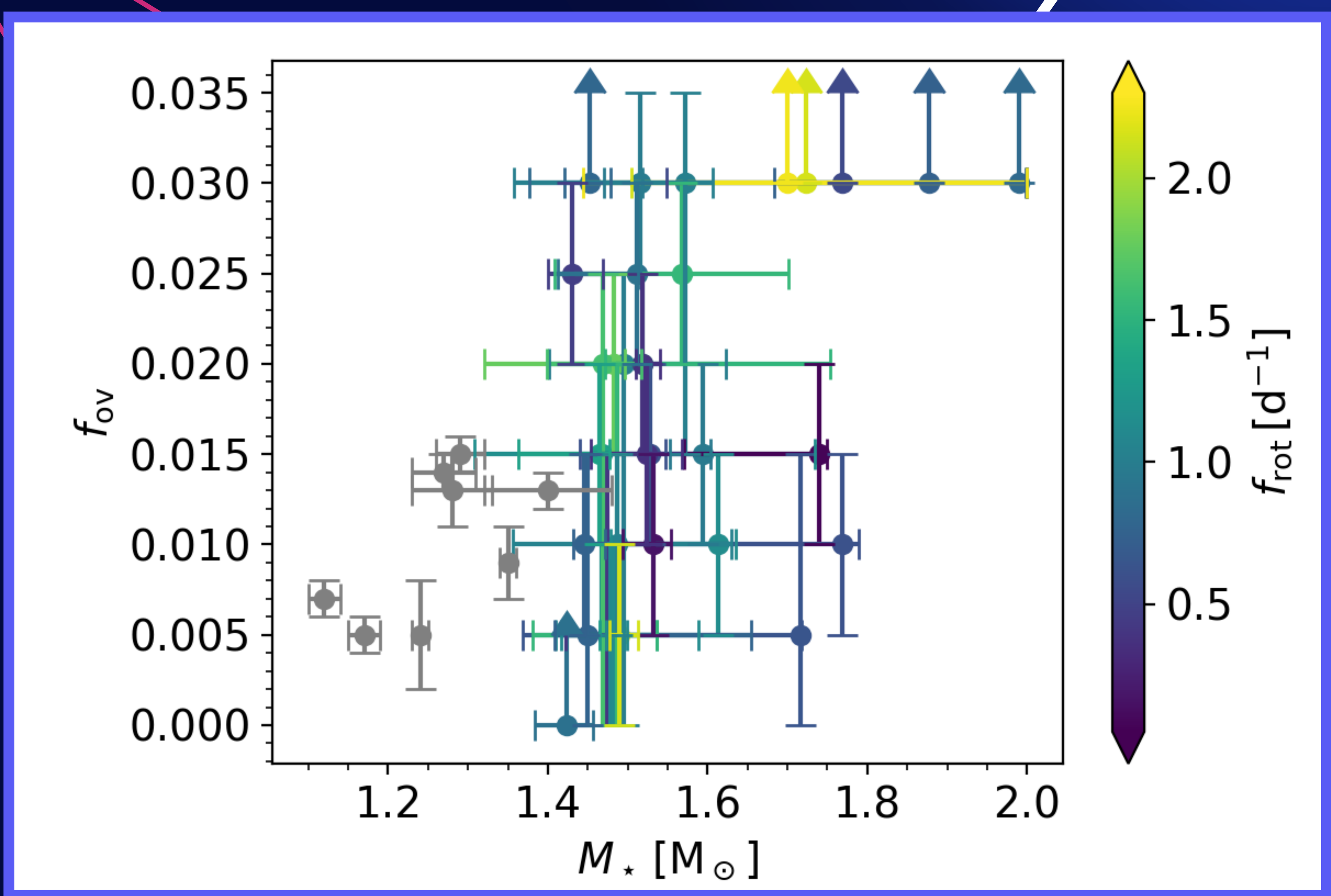


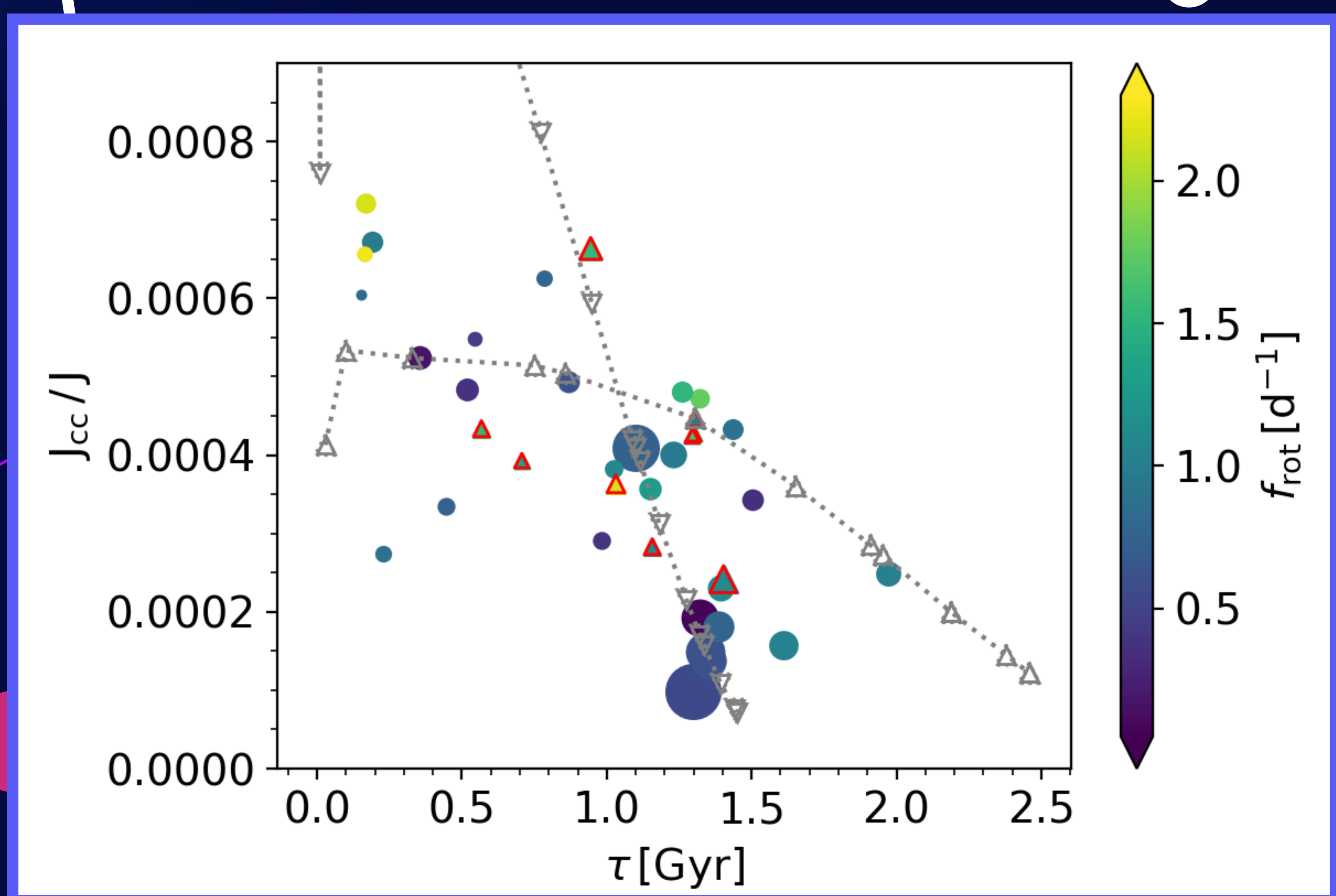
Radiative levitation

We have modelled the g mode spectrum of two slowly-rotating A/F pulsators, using (MESA) evolution models with and without atomic diffusion (including radiative levitation). For one of them, KIC11145123, we find that the pulsations and surface abundances are better matched when we include atomic diffusion (triangles vs circles in plot above, different colours indicate different initial compositions). The grey shaded lines indicate the observational uncertainties [4].



*Based on data from the *Kepler* mission





Angular momentum (AM)

The plot above shows the fractional AM in the core, compared to the total, as a function of stellar age. In general, the stars seem to rotate rigidly along the MS (grey markers are rigid models) [5]. Red triangles are stars which also have observed Rossby modes [1].

References

[1] Van Reeth et al., 2015, ApJS, 218, 27

[2] Van Reeth et al., 2016, A&A, 593, A120

[3] Mombarg et al., 2019, MNRAS, 485, 3248M

[4] Mombarg et al., 2020, ApJ, 895, 51M

[5] Mombarg et al. 2021, A&A, in press