

Revealing Cosmic Mysteries with the Help of Compact Binary Mergers

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Neutron stars are among the most compact objects in the Universe and the detection of gravitational waves and electromagnetic signals from the merger of two neutron stars in 2017 has been a revolution. This breakthrough observation enabled studies about the history of our cosmos, the formation of heavy elements, and the physics on subatomic scales. Since then, another binary neutron star merger was seen in April 2019, and in January 2020, the detection of two black hole – neutron star mergers completed the picture.

Essential for the interpretation of all these observations are reliable models describing the merger dynamics. We show how these models can be used to derive new constraints on the equation of state of supranuclear-dense matter and the Hubble constant. For this purpose, we analyze the gravitational waves and electromagnetic signals emitted from the binary neutron star merger GW170817 together with other gravitational-wave measurements, as well as X-ray and radio observation of single neutron stars.

Finally, we compare the constraints derived from our multi-messenger analysis with heavy-ion collisions of gold nuclei, showing a remarkable consistency between macroscopic collisions of compact binaries and microscopic collisions in particle colliders.