Contribution ID: **4** Type: **not specified**

Effects of Lighter-than-QCD Axions no Neutron Star Tidal Deformability

Tuesday 2 December 2025 13:30 (30 minutes)

Finite density corrections to the lighter-than-QCD axion can invert the effective axion potential, sourcing a non-trivial axion field inside dense objects. In this talk, I will present the first numerical study of the complete dynamics of the lighter-than-QCD axion in a neutron star in 1+1 general relativity, extending the region of analysis of the lighter-than-QCD axion to low-mass axions with kilometer-scale Compton wavelengths. I will discuss the gravitational effects of the axion field on the neutron star and show that for a broad range of axion masses and decay constants, macroscopic neutron star properties, such as the mass, radius, and compactness, are affected at the order-1 level. This result indicates that approximate universal tidal deformability-compactness relation for neutron stars is non-trivially broken and can serve as a probe of lighter-than-QCD axions, independent of the unknown nuclear equation of state. I will highlight the potential for axion studies with future gravitational-wave observations of neutron stars and applications of this work to other new physics signatures.

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