Title : Theoretical study of quantum gas experiments in an Earth-orbiting research laboratory
Keywords : Bose-Einstein condensate, quantum-degenerate mixtures, microgravity

One of the major goals of fundamental physics is to unify general relativity, which describes macroscopic phenomena driven by the influence of gravity, with quantum mechanics, which focuses on effects at microscopic scales. Ensembles of cold atoms, as massive quantum objects, lie at the crossroads of both theories and appear as a test object of choice. They can be used to test theories that postulate a violation of Einstein's Equivalence Principles, in particular a violation of the Universality of Free Fall (UFF).

Recent proposals suggest using mixtures of Bose-Einstein condensates (BEC) as sources for precision atom interferometry to perform UFF. These have the potential to match the precision of the best tests with classical test masses performed during the MICROSCOPE mission, and may even provide better results in the long term. The realization of experiments in microgravity, where atoms can float for long periods of time, allows longer interrogation times, thus increasing the performance of matter-wave sensors. To optimize the implementation of UFF tests, one needs