重力崩壊型超新星の空間三次元における
ボルツマン輻射流体計算

The Boltzmann Neutrino Radiation Hydrodynamic Simulation
of a Core-Collapse Supernova

発表者

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Core-Collapse Supernovae

Neutrino Radiation

Explosions of Massive Stars

Neutrino distribution function

$$f(t, r, \theta, \phi; \varepsilon_\nu, \mu_\nu, \phi_\nu)$$

Boltzmann Equation in the spheri

$$\frac{\partial f}{\partial t} + \cos\theta_\nu \frac{\partial f}{\partial r} + \frac{\sin\theta_\nu \cos\theta_\nu}{r} \frac{\partial f}{\partial \theta} + \frac{}{r\sin\theta} \frac{}{\partial \phi}$$
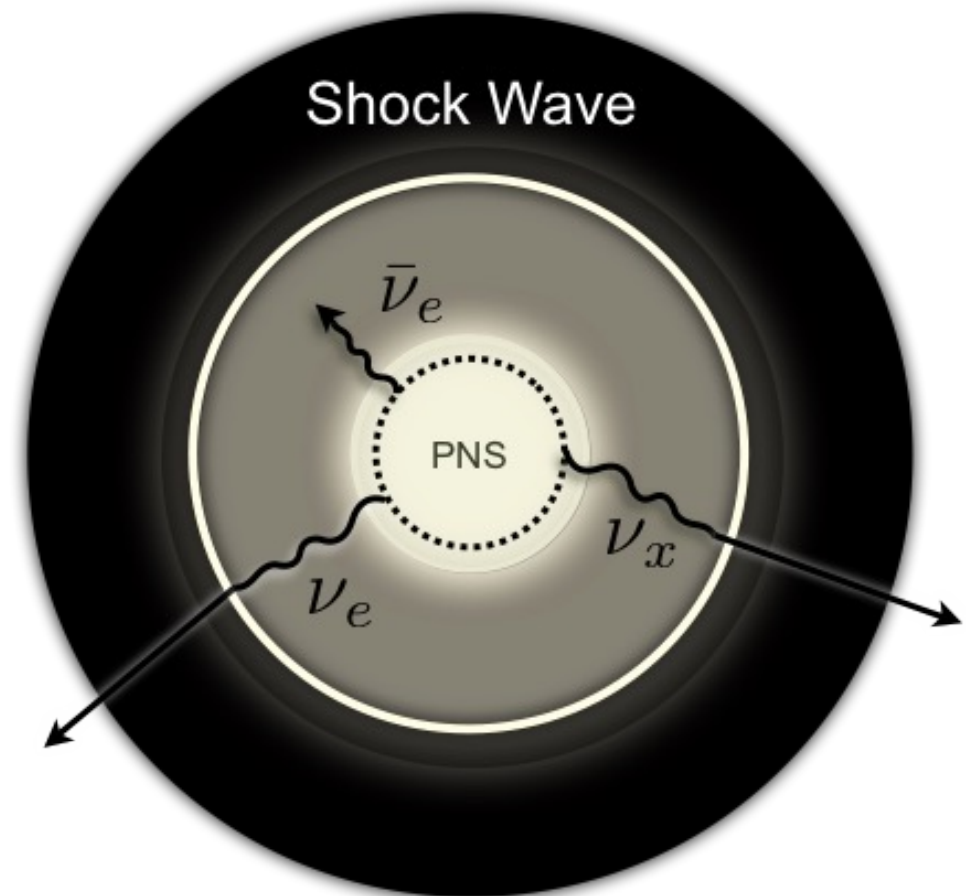
Optically thick   Optically thin

