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Deep Crustal Heating and Neutron Star Cooling Observation

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In this talk, I will present our recent work on a new mechanism for deep crustal heating in accreting neutron stars. During active accretion, charged pions (π^+) are produced in nuclear collisions on the neutron star surface. Upon decay, they provide a flux of neutrinos into the neutron star crust. We find that for massive and/or compact neutron stars, neutrinos deposit $\approx$ 1–2 MeV of heat per accreted nucleon into the inner crust. The strength of neutrino heating is comparable to the previously known sources of deep crustal heating, such as from pycnonuclear fusion reactions, and is relevant for studies of cooling neutron stars. We model the thermal evolution of a transient neutron star in a low-mass X-ray binary, and in the particular case of the neutron star MXB 1659-29, we show that additional deep crustal heating requires a higher thermal conductivity for the neutron star inner crust. A better knowledge of pion production cross sections near the threshold would improve the accuracy of our predictions.