報告番号	※　甲　　第　　　　号

主　論　文　の　要　旨

論 文 題 目　Acceleration and Diffusion of Cosmic Rays from Supernova Remnants in a Multiphase Interstellar Medium
（多相星間媒質中の超新星残骸における粒子加速と宇宙線粒子の伝搬）

氏　　名　　盧 淳榮

論 文 内 容 の 要 旨

Supernova remnants (SNRs) have long been believed to be the source of hadronic Galactic cosmic rays (GCRs) up to energies of the ‘knee’, near 5×10^{15} eV, of the cosmic ray (CR) spectrum. Supernova explosions forming collisionless shock waves induce the shocked gas and relativistic particles (hereafter cosmic rays) that produce multi-wavelength thermal and nonthermal emission. Diffusive shock acceleration (DSA) is the most promising mechanism for converting the kinetic energy of a supernova explosion into energetic particles and plays an important role in nonthermal emission during the overall process. Shock acceleration by DSA in SNR shocks is associated with transport processes, and some of the highest energy CRs inevitably escape from their acceleration sites by a so-called diffusion process due to interactions with turbulent magnetic fields. If quick diffusion takes place in the accelerator, it indicates inefficiency acceleration. Therefore, it is impossible to explain the standard theory illustrating observed rapid acceleration.

A recent report on observations from the Fermi satellite has shown a signature of pion- decay in the gamma-ray spectra of SNRs. This provides strong evidence for protons accelerated in middle-aged SNRs interacting with molecular clouds. The origin of gamma rays can be interpreted as the decay of neutral pions produced by CR protons that encounter the dense exteriors of accelerators such as molecular clouds. CR electrons emit synchrotron radiation of X-ray range, but X-ray and gamma rays distributions significantly differ. Therefore it requires diffusion coefficients of various CRs in order to be understood.

The interstellar medium (ISM) is an inhomogeneous, multiphase system in which gases of different temperatures, densities, and ionization fractions can coexist approximately in pressure equilibrium. We investigated the diffusion of CRs using a hydrodynamics simulation of a strong shock wave propagating in a realistic multiphase ISM. A blast wave generated by supernova expansion sweeps up the dense and clumpy HI clouds of the multiphase ISM, which eventually generates strong velocity shear in the magnetic fields. Magnetic fields undergo amplification from their typical strength of μG to mG due to the turbulent dynamo in the post-shock region. We performed test particle simulations that describe the propagation process of high-energy CR particles in an SNR where a blast wave interacts with a realistic ISM. The present study indicated that we could use the Bohm diffusion coefficient in practical calculations of CR particle diffusion, which may support the interpretation of high-energy emission from SNRs.