The formation and properties of toroidal iron atmosphere of a preneutron star

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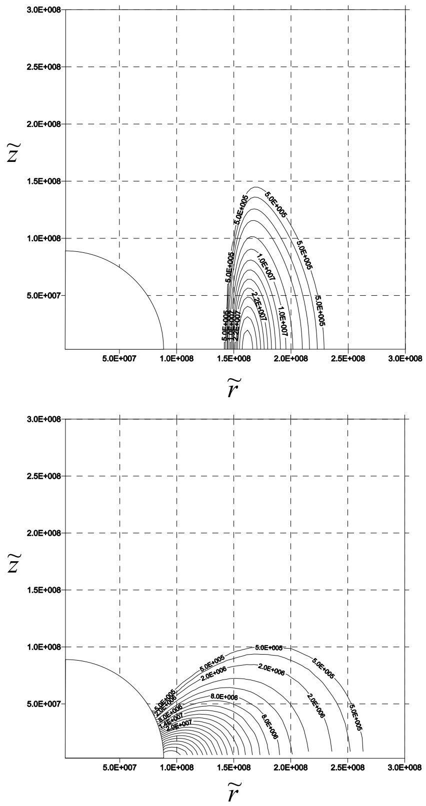

Figure 2: Lines of constant matter density for numerical solution (top) and analytical one (bottom)(from Ref.[2]).

A numerical method (described in [1]) is used to solve the two-dimensional axially symmetric hydrodynamic problem on the formation of a toroidal atmosphere during the collapse of an iron stellar core and outer stellar layers. In the initial data, we roughly specify an angular velocity distribution that is actually justified by the final result – the formation of a hydrostatic equilibrium toroidal atmosphere with reasonable values of total mass and total angular momentum. We analyze in detail the results of simulations and compare the numerical solution with our previous analytical solution in the form of toroidal atmospheres [2]. This comparison indicates that they are identical if we take into account the more general and complex equation of state with a nonzero temperature and self-gravitation effects in the atmosphere. Our numerical calculations, first, prove the stability of toroidal atmospheres on characteristic hydrodynamic time scales and, second, show the possibility of sporadic fragmentation of these atmospheres even after a hydrodynamic equilibrium is established.

References

[1] V. S. Imshennik, K. V. Manukovskii, M. S. Popov Astron. Lett. 29, 831 (2003)

[2] V. S. Imshennik, K. V. Manukovskii Astron. Lett. 26, 788 (2000)

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