Two Dimensional Cooling Simulations of Rotating Neutron Stars

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The effect of rotation on the cooling of neutron stars is investigated. The thermal evolution equations are solved in two dimensions with full account of general relativistic effects. It is found that rotation is particularly important in the early epoch when the neutron star's interior is not yet isothermal. The polar surface temperature is up to 63% higher than the equatorial temperature. This temperature difference might be observable if the thermal radiation of a young, rapidly rotating neutron star is detected. In the intermediate epoch ($10^2 < t < 10^5\,yr$), when the interior becomes isothermal, the polar temperature is still up to 31% higher than the equatorial temperature. Afterwards photon surface radiation dominates the cooling, and the surface becomes isothermal on a time scale of $10^7\,yr$. Furthermore, the transition between the early and the intermediate epochs is delayed by several hundred years. An additional effect of rotations is the reduction of the neutrino luminosity due to the reduction of the central density with respect to the non-rotating case.

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