CERN Joint EP/PP Seminars

SPEAKER: Prof. John March-Russell (Physics Department, University of Oxford)

TITLE: **Exploring String Axions with Astrophysics and Cosmology**

DATE: Tue 01/09/2009 16:30

PLACE: Main Auditorium**

ABSTRACT

String theory suggests the simultaneous presence of many ultralight axions, possibly populating each decade of mass down to the Hubble scale 10^{-33}eV. Conversely the presence of such a plenitude of axions (an ``axiverse'') would be evidence for string theory, since it arises due to the topological complexity of the extra-dimensional manifold and is ad hoc in a theory with just the four familiar dimensions. We investigate how several upcoming astrophysical experiments will be observationally exploring the possible existence of such axions over a vast mass range from $ 10^{-33}$eV to $ 10^{-10}$eV. Axions with masses between $ 10^{-33}$eV to $ 10^{-28}$eV can cause a rotation of the CMB polarization that is constant throughout the sky.
The predicted rotation angle is independent of the scale of inflation and the axion decay constant, and is within reach of the just launched Planck satellite. Axions in the mass range $ 10^{-28}$eV to $ 10^{-18}$eV give rise to multiple steps in the matter power spectrum, providing us with a snapshot of the axiverse that will be probed by galaxy surveys--such as BOSS, and 21 cm line tomography.
Axions in the mass range 10^{-22}eV to $ 10^{-10}$eV can affect the dynamics and gravitational wave emission of rapidly rotating astrophysical black holes through the Penrose superradiance process. When the axion Compton wavelength is of order of the black hole size, the axions develop ``superradiant'' atomic bound states around the black hole ``nucleus''. Their occupation number grows exponentially by extracting rotational energy and angular momentum from the ergosphere. For black holes lighter than $\sim10^7$ solar masses accretion cannot replenish the spin of the black hole, creating mass gaps in the spectrum of rapidly rotating black holes that diagnose the presence of destabilizing axions. In particular, the highly rotating black hole in the X-ray binary LMC X-1 implies an upper limit on the decay constant of the QCD axion 2×10^{17}GeV, much below the Planck mass. This reach can be improved down to the grand unification scale, the natural string theory value, by observing smaller stellar mass black holes.

Organised by: Maria Spiropulu / PH-EP ----------

**Tea and coffee will be served at 16:00