Contribution ID: **82** Type: **not specified**

A Photon Cloud Induced from an Axion Cloud

Friday, 11 July 2025 12:10 (20 minutes)

It is known that the coupling between axions and photons can lead to a superradiant growth and cause electromagnetic (EM) bursts when the coupling constant multiplied with the amplitude of the axion clould is larger than a critical value. In the first-order of the coupling constant, we studied how the existence of an axion cloud influences the distribution of EMs around a Kerr black hole, and found that even for very small couplings, as long as there is a background EM field satisfying the field equation in Kerr background, there would exist an oscillating photon EM cloud with the same frequency as the axion cloud. The evolution of the photon EM cloud with time and azimuthal angle is obtained analytically while the distribution on the cross section is solved numerically. Intriguingly, the induced EMs have very different symmetries in contrast with the background EMs, which may provides as a feature for the existence of both an axion cloud and the axion-photon coupling. Also, for near horizon region, we compare the induced EMs (photons as fields) with the photon region (photons as particles) and find some coincides. Essentially, the induced photon cloud is sourced by the axion cloud via the coupling, not related to superradiance effects.

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Session Classification: Parallel 1