NEUTRON STARS

Gravitational weigh-in

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Credit: R. Kaehler (ZIB), L. Rezzolla (AEI/GU)

A neutron star's gravitational force is so strong that beyond its maximum sustainable mass the addition of a single neutron will cause the star to collapse to a black hole — unless it starts to rotate. But calculating the maximum mass of a rapidly rotating neutron star is even more difficult than for the non-rotating case. However, there is a 'universal' relation between the masses of rotating and non-rotating stars (C. Breu and L. Rezzolla, *Mon. Not. R. Astron. Soc.* **459**, 646–656; 2016). Normalized in this manner, the masses become independent of the (unknown) equation of state.

Luciano Rezzolla, Elias Most and Lukas Weih added to this approach some observational constraints from the kilonova associated with the neutron-star merger that generated the gravitational wave event GW 170817 (simulation pictured). They found a maximum mass of a non-rotating neutron star to be $2.16^{+0.17}_{-0.15} M_{\odot}$.

The two most massive known neutron stars (pulsars) are 2.01 and 1.97 solar masses, consistent with this limit. The theoretical value of $2.16 M_{\odot}$ also agrees with those obtained by others using different methods that also include data from GRB 170817A, but which make use of numerical simulations. As for the internal structure of these stars, more observational data are needed to refine equation-of-state models and provide tighter constraints on the maximum mass.

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