Contribution ID: **20** Type: **Talk**

Hierarchical star cluster assembly boosts intermediate-mass black hole formation

Tuesday, 20 August 2024 17:46 (3 minutes)

Observations and high-resolution hydrodynamical simulations indicate that massive star clusters assemble hierarchically from sub-clusters with a universal power-law cluster mass function. We study the consequences of such assembly for the formation of intermediate-mass black holes (IMBHs) at low metallicities ($Z = 0.01\ Z_{\odot}$) with our updated N-body code BIFROST based on the hierarchical fourth-order forward integrator. BIFROST integrates few-body systems using secular and regularized techniques including post-Newtonian equations of motion up to order PN3.5 and gravitational-wave recoil kicks for BHs. Single stellar evolution is treated using the fast population synthesis code SEVN. We evolve three cluster assembly regions with $N_{\mathrm{tot}} = 1.70–2.35 \times 10^6$ stars following a realistic IMF in ∼1000 sub-clusters for $t = 50$ Myr. IMBHs with masses up to $m_{\bullet} \sim 2200\ M_{\odot}$ form rapidly mainly via the collapse of very massive stars (VMSs) assembled through repeated collisions of massive stars followed by growth through tidal disruption events and BH mergers. No IMBHs originate from the stars in the initially most massive clusters. We explain this by suppression of hard massive star binary formation at high velocity dispersions and the competition between core collapse and massive star life-times. Later the IMBHs form subsystems resulting in gravitational-wave BH-BH, IMBH-BH and IMBH-IMBH mergers with a $m_{\bullet} \sim 1000\ M_{\odot}$ gravitational-wave detection being the observable prediction. Our simulations indicate that the hierarchical formation of massive star clusters in metal poor environments naturally results in formation of potential seeds for supermassive black holes.

Affliation

Max Planck Institute for Astrophysics, Garching, Germany

Current Position

Postdoc

Primary author: RANTALA, Antti (Max Planck Institute for Astrophysics)

Presenter: RANTALA, Antti (Max Planck Institute for Astrophysics)

Session Classification: Virtual Poster Presentations

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