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Pycnonuclear burning on accreting neutron stars and constraints on the nuclear equation of state[1]

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Many neutron stars accrete H- and He-rich matter from a stellar companion. Over the lifetime of the binary, enough matter can be transferred to replace the crust of neutron star. As the material is compressed, the rising electron Fermi energy induces electron captures. When the ionic charge becomes sufficiently small, the zero-point motion of the ions induces the pycnonuclear fusion of nuclei. These reactions release approximately 1 MeV per accreted nucleon deep in the crust, where the thermal diffusion time is years to decades. The temperature in the crust is set by balancing this heating with thermal radiation from the surface and neutrino emission from the crust and core. Many neutron stars accrete intermittently; when the accretion halts, the surface is detectable with X-ray telescopes such as *Chandra* and *XMM*. Observations of transiently accreting neutron stars thus provide a means to infer the neutrino emissivity of the core, complimentary to observations of isolated neutron stars. In this talk, I compare theory and observations of transiently accreting neutron stars. Observations can detect the thermal relaxation of the neutron star crust following the end of rapid accretion, and appear consistent with an enhanced neutrino emissivity, such as direct Urca, from the core. The temperature of the crust also sets, in part, the depth at which carbon unstably ignites. Unlike the transients, the recurrence time and energetics of unstable carbon burning are more consistent with a hotter neutron star crust, as if the neutrino emissivity were suppressed. I discuss ongoing work to improve the nuclear physics input for models of the neutron star crust.

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