THE NEUTRONIZATION OF THE MATTER AND HYDRODYNAMIC INSTABILITY AT FINAL STAGES OF STELLAR EVOLUTION

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In this report I consider dynamic instability when the non-equilibrium neutronization of matter plays the main role. The model of the deflagration supernova has been developed during more than ten year in our group. In 1973 it was shown that thermal flash evolves in the deflagration regime. In our computations the deflagration regime is stipuleted by joint effect of compression of matter and weak shock waves, obtained at the pulsing regime of burning. Fig. 1 shows the graduated growth of entropy in mass zone through passage of weak shock waves.

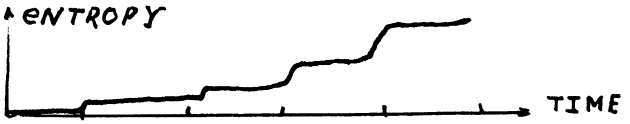

Figure 1. Entropy versus time for the mass zone.

The proof of the deflagration regime has the principal meaning for theory of supernova. The competitions between explosion and collapse in the flash of CO-core develops from start. Thermal explosion results in a hydrodynamic explosion. The neutronization of burning matter leads to the collapse of the core. The deflagration regime leads to the higher tendency towards collapse in the case $\rho_c < 3\times10^{10}$g/cm^3. In 1975 the neutrino ignition of CO-cores was suggested. The neutrino ignition results in deflagration with subsonic propagation. After compression up to $\rho_c \gtrsim 3\times10^{10}$g/cm^3 does it involve detonation with supersonic propagation. We obtained in calculations two versions of explosions: at $2\times10^9 < \rho_c < 9\times10^9$g/cm^3 there is disruption of the star with 10^{50}-10^{51} erg kinetic energy and at $\rho_c > 9\times10^9$g/cm^3 the stellar core collapses into a neutron star with outburst of the envelope with a kinetic energy of 10^{49}-10^{50} erg. The first version corresponds to SN II, and the second, supplemented by mechanism of slow energy release into the envelope, corresponds to SN I.

D. Sugimoto, D. Q. Lamb, and D. N. Schramm (eds.), Fundamental Problems in the Theory of Stellar Evolution, 320–321.

DISCUSSION

Sugimoto: As discussed in our paper of 1976, the fate of the deflagration wave depends sensitively on the speed with which the deflagration front propagates, and thus on the mode of heat transport. In the deflagration regime, the effect of heat transport by convection or by the Rayleigh-Tayler instability is more effective than the effect of the weak shock; this is even the definition of deflagration in contrast to detonation. If you take account of the effects of such heat transport, how do your results change?

Chechetkin: The propagation of the deflagration front by the weak shock wave is faster than the mechanism of convection. Therefore the first mechanism is more important.

Sugimoto: How long is the time scale involved in the propagation of the detonation front?

Chechetkin: The detonation front doesn't exist when the burning begins. If a detonation front arises, then the time scale of its propagation is less than 1 sec.