THE RAYLEIGH-TAYLOR INSTABILITY OVERTURN OF SUPERNOVA CORES DURING BOUNCING AND RESULTING NEUTRINO ENERGY RELEASE

S. A. Colgate and A. G. Petschek
University of California, Los Alamos Scientific Laboratory
Los Alamos, New Mexico 87545, USA
and New Mexico Institute of Mining and Technology
Socorro, New Mexico 87801, USA

We show that Rayleigh-Taylor convective overturn of the dynamically formed lepton-trapped core of a supernova is a likely outcome of three sequential events: (1) The bounce or weak reversal shock; (2) the diffusive and convective lepton release from the neutrinosphere during a fraction of the reversal time ($\cong$ 100 ms); and (3) the rapid ($\lesssim$ 10 ms) Rayleigh-Taylor growth of the $\ell = 2$ mode of an initial rotational perturbation. The overturn releases gravitational energy corresponding to a differential trapped lepton pressure energy of 30 to 50 MeV/nucleon by P dV work in beta equilibrium in a fraction of a millisecond. The resulting kinetic energy of $\cong 7 \times 10^{52}$ ergs is more than adequate to cause the observed supernova emission. Also, the sudden release of $\cong 7 \times 10^{51}$ ergs of $\sim$ 10 MeV neutrinos from the neutrinosphere will cause adequate mass and energy ejection.

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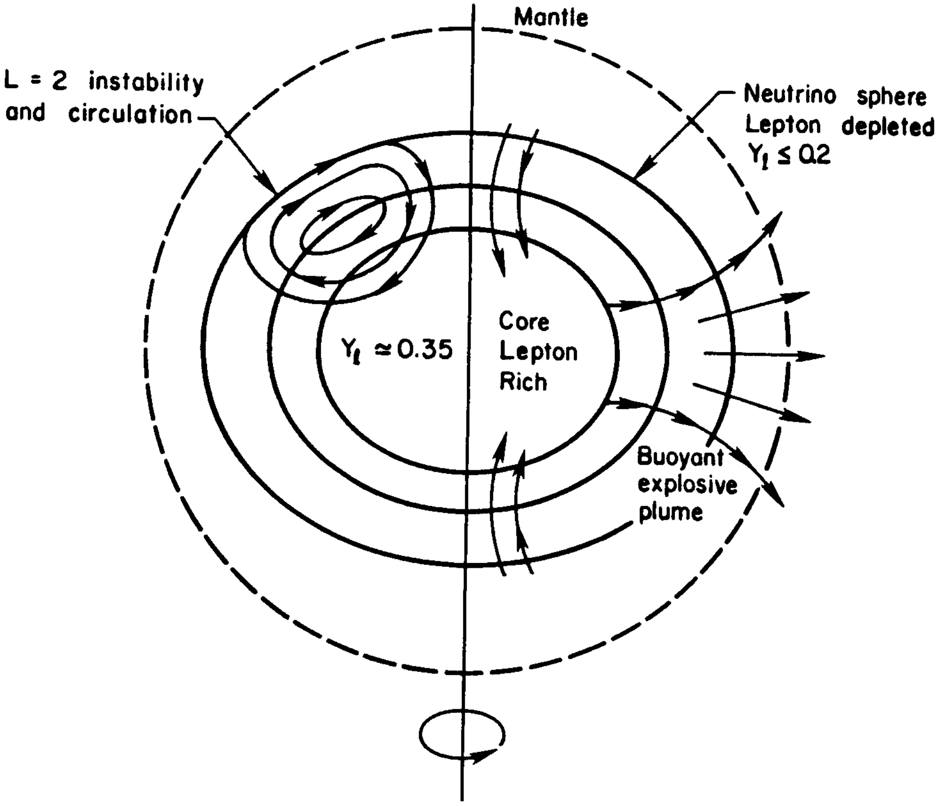

Figure 1 depicts two extreme limits of the fluid flow expected from the unstable overturn of the partially deleptonized neutron star core during formation. The circulation shown on the left occurs if the $\ell = 2$ instability grows with a relatively small unstable potential difference. The explosive plume on the right occurs if the instability potential is large, i.e. the difference in potential energy between inner and outer core is comparable to the binding energy of the deleptonized outer core.

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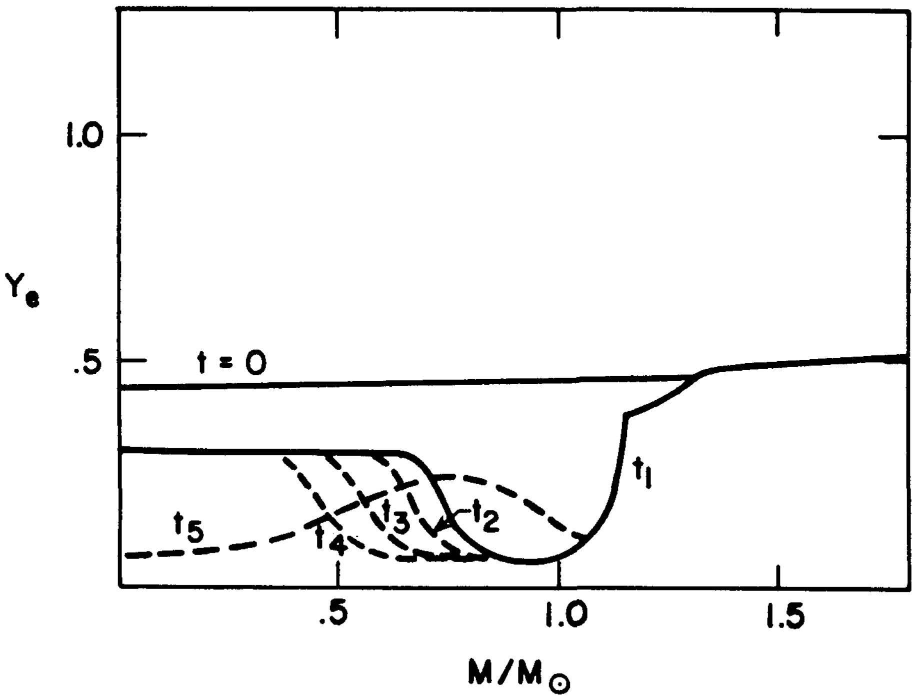

Figure 2 shows the expected distribution of Y_e as a function of time. The two solid curves t_0 and t_1 are from Wilson (1979a) where no lepton convection was involved, just neutrino diffusion. The curve t_1 occurs at 250 msec after several bounces, late in time, where the mantle is again falling back onto the neutron star. In later calculations (Wilson 1979b) lepton convection was included and a distribution like t_1 occurs earlier at about 8 msec. The dotted curves at t_2, t_3, t_4 are what we expect due to lepton convection at intermediate times before the recollapse of the mantle. At some time during this sequence we expect core overturn and for a brief instance we expect the distribution t_5 if an explosive plume carries the lepton rich matter to the outer core.

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