# Simulating super-Alfvénic plasma flows interacting with magnetised obstacles

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Magnetised stellar winds are a common space physics phenomenon. When they encounter magnetised objects, e.g. a planet with a dipole, the interaction can result in physical processes such as magnetic reconnection and bow shock formation. These systems can behave differently depending on the planet's magnetic field configuration and the variation of stellar wind conditions. In the laboratory, magnetised plasma flows can be generated using inverse wire array z-pinches[1]. The experiments discussed are carried out at the MAGPIE pulsed-power facility at Imperial College London.

We have simulated the interaction of a super-Alfvénic magnetised plasma flow encountering a magnetic dipole. The flow advects a uniform magnetic field which bends around the obstacle. This allows us to observe magnetic reconnection, flux compression and shock formation, and how they change depending on the orientation of the dipole. We expect diagnosing this experiment will be challenging given the topology of the fields involved, so we have generated results using synthetic diagnostics to aid with the interpretation.

To better understand the above interaction, we have studied some of the physical processes separately: (a) Magnetic reconnection and flux compression using counter propagating flows from two inverse wire arrays, and (b) the formation of magnetised bow shocks when the plasma flow from a wire array encounters a conducting cylindrical obstacle. These experiments provide better diagnostic access and are also a good point of comparison to verify the code's capabilities.

These simulations were generated using Gorgon[2], a resistive MHD code. Gorgon has been used extensively to simulate MAGPIE experiments. It has also been adapted to simulate the interaction between Earth's magnetosphere and the solar wind under real solar wind conditions[3].

1. Harvey-Thompson, A. J. *et al.* Quantitative analysis of plasma ablation using inverse wire array Z pinches. *Phys. Plasmas* **16,** 22701 (2009).
2. Chittenden, J. P. *et al.* X-ray generation mechanisms in three-dimensional simulations of wire array Z-pinches. *Plasma Phys. Control. Fusion* **46,** B457–B476 (2004).
3. Mejnertsen, L. *et al.* Global MHD Simulations of the Earth’s Bow Shock Shape and Motion Under Variable Solar Wind Conditions. *J. Geophys. Res. Sp. Phys.* 1–13 (2018). doi:10.1002/2017JA024690