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Pycnonuclear Fusion and the Shallow Heat Source in Accreting Neutron Star Crusts[1] R. JAIN, H. SCHATZ, Michigan State, R. LAU, HKU Space, M. BEARD, Notre Dame, S. S. GUPTA, IIT Ropar, A. V. AFANASJEV, Mississippi State, E. F. BROWN, Michigan State, A. DEIBEL, Indiana, L. R. GASQUES, Sao Paulo, G. W. HITT, Coastal Carolina, W. R. HIX, Oak Ridge, L. KEEK, Maryland, P. MOLLER, JINA-CEE, P. S. SHTERNIN, Ioffe Institute, A. W. STEINER, Oak Ridge, M. WIESCHER, Notre Dame, Y. XU, ELI, Romania
— Observing X-rays during quiescence from transiently accreting neutron stars provide unique clues about the nature of dense matter. Current models of neutron star crust, however, systematically predict lower temperatures than those observed, and an artificial shallow heat source is required to account for the observations. It has been previously proposed that the shallow heat source could be of nuclear origin, particularly the fusion of lighter elements in the crust. The pycnonuclear fusion reaction rates implemented in our models have large uncertainties spanning several orders of magnitude. We present the sensitivity studies of these pycnonuclear fusion reactions in realistic network calculations and also study their impact on the neutron star cooling curves in quiescence. Although we see a shallower deposition of nuclear heat when pycnonuclear fusion reaction rates are enhanced, we eliminate the possibility that the problem of shallow heating could be attributed to the uncertainties in pycnonuclear fusion reaction rates.

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