Confinement of Pulsar Wind Nebulae by Their Supernova Remnant and Magnetic Dissipation

S. J. Tanaka[1*]

[1] Department of Physics, Faculty of Science and Engineering, Konan University, 8-9-1 Okamoto, Kobe, Hyogo 658-8501, Japan

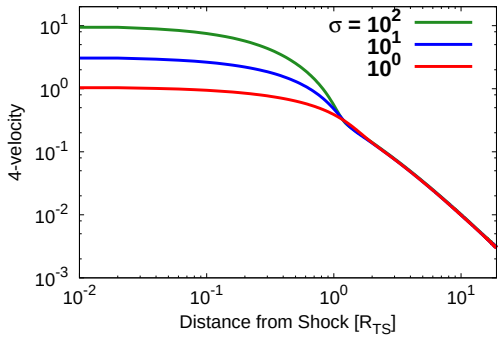

Figure 1: The velocity profile inside a PWN. Three lines are different magneization just before the termination shock. Dissipation length-scales are also diffrent for three lines.

Pulsar wind nebulae (PWNe) are composed of relativistic magnetized plasma wind supplied from their central pulsars. The basis of the pulsar wind is a magnetosphere of the pulsar, where the magnetization σ (the ratio of the magnetic to particle energy) is much larger than unity (e.g., [1]). On the other hand, the magnetization of the PWN plasma is considered much smaller than unity from both the observed non-relativistic expansion velocity of PWN and the observed broadband spectrum of PWNe (e.g., [2]). This is the σ-problem of the pulsar wind [3, 4]. It is known that reducing from $\sigma \gg 1$ to $\sigma \ll 1$ is difficult for ideal magnetohydrodynamics outflows.

We study a steady and spherically symmetric model of PWNe. Although the dissipation of the magnetic energy in the pre-shock pulsar wind region have been discussed [5], here, we discuss the magnetic energy dissipation at the post shock PWN region. We adopt the phenomenological expression of the magnetic dissipation from [6], where they applied the magnetic dissipation to accelerate the supersonic outflow. We find that the significant dissipation of the magnetic field allows to decelerate the post shock flow to non-relativistic velocity (Figure 1). Recently, the similar results for the deceleration of outflow was also obtained by [7]. We also discuss the broadband spectrum of PWNe.

References

[1] J. K. Daughty & A. K. Harding, *ApJ*, **252**, 337 (1982)
[2] M. J. Rees & J. E. Gunn, *MNRAS*, **167**, 1 (1974)
[3] C. F. Kennel & F. V. Coroniti, *ApJ*, **283**, 694 (1984)
[4] C. F. Kennel & F. V. Coroniti, *ApJ*, **283**, 710 (1984)
[5] F. V. Coroniti, *ApJ*, **349**, 538 (1990)
[6] G. Drenkhahn, *A&A*, **387**, 714 (2002)
[7] J. Zrake & J. Arons, arXiv:1612.02330

*E-mail: sjtanaka@center.konan-u.ac.jp