



Contribution ID: 73

Type: **not specified**

Axion-like particle effects in high-energy astrophysics

Tuesday, 4 July 2023 10:55 (30 minutes)

Abstract: Axion-like particles (ALPs) are very light neutral spin-zero bosons predicted by superstring theory and primarily interacting with two photons. In the presence of an external magnetic field they give rise to two effects: (i) photon-ALP oscillations, (ii) change of the photon polarization state. The former effect produces a modification of the photon transparency and irregularities in observed spectra. In addition, two hints at ALP existence have been discovered associated with photon-ALP oscillations. Observatories like ASTRI, CTA, LHAASO will likely provide us additional information. ALP-induced effects on photon polarization are also sizable in a wide energy band from the X-ray up to the MeV range when photons are produced in the central region of galaxy clusters or at the jet base of blazars. The ALP-induced features on photon polarization can give us additional hints at the ALP existence or further constrain the ALP parameter space. We expect observatories like IXPE in the X-ray band, and like COSI and AMEGO in the MeV range to be able to detect these possible effects.

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Session Classification: Tuesday Session 2