

Invited Talk: Huiyu ZHU (Title: Survival of the Fittest: Testing Superradiance Termination with Simulated Binary Black Hole Statistics)

Monday, 26 May 2025 14:15 (45 minutes)

Title: Survival of the Fittest: Testing Superradiance Termination with Simulated Binary Black Hole Statistics

Abstract: The superradiance instability of rotating black holes leads to the formation of an ultralight boson cloud with distinctive observational signatures, making black holes an effective probe of ultralight bosons. However, around black holes in a binary system, the superradiance effect of such clouds can be terminated by tidal perturbations from the companion, leading to cloud depletion. In this study, we focus on the superradiance of a scalar boson and perform the first analysis of the impact of this termination effect on superradiant black hole binaries which are realistically modeled after their statistics in our Galaxy. Working with a dataset of approximately 10^7 black hole binaries simulated using the Stellar EVolution for N-body (SEVN) population synthesis code, we identify the superradiant candidates and those that manage to survive the termination effect. We then calculate the cloud survival rate for various boson masses and black hole spin models. Our findings reveal that the $l=m=1$ cloud modes are generally stable against termination, whereas the $l=m=2$ modes can be significantly affected, with survival rates dropping below 10% for boson masses below approximately 0.5×10^{-12} eV. In addition, our analysis indicates that clouds that overcome termination typically exhibit a higher superradiant growth rate and therefore a higher detectability.