Title : MHD Instabilities in stellar radiative regions

Abstract : The recent space-borne missions such as Kepler provided us with a wealth of new observational constraints on stellar evolution. For instance, the slow-down of the core rotation of stars along with their evolution remains unexplained as it requires angular momentum redistribution from the internal to the external layer. The stellar dynamo is also still investigated and recent studies are proposing new limits on the value of the toroidal magnetic field.

As magnetohydrodynamic instabilities are potentially able to play a key role in the dynamo processes, acting during the transition between magnetic configurations and as these instabilities also drive angular momentum transport inside radiative regions of stars ; a comprehensive view of them in stellar interiors is definitively needed.

In this context, our study focuses on - the magnetorotational instability (MRI) that is induced by shear within a magnetic field - and the Tayler Instability (TI), a kink-type instability induced by a strong toroidal field. Considering the stratification and the thermal dissipation through a general approach provides us with a more realistic stability criteria.

We consider an azimuthal flow immersed in a magnetic field and used a local stability analysis (WKB approximation). We displayed regions of non-stability, and the growth rate associated, for typical ranges of parameters of stellar interiors and of MHD numerical simulation flows.

We have recovered results on MRI for axisymmetric perturbations, exhibiting the competition of the stratification and the shear. We have shown that local axial shear or magnetic axial shear is highly destabilizing. We then studied the non-axisymmetric perturbations and keeping the general approach, we identified the instability regions of the MRI and the TI and how they merge for certain range of parameters. We aim to predict the MHD-unstable radiative regions in the stars among the Hertzsprung-Russel diagram.