Acceleration of Particles at the Termination Shock of a Relativistic Striped Wind

Lorenzo Sironi and Anatoly Spitkovsky

Department of Astrophysical Sciences, Princeton University, Princeton, NJ 08544-1001, USA

lsironi@astro.princeton.edu;
anatoly@astro.princeton.edu

ABSTRACT

The relativistic wind of pulsars consists of toroidal stripes of opposite magnetic field polarity, separated by current sheets of hot plasma. By means of 2D and 3D particle-in-cell simulations, we investigate particle acceleration and magnetic field dissipation at the termination shock of a relativistic striped wind. At the shock, the flow compresses and the alternating fields annihilate by driven magnetic reconnection. Irrespective of the stripe wavelength λ or the wind magnetization σ (in the regime $\sigma \gg 1$ of magnetically dominated flows), shock-driven reconnection transfers all the magnetic energy of alternating fields to the particles. In the limit $\lambda/(r_L\sigma) \gg 1$, where r_L is the relativistic Larmor radius in the wind, the post-shock spectrum approaches a flat power-law tail with slope around -1.5, populated by particles accelerated by the reconnection electric field. Close to the equatorial plane of the wind, where the stripes are symmetric, the highest energy particles resulting from magnetic reconnection can escape ahead of the shock, and be injected into a Fermi-like acceleration process. Our findings place important constraints on the models of non-thermal radiation from Pulsar Wind Nebulae.

Proposed Session: Space and Astrophysical Plasmas