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宇宙地球フロンティア実地研修 報告書

Report for Onsite Training in Earth-Space Frontier Science

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Neutron stars are compact stellar remnants that mainly form at the center of a collapsing massive star with zero-age main sequence (ZAMS) mass $M_{\rm ZAMS} \gtrsim 10M_{\odot}$ and iron cores at the last stage of the stellar evolution, usually accompanied by a supernova (SN) explosion. The first signal being detected from the NS came from pulsars, which has rotation periods ~ 0.01-1 s (Hewish et al., 1968). They mainly lose rotation energy through ejecting energetic particles to their surrounding pulsar wind nebulae (PWN) and pulsates in a remarkably regular way.

My research during the reporting period mainly focused on the first double pulsar system PSR J0737-3039, which consists of one millisecond pulsar PSR J0737-3039A (P ~ 2 ms) and one normal pulsar PSR J0737-3039B (P ~ 2 s). This system is special in the sense of

- A Highly relativistic and weakly magnetized pulsar wind from PSR J0737-3039A, with wind lorentz factor > 10. It interacts with the magnetosphere of PSR J0737-3039B, which produces a bow shock and a magnetopause;
- The magnetopause that resides well inside the light cylinder of PSR J0737-3039B. This implies that the energy loss rate from PSR J0737-3039B through electromagnetic torques can be significantly altered by the interaction with its companion wind, and thus deviates from the well-known analytical formula being used to estimate the magnetic field strength of isolated pulsars.

Working with Prof. Anatoly Spitkovsky at the department of Astrophysical science in Princeton University, we used multi-dimensional particle-in-cell (PIC) simulations to reveal the global structure of pulsar magnetospheres affected by companion winds, together with their observational imprints.

Fig. Department of Astrophysical science in Princeton University