N47a ニュートリノ加熱によって起こる超新星の爆発エネルギーについて

茂山俊和 (東大理天文)

The energy brought by the ejected material (explosion energy) in a neutrino-driven supernova is constrained by a dimensional analysis. The minimum energy is obtained from the requirement that the energy in the ejecta overcomes the gravity of the neutron star. The maximum energy is given by the absorbed neutrino emission during the time scale of explosion. It is found that both energies depend on the mass of the neutron star $M_{\rm NS}$, the neutrino luminosity $l = \int_0^\infty \kappa_\nu \frac{dL_\nu}{d\varepsilon} d\varepsilon / \left(4\pi c G M_{\rm NS}\right)$, and the density structure of the outer envelope $\rho(r) = H_{\rm n}/r^n$ in the same manner ($(n$ is a parameter). Thus it is very likely that the actual explosion energy $\mathcal{E}$ depends on these three quantities in the same manner as the maximum and minimum do. As a result, on e can show that the energy is expressed as

$$\mathcal{E} = C_0 \times l^{n-2} H_{\rm n} \left(G M_{\rm NS}\right)^{3-n} c^{2n-4},$$

with an unknown constant C_0. Here c is the speed of light.