

Instability of exotic compact objects and its implications for gravitational-wave echoes

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Abstract

Exotic compact objects (ECOs) have recently become an exciting research subject, since they are speculated to have a special response to the incident gravitational waves (GWs) that leads to GW echoes. We show that energy carried by GWs can easily cause the event horizon to form out of a static ECO — leaving no echo signals towards spatial infinity. To show this, we use the ingoing Vaidya spacetime and take into account the back reaction due to incoming GWs. Demanding that an ECO does not collapse into a black hole puts an upper bound on the compactness of the ECO, at the cost of less distinct echo signals for smaller compactness. The trade-off between echoes' detectability and distinguishability leads to a fine tuning of ECO parameters for LIGO to find distinct echoes. We also show that an extremely compact ECO that can survive the gravitational collapse and give rise to GW echoes might have to expand its surface in a non-causal way.