Astrometric Explorations of the Gravitational Wave Background and Photon Ring Astrometry

Yifan Chen*[1]

[1]Niels Bohr Institute [Copenhagen] – Denmark

Abstract

Astrometry, the precise measurement of star motions, offers a method to investigate low-frequency gravitational waves through the spatial deflection of photons, complementing pulsar timing arrays that depend on timing residuals. Upcoming data from the Gaia and Roman missions will not only corroborate findings from pulsar timing arrays but also explore the previously uncharted frequency range that bridges the capabilities of pulsar timing arrays and LISA. This talk will detail how harmonic analysis effectively assesses astrometric observations to resolve critical properties such as spectral index and chirality, and to identify quadrupolar correlations exemplified by generalized Hellings-Downs curves. Additionally, it will explore the potential of photon ring astrometry around supermassive black holes, where photons may orbit multiple times before reaching the observer. This approach opens new possibilities for measuring phenomena like hotspots, searching for superradiant clouds, and visualizing the ringdown of black holes.

*Speaker