Heating and cooling in accreting neutron star crusts

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In accreting neutron stars, material in the crust undergoes complex nuclear reaction sequences that involve a broad range of nuclei ranging from stability to the neutron drip line and beyond. We recently showed [1] that these reactions not only heat the crust, but can also lead to efficient cooling through an Urca process that involves electron capture and beta decay between pairs of nuclei. This Urca process limits the temperature neutron star crusts can be heated to. It also leads to a thermal decoupling of the surface from deep crustal heating and severely limits the options for identifying the unknown mechanism that heats the surface layers of the neutron star to temperatures consistent with the observed recurrence time of thermonuclear superbursts. Urca cooling and crustal heating depend sensitively on the properties of neutron rich nuclei that in many cases are only poorly known. I will review observations, models, and experimental efforts to constrain the relevant nuclear physics, and discuss the key nuclear physics questions that arise from these new effects.

[1] H. Schatz et al., Nature, 505, 62 (2014)