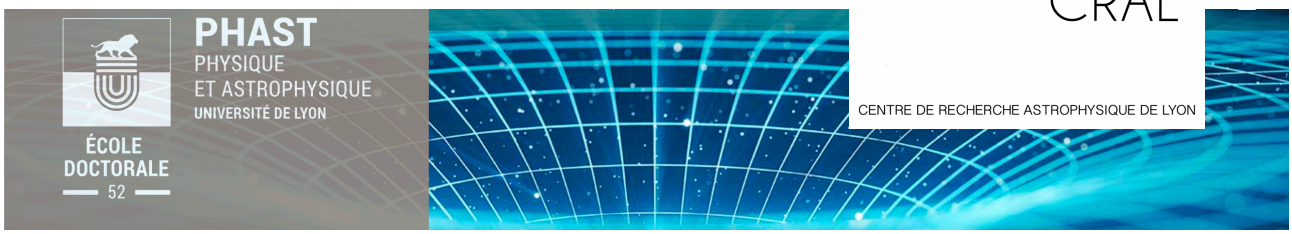


English below

TITRE DE LA THÈSE EN FRANÇAIS

Laboratoire : Centre de Recherche Astrophysique de Lyon – UMR 5574 (https://cral.univ-lyon1.fr/)

Directrice : Laurence Tresse

Directeur ou Directrice de thèse : NOM, Prénom et Statut, Équipe de Recherche

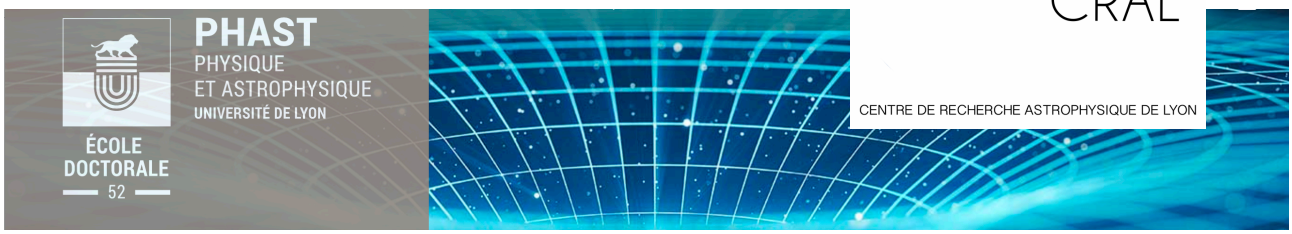
Co-direction : Nom, Prénom et Statut, Équipe de Recherche

Adresse électronique et téléphone :

Contexte et Description du projet :
UNE PAGE MAX

Date de début de thèse :

Autres sources de financement envisagées : (préciser le type de demandes déposées (CNRS, CEA, CIFRE, région, allocation auprès d'une autre ED) et le statut de la demande (acquis ou non)



Cosmological Simulations of Cosmic Rays and Reionisation

Institute: Centre de Recherche Astrophysique de Lyon – UMR 5574 (https://cral.univ-lyon1.fr/)
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Context and Project description:

During the first billion years or so after the Big Bang, the dark, cold, and neutral Universe was flooded with radiation and underwent a transition to a warm ionised state, in a process known as reionisation. This last major transition of our Universe is at the frontier of observational astrophysics and is the focus of the main upcoming telescopes such as the James Webb Space Telescope and the Square Kilometre Array. A theoretical understanding of galaxy evolution during the Epoch of Reionisation is vital for preparing observational campaigns and interpreting eventual observations, and the best way to gain understanding is to use cosmological simulations.

Recently, the Galpac team at CRAL has developed the SPHINX suite of radiation-hydrodynamical simulations (https://sphinx.univ-lyon1.fr), designed to predict the formation of galaxies during the first billion years and understand the process of reionisation as well its sources, which likely are predominantly young stars formed in the earliest galaxies. These simulations are unique and the first to simultaneously capture the process of reionisation while resolving the escape of radiation trough the inter-stellar medium of thousands of galaxies. Yet, as with all simulations, many simplifications and assumptions must be made. One of those is that the growth of galaxies is suppressed predominantly by feedback from supernova (SN) explosions, while many recent works have suggested that other feedback mechanisms are important in galaxies. One of the currently most promising channels of feedback is cosmic rays (CRs) — charged particles that are created in shocks and travel along magnetic field lines, exerting pressure on interstellar gas and hence preventing star formation and perhaps even ejecting gas altogether from galaxies via outflows.

The idea for this numerically oriented PhD project is to study the role of CRs in galaxy formation and reionisation, using cosmological simulations. First CRs will be incorporated into the SPHINX simulation set-up from an existing implementation in the RAMSES code (used for SPHINX), in collaboration with method authors Y Dubois and B Commerçon. Then CR diffusivity and energetics will be calibrated within the parameter space of known constraints to understand which limits lead to the formation of realistic galaxies compared to high-redshift observations, and, finally, how these optimal limits for CR feedback affect the escape of ionising radiation from galaxies and hence reionisation.

Starting PhD date: September 1st, 2019

Other foreseen funding: None