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Studying the onset of deconfinement with multi-messenger astronomy of neutron stars

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One of the most intriguing questions in the astrophysics of neutron stars is whether their interiors harbour deconfined quark matter. With the first multi-messenger observation of a binary neutron star merger (GW170817) new constraints became available for masses and radii of neutron stars. In this lecture, I will discuss what we may infer for their mass and the central density at the onset of deconfinement under certain assumptions that may become testable in the near future. First, I will give an overview on the scenarios discussed in the literature, involving variations of hadronic as well as quark matter equations of state and commenting on their reliability. Then I will focus on the implications that precise simultaneous measurements of mass and radius in certain regions of the mass radius diagram will have for disentangling the onset of deconfinement and the characteristics of the phase transition. Such measurements are expected in near future from the NICER experiment. I will discuss Bayesian analyses with the presently available data as well as fictitious mass radius data that could in principle be the outcome of the NICER observations. Finally I will give an outlook on possible consequences for the structure of the QCD phase diagram, in particular for the existence of one or more critical endpoints of first-order phase transitions.

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