

Theory Seminar

Monday, October 4, 2010 2:10 PM 831 Pupin Hall

Exploring the String Axiverse with Astrophysical Black Holes



Recent advances in X-ray astronomy open the possibility for high precision spin and mass determination for astrophysical black holes starting the era of precision black hole physics. These observations turn astrophysical black holes into sensitive probes of ultra-light axion-like particles motivated by the strong CP problem and string theory (the "Axiverse"). When the axion Compton wavelength matches the black hole size, the axions develop superradiant atomic bound states around the black hole "nucleus" through the Penrose superradiance process. Their occupation number grows exponentially by extracting rotational energy from the ergosphere, culminating in a rotating Bose-Einstein axion condensate emitting gravitational waves. This transfer of angular momentum from the black hole to the axion condensate results in mass gaps in the spectrum of rapidly rotating black holes, gives rise to distinctive gravity wave signals, and modifies the near horizon metric. In particular, the QCD axion with a decay constant of order of the Grand Unification scale affects the dynamics of stellar mass black holes. This opens the possibility for the discovery of the QCD axion through ongoing measurements of black hole spins. The corresponding gravity wave signal may be within reach of Advanced LIGO. Axions coupled to hidden gauge sectors---hidden valleys---may trigger the avalanche instability in these sectors in the presence of a black hole. Electromagnetic echoes of hidden valley avalanches would be observed as an exotic class of gamma ray bursts.

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