Boltzmann Equation
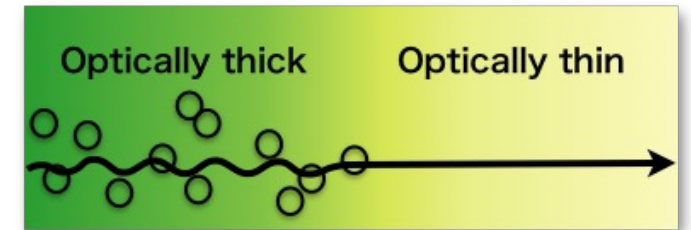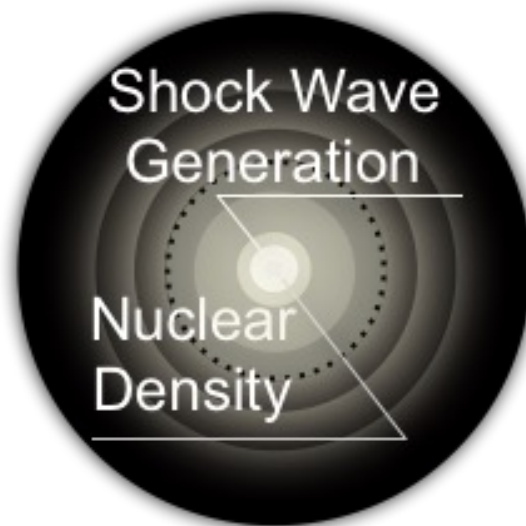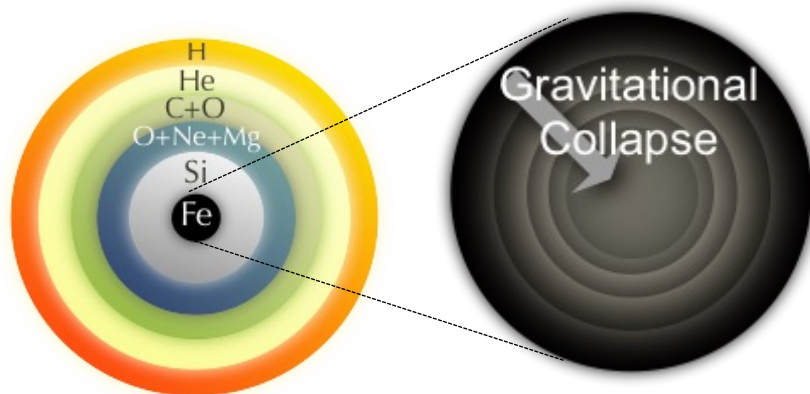
$$\frac{dx^\mu}{d\lambda} \frac{\partial f}{\partial x^\mu} + \frac{dp^i}{d\lambda} \frac{\partial f}{\partial p^i} = \left(\frac{\delta f}{\delta \lambda}\right)_{\text{collision}}$$
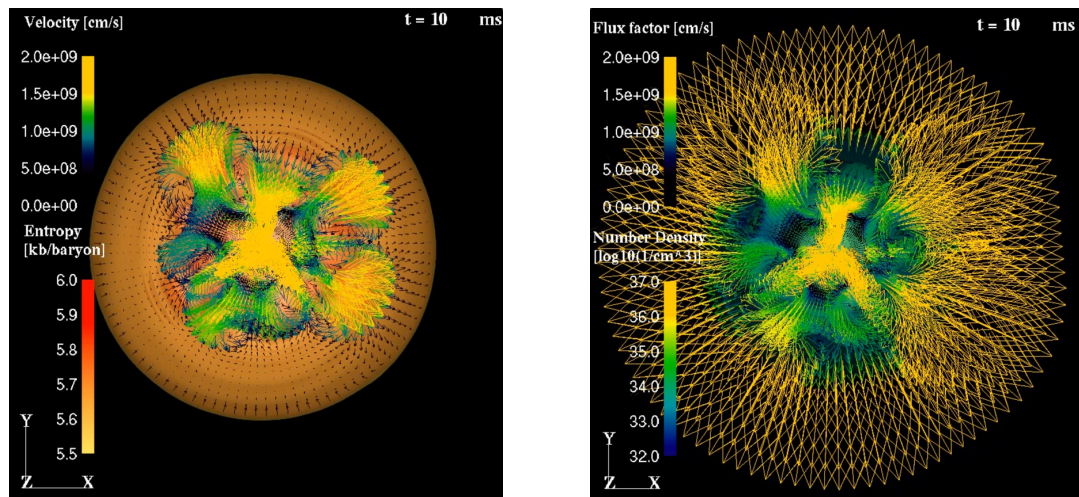
Neutrino distribution function

$$f(t, r, \theta, \phi; \varepsilon_\nu, \mu_\nu, \phi_\nu)$$

$$\frac{\sin\phi_\nu}{r} \frac{\partial f}{} \quad \left(\frac{}{}\right)_{\text{collision}}$$

