

A no-go theorem for exotic alternatives to black holes as LIGO/Virgo sources

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Five of the ground-breaking gravitational wave detections by the LIGO/Virgo collaboration have been interpreted as black hole collisions forming a more massive black hole. It is hard to demonstrate conclusively that these objects are indeed black holes, and there is a lively debate on the intriguing possibility that other, more exotic alternatives could explain the observations. In an article published in *Physical Review Letters*, P. Cunha and C. Herdeiro, from Aveiro University's physics department, together with E. Berti from the University of Mississippi, provide a generic no-go theorem for these exotic alternatives.

The remnant black hole born from black hole collisions vibrates with a characteristic signature – a “sound” similar to a ringing bell. This special signature, called “ringdown”, is related to the existence of special orbits called “light rings”: around a black hole, gravity bends light so much that light rays can circumnavigate the black hole (so if you were close enough to a black hole, you could see the back of your head). Some exotic alternatives to black holes can also have light rings, and therefore they can ring down just like black holes. It has been proposed that these “black hole mimickers” could have produced the events observed by LIGO/Virgo.

Applying mathematical techniques from the field of topology to black hole physics, Cunha, Berti and Herdeiro show, that if the compact object is not a black hole it must have a second light ring. This second light ring differs from the first in one crucial way: it traps radiation. The trapped radiation piles up and destabilizes the exotic compact object, making it unlikely to exist in Nature. The implication is that these exotic objects are generically unstable, and therefore that the LIGO-Virgo detections are really evidence for black holes. In fact, the generality of the argument is a strong obstacle to the existence of objects in nature that mimic black holes, but are not really black holes.

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