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Can one peek inside black holes using a wormhole?

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In the extreme mass ratio limit, the evolution of the event horizon in a merging event between a large black hole and a small compact object can be computed exactly with elementary ray-tracing techniques. I will describe what happens when the small body is an Ellis-Bronnikov traversable wormhole. A double-mouth wormhole within the same universe is obtained by gluing two such geometries — in this setting the ratio of the distance between the two mouths to the distance traversed through the wormhole plays an important role. At scales comparable to the wormhole, its geometry drastically distorts the planar horizon of the large black hole. When a ‘short’ wormhole falls in, the horizon wraps around it and an island is formed, representing a region of spacetime that is spatially disconnected from the exterior of the black hole, but in causal contact with future null infinity (through the wormhole). This region shrinks as time evolves and eventually disappears. The lifetime of the island essentially grows linearly with the inter-mouth distance, but also decreases linearly with the length of the wormhole throat. Imposing physically reasonable energy conditions severely restricts the duration of the open communication channel with the interior of the black hole.

Primary author: FRASSINO, Antonia Micol (Alcalá U. & ICCUB)

Presenter: FRASSINO, Antonia Micol (Alcalá U. & ICCUB)

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