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The cooling of neutron star transients[1]

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Accretion of matter from a stellar companion compresses the crust of a neutron star and induces reactions that heat its interior. The temperature in the crust is set by balancing this nuclear heating with thermal radiation from the surface and neutrino emission from the crust and core. As a result, the crust is hotter than the core. Many neutron stars accrete intermittently; when the accretion halts, the crust cools. Recent observations of KS 1731−260 and MXB 1659−29 show a roughly exponential decline in the luminosity following an accretion outburst, consistent with this cooling. Moreover, the transient 1H 1905+000 has a very low quiescent luminosity, $< 10^{31}$ergs s^{-1}. In this talk, I describe what these observations tell us about the physics of the neutron star crust and core. In particular, I explore how the thermal timescale depends on the equation of state of the neutron star core and the constraints on the strength of the neutrino emissivity. Our models of the heating and cooling in the neutron star crust incorporate new calculations of electron capture rates in the outer crust. We find that the heat deposition in the outer crust is substantially larger than previous estimates. In addition, our models allow us to compute the heating in the outer crust for a wide range of possible crust compositions.

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