Joint Institute for Nuclear Astrophysics

Induced Rotation in 3D Simulations of Core-Collapse Supernovae:Implications for Pulsar Spins

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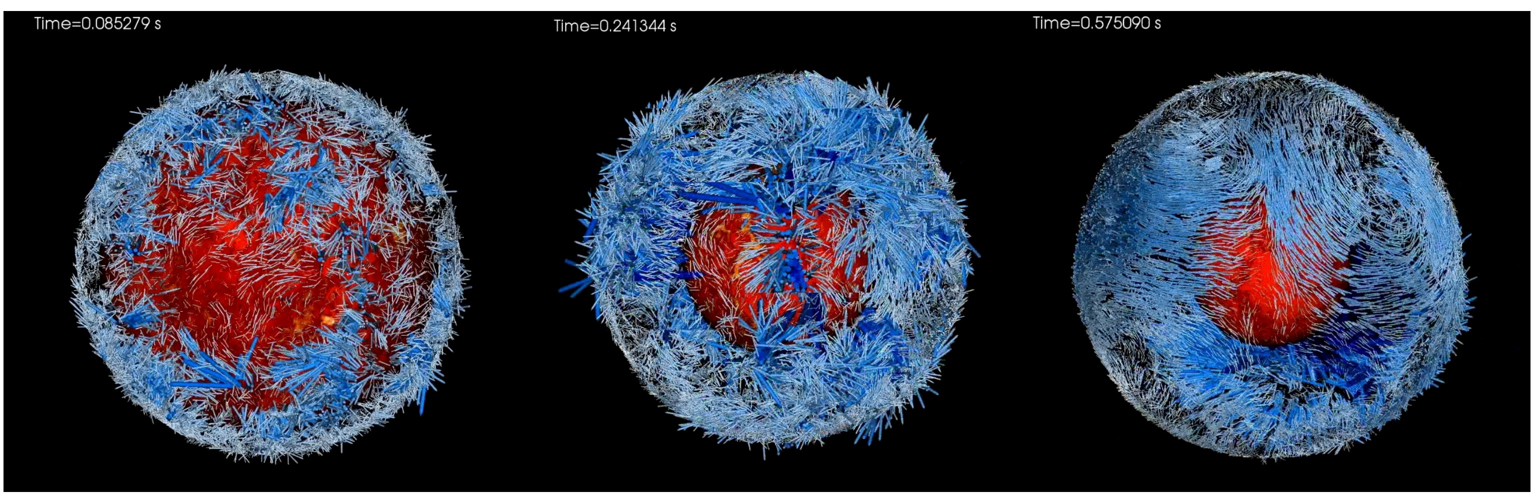
It has been suggested that the observed rotation periods of radio pulsars might be induced by a non-axisymmetric spiral-mode instability in the turbulent region behind the stalled supernova bounce shock, even if the progenitor core was not initially rotating. using the three-dimensional AMR code CASTRO with a realistic progenitor and equation of state and a simple neutrino heating and cooling scheme, Rantsiou et al. (2010) presented a numerical study of the evolution in 3D of the rotational profile of a supernova core from collapse, through bounce and shock stagnation, to delayed explosion. By the end of their simulation (~420 ms after core bounce), they do not witness any significant spin up of the proto-neutron star core left behind. However, they do see the development before explosion of strong differential rotation in the turbulent gain region between the core and stalled shock. Shells in this region acquire high spin rates that reach ~150 Hz, but this region contains too little mass and angular momentum to translate, even if left behind, into rotational frequencies of significance for the full neutron star. They also find that much of the induced angular momentum is likely to be ejected in the explosion, and moreover that even if the optimal amount of induced angular momentum is retained in the core, the resulting spin period is likely to be quite modest.



Contact: Adam Burrows, Department of Astrophysical Sciences, Princeton University, Princeton, NJ
Researchers: E. Rantsiou, A. Burrows, J. Nordhaus, & A. Almgren
Website: http://www.astro.princeton.edu/~burrows/sn.3d/

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