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Supermassive black holes as detectors for ultralight bosons

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Ultralight bosons behave like coherent waves when the occupation number is large enough. If they are coupled to the Standard Model sector of the particle physics, such an oscillating background can induce a tiny signal. Near a fast rotating black hole, ultralight bosons within one order of the mass window can accumulate through superradiance with a large density expected. If linearly polarized radiation is emitted near the black hole, axion can contribute to birefringence effect that shifts the position angle periodically, making the polarimetric measurements of the Event Horizon Telescope on M87*a powerful way to look for ultra-light axions. On the other hand, the superradiance phase where black hole spin decreases exponentially can leave imprints on the shadow contour drift or azimuthal angle lapse of photon ring autorrelations, which makes future observations of SgrA* optimal to look for such signals. Finally, gravitational atoms can induce oscillating metric perturbations that modify the geodesics of photons, creating a new observation channel for the future precise measurement of supermassive black holes.

Author: CHEN, Yifan (Niels Bohr International Academy)

Presenter: CHEN, Yifan (Niels Bohr International Academy)

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