IRFU : Institut de recherche sur les lois fondamentales de l'univers

Saclay

DAp/LDE3

Interactions ondes-turbulences dans les zones de convection stellaire

Spécialité Astrophysique

Niveau d'étude Bac+5

Formation Master 2

Unité d'accueil DAp/LDE3

Candidature avant le 02/03/2020

Durée 4 mois

Poursuite possible en thèse oui

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Résumé

Le stagiaire effectuera des études mathématiques et numériques sur les interactions entre les ondes d'inertie des marées et un modèle de colonne de Taylor convectif. Les aspects hydrodynamiques tels que la réponse optimaux et leur mécanisme, ou les aspects astrophysiques tels que les applications en tant que modèles de dissipation de la marée turbulente seront développés tout au long du stage.

Sujet détaillé

Stellar and planetary convection zones, where the thermal energy is mainly transported by the turbulent convective fluid motions, are subject to the rotation of stars and planets. The combination of rotation and turbulent convective motions can generate statistically-balanced turbulent structures known as the convective Taylor columns (CTCs). Moreover, in the presence of planets/moons orbiting stars/planets, tidal inertial waves known as the dynamical tide are excited in these convective regions due to the restoring Coriolis acceleration. Such tidal waves are responsible because of their dissipation of the orbital evolution of planetary systems and of the rotational dynamics of their components. Up to date, it is not clearly understood how the CTCs and such inertial waves will interact each other. This knowledge is crucial to understand and evaluate the tidal dissipation affected by these turbulent convective structures. To this extent, it is imperative to investigate a priori dynamical aspects of the interactions between tidal waves and the CTCs.

In this internship, we propose to perform mathematical and numerical studies on interactions between tidal inertial waves and a convective Taylor column model proposed by Grooms et al. (PRL, 2010, 104, 224501). Our approach extends the previous work by Dandoy et al. (to be submitted) on the linear stability of the Grooms' model. We will first derive mathematical formulation of the forcing-response equations employing fluid-dynamics approach. The optimal forcing and response problem will also be considered by adopting the adjoint method. We will investigate numerically the frequency response spectra of the CTC model generated by the interactions with tidal waves. Fluid-dynamical aspects such as the optimal response and mechanisms, or astrophysical aspects such as applications as turbulent tidal dissipation models will be developed throughout the internship.

Mots clés

Hydrodynamique

Compétences

Méthodes numériques, analyse de stabilité

Logiciels

MATLAB, Fortran, C/C++

Interactions between tidal waves and turbulent coherent structures in stellar convection zones

Summary

The internship student will perform mathematical and numerical studies on interactions between tidal inertial waves and a convective Taylor column model. Fluid-dynamical aspects such as the optimal response and mechanisms, or astrophysical aspects such as applications as turbulent tidal dissipation models will be developed throughout the internship.

Full description

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Keywords

Hydrodynamics

Skills

Numerical methods, Stability analysis

Softwares

MATLAB, Fortran, C/C++