

ABSTRACT

Neutron stars are composed of the densest observable matter in nature and occupy the intellectual frontier between astrophysics and nuclear physics. Within the next decade, current and planned nuclear experiments on heavy nuclei, X-ray observations, and, perhaps, gravity wave observations of neutron stars will be exploring the nature of dense matter from complimentary approaches. Many observed neutron stars accrete hydrogen- and helium-rich matter from a companion. During the slow compression to nuclear density the accreted matter is transmuted from being proton-rich to being proton-poor. These reactions affect many observable phenomena -- from energetic explosions on the neutron star's surface to thermal relaxation of the surface layers -- that in turn inform us about the nature of the deep interior of the neutron star. In this talk, I shall describe what recent astronomical observations and nuclear physics experiments tell us about the nature of matter at nuclear densities, and highlight how this work has led to a growing mystery in our understanding of explosions on the neutron surface.