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Gravitational waves signatures and magnetars

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A neutron star was first detected as a pulsar in 1967. It is one of the most mysterious objects in the universe, with a radius of the order of 10 km and masses that can reach two solar masses. In 2017, a gravitational wave was detected (GW170817) and its source was identified as the merger of two neutron stars. The same event was seen in X-ray, gamma-ray, UV, IR, radio frequency and even in the optical region of the electromagnetic spectrum, starting the new era of multi- messenger astronomy. To understand neutron stars, an appropriate equation of state that satisfies bulk nuclear matter properties has to be used and GW170817 has provided some extra constraints to determine it. On the other hand, some neutron stars have strong magnetic fields up to 10^{15} Gauss on the surface as compared with the usual 10^{12} Gauss normally present in ordinary pulsars. They are called magnetars. While the description of ordinary pulsars is not completely established, describing magnetars poses a real challenge because the magnetic fields can produce an anisotropic equation of state. One elegant way to circumvent this problem is the use of the chaotic field approximation. It is also known that low magnetic fields do not affect the equation of state and the resulting star macroscopic properties but they do affect the crust-core transition and the crust thickness with many consequences, as the explanation of glitches and the calculation of the Love number that enters the quadrupole tidal polarizabilities. Moreover, just before the merging, tidal interactions can excite the star crust fluid modes by resonance and the fundamental mode can be greatly excited with a strong influence on the gravitational wave emission. I will talk about the importance of the new constraints imposed by GW170817 in the determination of appropriate equations of state, in the calculation of the fundamental mode and possible ways to describe hadronic and quark matter subject to strong magnetic fields.

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