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Evolution of Supernova Remnant Interacting with Turbulent Molecular Cloud : Towards Understanding Cosmic-ray Acceleration Efficiency

Kenta Tatsumi[1], Tsuyoshi Inoue[1],
[1]Department of Physics, Konan University, Okamoto 8-9-1, Higashinada-ku, Kobe, Hyogo, Japan
e-mail (speaker): d2421001@s.konan-u.ac.jp

The interaction between a SNR and molecular clouds is known to have a significant effect on the properties of SNRs through the enhancement of particle acceleration by turbulent magnetic field amplification and the enhancement of X-ray and gamma-ray emissions.

According to observations, the total energy of cosmic-ray protons in SNR: RXJ1713.7-3946 was estimated to be about 10^{48}erg[1]. This value is an order of magnitude smaller than that expected from observed galactic cosmic-ray energy density. However, this estimation assumes that the volume filling factor of the molecular gas, where gamma-rays are emitted, is close to 100%, and the total cosmic-ray energy could be higher if the volume filling factor is low. In the case of the core collapsing supernova, the stellar wind and expansion of the HII region that occur before the explosion blow out the low-density part of the molecular cloud away, leaving a very clumpy structure with low volume filling factor of molecular clumps[2].

By means of numerical simulations, we investigate the influence of the low volume filling factor medium on the evolution of SNR. We found that if the volume filling factor is larger than roughly 10%, the propagation velocity of the SNR blast wave shock becomes substantially slower than observed velocity. We discuss the possible values of the cosmic ray acceleration efficiency of RXJ1713.7-3946 based on the results of simulations.

References

[1] Y.Fukui et al, The Astrophysical Journal, 746, 82, 2012
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