Shock Wave

$\bar{\nu}_e$

Explosion Mechanism

e_ϕ e_r

Neutrino Heating ν

e_z

Momentum Space
PNS

Momentum Space

e_r

θ

$|p| = \varepsilon_\nu$

$p_{\mathrm{Z}} = |p| \cos\theta_\nu$

Shock Wave
Generation

Gravitational
Collapse

θ
t r

e_θ

e_y

Nuclear
Density

$p_{\mathrm{Y}} = |p| \sin\theta_\nu \sin\phi_\nu$

ν_x

e_ϕ

e_x Φ

Coordinate Space

p_{X} $|p| \sin\theta_\nu \cos\phi_\nu$

e_θ

Φ_ν

$\mu_\nu = \cos\theta_\nu$
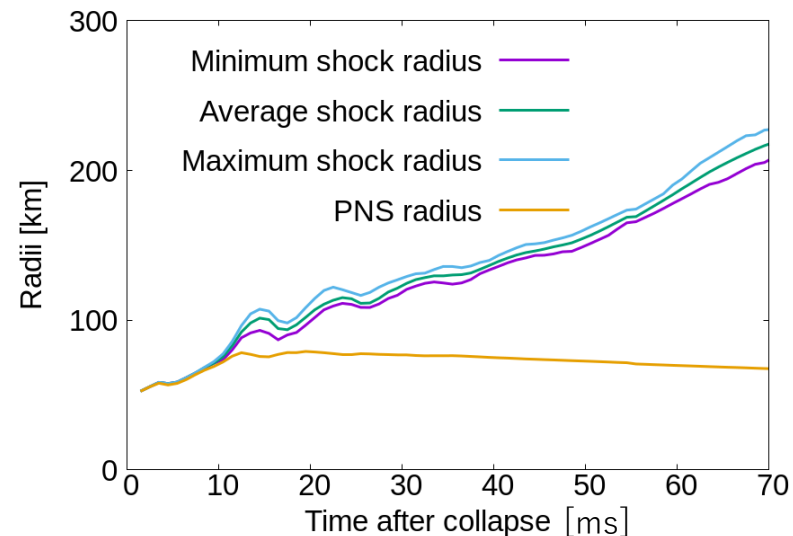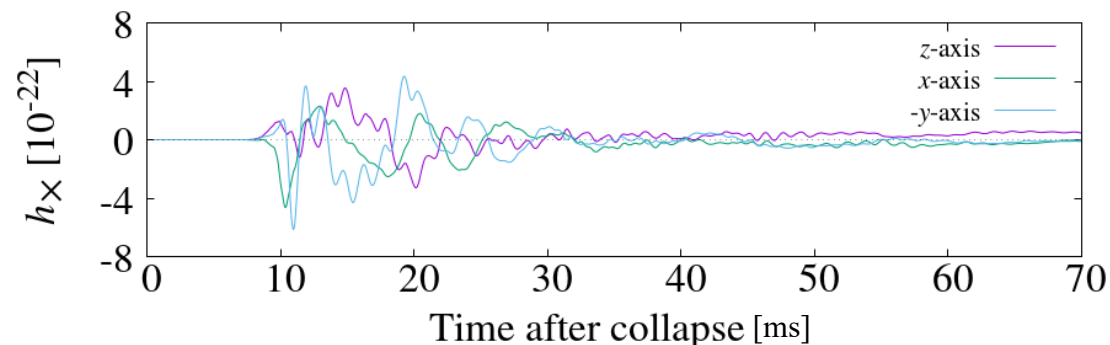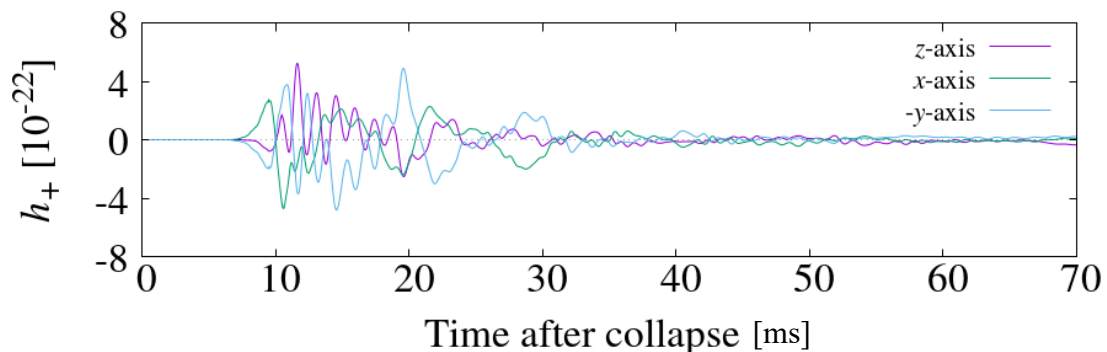
Prompt Convection

Time Evolution of the Shock Wave

Time History of the Gravitational Wave from Matter

GW originated from matter is radiated in the various directions when the prompt convection is strongly developed.

GW from neutrino will be also calculated and the correlation with the neutrino signal is investigated in the future work.