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Specks of light from AGNs as possible indicators of dynamical formation of binary black holes

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Gravitational wave detections of black holes (BHs) in the pair-instability mass gap have sparked interest in dynamical formation channels. In my work, I have explored the process of hierarchical BH mergers in active galactic nuclei (AGNs), which stand out with respect to other dynamical environments for three main reasons: enhanced binary formation due to migration traps, accelerated binary inspiral due to gas hardening and high merger remnant retention due to the deep gravitational potential of the AGN. In this talk, I will present the main results of my new semi-analytical model, which allows me to effectively explore the parameter space while capturing all the main physical processes involved. I will show that the interplay between gas torques and multi-body effects creates a population of binary BHs (BBHs) with unique and distinguishable characteristics: hierarchical mergers in this environment produce a strong correlation between masses and spins of BBH components, with some specimens having masses of thousands of solar masses with spins approaching the theoretical upper limit. Furthermore, I will show that some observed GW transients such as GW190521 are compatible with being produced from this channel. This hypothesis is further corroborated by the co-occurrence with the AGN flare ZTF19abanrhr, which is preferred over a random coincidence of the two transients with a log Bayes'factor of 8.6. I will also compare the AGN BBH population with other dynamical channels as well as the isolated evolution channel, evaluating their relative contributions to the third gravitational-wave transient catalog of the LIGO-Virgo-KAGRA collaboration.

Affliation

Heidelberg University

Current Position

PhD Student

Primary author: VACCARO, M. Paola (ITA-ZAH, Heidelberg University)

Co-author: MAPELLI, Michela (Institut für Theoretische Astrophysik - Universität Heidelberg)

Presenter: VACCARO, M. Paola (ITA-ZAH, Heidelberg University)

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