# U03a 電子温度の緩和過程を考慮した第一世代超新星残骸中の種磁場の生成

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Although magnetic fields are ubiquitous in the Universe, the origin of them is still unknown. An amplification mechanism such as galactic dynamos is suggested to explain the observed strength of magnetic fields, $\sim \mu$G. However, for seed fields amplified with the dynamos, various origins have been proposed but there is no consensus. One of plausible generation processes of magnetic fields is the Biermann mechanism which is expected to work in a non-barotropic region. The interior of a supernova remnant (SNR) is such a non-barotropic region. We show that the Biermann mechanism produces magnetic fields in the first generation SNR, using magnetohydrodynamical (MHD) simulations. We perform a series of two-dimensional MHD simulations taking account of the Biermann effect. Especially, since (i) the Biermann mechanism depends on the electron pressure (or temperature) and (ii) the electron temperature is not equilibrated to the ion temperature in the early adiabatic expansion phase, we incorporate the relaxation process of the electron and ion temperatures with the Coulomb interaction and calculate the magnetic fields with the electron pressure in the region where equilibrium is sufficiently achieved. For a model of the surroundings of an SNR, we assume a density inhomogeneity which is expected for the ionized region around a supernova. As a result, we find that the magnetic fields with a magnitude of $10^{-17} - 10^{-18}$ G are generated in the SNR. The total magnetic energy attains $10^{25} - 10^{26}$ erg per each SNR at $z \sim 20$. Considering the cosmic star formation (i.e. supernova rate) history, the average energy density of the cosmic magnetic fields is estimated as $10^{-42}$ erg cm$^{-3}$ at $z \sim 10$, and it will be amplified to $\sim 10^{-39}$ erg cm$^{-3}$ which corresponds to magnetic fields $10^{-19}$ G at the formation epoch of primordial galaxies.