

Quest for the unified picture of the explosion mechanism of supernovae and the central engine of gamma-ray bursts

Katsuhiko Sato

(The University of Tokyo, Department of Physics, School of Science, Professor)

【Outline of survey】

It is believed that stellar cores of massive stars collapse gravitationally at the end of the evolution and cause the supernova explosion. However, the mechanism of collapse-driven supernovae has not been made clear and is remaining one of the mysteries of astrophysics. Elucidation of this phenomenon by observations is very difficult because the rate of supernova explosions is very small. In recent years, however, it has been recognized that collapse-driven supernovae accompany a certain kind of gamma-ray bursts and that gamma-ray bursts are one of the final forms of the evolution of massive stars. Now it is a good chance for us to construct the unified picture of various gravitational collapse scenarios and to elucidate the mechanism of supernovae and the central engine of gamma-ray bursts. We investigate 1) the evolution of massive stars until the gravitational collapse, 2) the formation of black holes and accretion disks, 3) the jet formation and nucleosynthesis therein, and 4) the emissions of high-energy particles and electromagnetic radiations, by carrying out the numerical simulations of stellar evolution, and general relativistic collapse of rotating and magnetized stellar cores including the state-of-the-art microscopic physical processes.

【Expected results】

1) The final mass, metal abundance and angular momentum of massive stars are clarified systematically. 2) The dependence of the explosion on the stellar rotation and magnetic field as well as the equation of state is elucidated. 3) The detectability of neutrinos and gravitational waves is clarified. 4) The unified picture of the gravitational collapse, from the formation of black holes to the jet generations via accretion disks, is obtained by numerical simulations.

【References by the principal investigator】

- Explosion Mechanism, Neutrino Burst, and Gravitational Wave in Core-Collapse Supernovae, Reports on Progress in Physics 69 (2006), 971-1144.
Kei Kotake, Katsuhiko Sato, Keitaro Takahashi
- Magneto-driven Shock Waves in Core-Collapse Supernova, Astrophys. J. **613** (2004) 1086-1094. Tomoya Takiwaki, Kei Kotake, Shigehiro Nagataki and Katsuhiko Sato

【Term of project】 FY2007—2011

【Budget allocation】 15,300,000 yen

(2007 direct cost)

【Homepage address】

None