ÉCOLE DOCTORALE
SCIENCES DE LA TERRE ET DE L'ENVIRONNEMENT
ET PHYSIQUE DE L'UNIVERS, PARIS

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Titre du sujet : **SEARCHING FOR PRIMORDIAL GRAVITATIONAL WAVES WITH QUBIC: Pipeline development and cosmological constraints**

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Equipe d'accueil : **APC, Equipe de Cosmologie - UMR7164**

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Développement du sujet : (Maximum 2 pages)

The quest for B-mode polarization of the Cosmic Microwave Background is the primary challenge in Observational Cosmology and is pursued by a worldwide effort. Measurement of B-mode polarization in the CMB will be clear evidence of primordial gravitational waves which are theoretically expected to be produced during inflation at about 10-35 seconds after the Planck epoch. Their presence would be a non-trivial result concerning quantum gravity because tensor modes would mean the metric must be quantized. The B-mode measurement is perhaps the most difficult cosmological challenge because the expected signal is very small. It requires high sensitivity and negligible instrument systematic effects with wide frequency coverage to separate the primordial signal from foreground emissions.

QUBIC (QU Bolometric Interferometer for Cosmology: http://qubic.org.ar) is a novel instrument that brings together the advantages of bolometers with their high sensitivity and interferometers with their exquisite control of instrument systematic effects. The interferometric nature of QUBIC also allows spectral-imaging with high spectral resolution compared to direct imagers, which is a significant advantage for foreground removal. The QUBIC Observatory was inaugurated in Nov. 2022 on its observing site at 5000m a.s.l. in the province of Salta in Argentina. The Technological Demonstrator is installed at the site and is currently undergoing commissioning. Observations are expected to start in 2025.

In addition to participation in data acquisition and analysis of QUBIC (including travel to Argentina), the Ph.D. student will participate in the following topics:

- Developing the data analysis pipeline: Time-domain raw data processing, filtering, map reconstruction, angular power spectrum measurement, and cosmological constraints, especially using the spectral-imaging technique unique to QUBIC, that allows improved cleaning from the contamination of foreground emission.
- Developing data analysis techniques based on classical techniques as well as on Artificial Intelligence for the QUBIC data analysis pipeline: raw data cleaning, map-making, component separation, and cosmological parameters estimation.

The student will work within the QUBIC-APC team at APC, with the rest of the collaboration in France, Italy, Ireland, and Argentina.