Distinguishing binary neutron star from neutron star-black hole mergers with gravitational waves

(Dated: March 15, 2019)

The merger of two neutron stars emits a gravitational-wave signal that cannot be easily differentiated from the signal from the merger of a mixed binary of a neutron star and a black hole with comparable masses. Indeed, both binary types could account for the gravitational-wave signal GW170817 even if its electromagnetic counterpart emission is taken into account. The existence of low-mass black holes ($< 5M_{\odot}$) is astrophysically disfavored, however such back holes could be of primordial origin or the outcome of the interaction between neutron stars and dark matter. I will present a method to identify mixed binaries of neutron stars merging with low-mass black holes using gravitational-wave signals alone. Our method is based on the fact that certain neutron star properties that can be measured with gravitational-waves are common, or approximately common, for all neutron stars. For example, all neutron stars share the same equation of state and if the latter is hadronic, neutron stars have similar radii. If a mixed binary is misidentified as a neutron star binary, the inferred neutron star properties will be misestimated and will appear as outliers in a population of low-mass binaries. We show that as few as five low-mass events will allow for a 80% confidence level identification of such outliers and determination of the event type. Our method can be used to constrain the existence of low-mass black holes in binaries or measure their relative abundance compared to neutron star binaries. This approach requires neither accurate waveform models for mixed binaries nor any associated electromagnetic observations.