Contribution ID: **123**

Type: **Talk**

Through the mantle of hydrogen: understanding mass transfer in black hole - star systems and the formation of binary black hole mergers

Thursday, 22 August 2024 17:00 (20 minutes)

One of the great challenges for gravitational-wave astrophysics is disentangling different formation channels of binary black-hole (BBH) mergers. Achieving this requires in-depth understanding of BBH formation pathways and robust predictions for observable channel characteristics. We tackle this challenge for binary evolution scenarios by systematically modeling mass transfer evolution in BH-star systems with MESA. We find that there is a limit to how close stable mass transfer (SMT) evolution can bring a star and a BH together without triggering them to merge as a result of a runaway mass-transfer instability. This limit is significantly more stringent than that imposed by the size of naked helium stars and it is independent of angular momentum loss during SMT. Instead, it results from the stellar structure and the flat entropy profile of the near-core layers in massive radiative donors. We show that this leads to a trend: the more evolved (expanded) the donor star, the more compact its core, and therefore the smaller orbital separation can be achieved. This trend is robust against modeling uncertainties and naturally produces an anticorrelation between effective spins and mass ratios of detectable BBH mergers. We demonstrate that the overall effectiveness of the SMT channel, on the other hand, is strongly tied to some of the key uncertainties in stellar evolution, such as internal chemical mixing, core-rejuvenation, and the extend of Main Sequence. I will discuss the significance of modern high-precision stellar astrophysics and surveys in narrowing down those long-standing unknowns to pave the way towards a robust model of BBH merger formation, in particular in the metal-poor regime that is also key for dynamical channels. Finally, we propose a new simple criteria for mass transfer stability for population synthesis that stems from the physical origin of instability in radiative donors and well approximates the behavior of detailed models.

Affliation

ESO Garching

Current Position

Postdoc

Primary author: KLENCKI, Jakub (ESO Garching)

Presenter: KLENCKI, Jakub (ESO Garching)

Session Classification: Chris Belczynski memorial session on compact objects and gravitational wave sources

Track Classification: Chris Belczynski memorial session on compact objects and gravitational wave source