独立行政法人理化学研究所　仁科加速器研究センター
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Nuclear Astrophysics in Astrophysical Big Bang Laboratory

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Nuclear physics plays an important role in astrophysics. Heavy elements, including r/s-process elements, are produced mainly in massive stars, and they are ejected through supernova explosions. The most powerful explosions in the universe, gamma-ray bursts, sometimes accompany peculiar supernova explosions. They may be another origins of rare, heavy elements. These heavy elements can be observed in legacy of supernova explosions: supernova remnants. Distribution of heavy elements are observed in some supernova remnants, and they are far from spherical symmetric. Especially in a young, aspherical supernova remnant, Cassiopeia A, it looks that iron is outside of lighter elements. This is amazing because its progenitor star should have an onion-like structure in composition and heavier elements should have been produced inside, leaving lighter elements outside. Nuclear physics also plays a very important role in the explosion mechanism of supernovae and gamma-ray bursts. Equation of state in high density matter is important for their dynamics. The new light may be shed in the near future especially on the mechanism of supernova explosions by gravitational wave and neutrino observations. Supernova explosions and gamma-ray bursts are producing high energy particles called as cosmic-rays. The highest energy of cosmic-rays in the universe is 1000 times greater than the particles produced at LHC, but their composition is still not known well. They may be irons, but they may be protons. Giant resonance between highest energy cosmic-rays and background photons determines how nuclear cosmic-rays propagate in space, which is crucial to understand the origin of the cosmic-rays. In this talk, I would like to introduce these phenomena and our group's recent, on-going, and possible contributions to this field.

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