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Rotochemical heating with NSCool 2D

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A significant fraction of neutron stars (NSs) rotate, and they can rotate very fast (e.g., millisecond pulsar). An isolated rotating NS or an NS that has permanently stopped accreting from its companion gradually loses its rotational energy and spins down. The most common cause for this is magnetic braking. As the star spins down, the centrifugal force decreases, the star shrinks, and its density increases. This drives the matter inside the star out of beta equilibrium. Restoration of equilibrium occurs via nuclear reactions. As weak interactions are relatively slow, the matter can remain in a non-equilibrium state and thus accumulate chemical energy that can be released and heat up the star. This phenomenon is called “rotochemical heating.”Most works dedicated to it were performed in the 1D spherical symmetry approximation and assumed isothermal interiors of the NS. We present our preliminary results of the investigation of rotochemical heating employing our advanced NSs thermal evolution code NSCool 2D updated to handle spinning down stars. The calculations were carried out in full general relativity, in 2D axial symmetry, and take into account the full 2D distribution of temperature inside the star. We analyze the impact of the magnetic field strength, the initial rotation frequency, the equations of state of dense matter, and the mass of the star. While general features coincide with the results of earlier works, we show that some differences exist.

Authors: Dr BEZNOGOV, Mikhail (National Institute for R&D in Physics and Nuclear Engineering (IFIN)); Dr RADUTA, Adriana (IFIN-HH)

Presenter: Dr BEZNOGOV, Mikhail (National Institute for R&D in Physics and Nuclear Engineering (IFIN))