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Black hole-wormhole collisions and the emergence of islands

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We use ray-tracing techniques to determine the evolution of the event horizon of a large black hole that "gobbles"a tiny, traversable wormhole. The wormhole considered is described by the Ellis-Bronnikov spacetime, which is a solution of modified gravity. This calculation has physical meaning in the extreme mass ratio limit. Two setups are considered: a single-mouth wormhole connecting two otherwise independent universes, and a double-mouth zero-length wormhole within the same universe. In the first setting it turns out that, at early times, there exist two disconnected horizons, one in each universe, which then merge as the wormhole falls into the large black hole. In the second setup, we observe the appearance of an 'island', a region of spacetime that is spatially disconnected from the exterior of the black hole, but in causal contact with future null infinity. The island shrinks as time evolves and eventually disappears after sufficient time has elapsed, as compared to the distance between the two mouths. This provides a communication channel with the interior of the large black hole for a certain time interval. We compute numerically the lifetime of the island and verify that it depends linearly on the inter-mouth distance.

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