Contribution ID: **6** Type: **Contributed talk**

Evolution of massive black hole binaries in gaseous environments

Thursday, 10 October 2024 17:15 (15 minutes)

Understanding the interaction of massive black hole binaries with their gaseous environment is crucial since at sub-parsec scales the binary is too wide for gravitational wave emission to take over and to drive the two black holes to merge.
Furthermore the presence of a gaseous disc around sub-pc massive black hole binaries can trigger electromagnetic emission that can be detected by the Zwicky Transient Facility and the upcoming Vera Rubin Observatory, therefore revealing the presence of hidden binaries.
The outcome of binary-disc interaction in terms of binary evolution remains poorly explored mainly due to numerical limitations and simplistic assumptions in the modelling of these systems.
In this talk I will present our recent results on the evolution of massive black hole binaries embedded in both isothermal and self-gravitating circumbinary discs obtained using hyper-Lagrangian 3D hydrodynamics simulations.
Our approach allows to perfectly resolve the gas dynamics inside the cavity and to therefore measure the torques acting on the binary with high numerical precision. This is crucial in order to infer the correct results in terms of binary parameters evolution. I will discuss how the gas temperature affects the electromagnetic emission, which is crucial in order to pinpoint the origin of the GW sources.
Our results are especially important for massive black hole binaries in the LISA and PTA band.

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Session Classification: Day 2: Latest results