Type: not specified

## Modeling the Lyman-alpha backscatter observed by Voyager 1 and 2 in the outer heliosphere and the structure of the heliospheric bow shock

Saturday, 28 September 2013 10:45 (30 minutes)

1) Observations made by ultraviolet (UV) detectors on board Pioneer 10, Voyager 1, and Voyager 2 can be used to analyze the distribution of neutral hydrogen throughout the heliosphere, including the interaction regions of the solar wind and local interstellar medium. We use state-of-the art three-dimensional (3D) magnetohydrodynamic (MHD) – kinetic neutral H models to simulate Lyman-alpha backscatter as would be seen by the three spacecraft, exploiting a new 3D Monte Carlo radiative transfer code under solar minimum conditions (Fayock et al., 2013). Both observations and simulations of the UV backscatter intensity are normalized for each spacecraft flight path at 15 AU, and we compare simulations with Voyager 1 and 2 and Pioneer 10 Lyman-alpha data results, finding a very close match with the Voyager data. Our results predict a large increase in the Lyman-alpha intensity as the hydrogen wall is approached.

2) Recent IBEX observations indicate that the local interstellar medium (LISM) flow speed is less than previously thought (23.2 km/s rather than 26 km/s), indicating that the LISM flow may be either marginally super-fast magnetosonic or sub-fast magnetosonic. This raises two questions: (A) Can a LISM model that is barely super-fast or sub-fast magnetosonic account for Ly-alpha observations that rely critically on the additional absorption provided by the hydrogen wall (H-wall)? and (B) If the LISM flow is weakly super-fast magnetosonic, does the transition assume the form of a traditional shock or does neutral hydrogen (H) mediate shock dissipation and hence structure through charge exchange? Both questions are addressed using three-dimensional self-consistently coupled magnetohydrodynamic plasma - kinetic neutral H models with different LISM magnetic field strengths (2, 3, and 4mG) as well as plasma and neutral H number densities. The 2 and 3mG models are fast magnetosonic far upwind of the heliopause whereas the 4µ G model is fully subsonic. The 2mG model admits a broad (~50-75 AU) bow-shock-like structure. The 3mG model has a smooth super-fast-sub-fast magnetosonic transition that resembles a very broad, ~200 AU thick, bow wave. A theoretical analysis shows that the transition from a super-fast to a sub-fast magnetosonic downstream state is due to the charge exchange of fast neutral H and hot neutral H created in the supersonic solar wind and hot inner heliosheath, respectively. For both the 2mG and the 3mG models, the super-fast magnetosonic LISM flow passes through a critical point. Because the Mach number is only barely super-fast magnetosonic in the 3mG case, the hot and fast neutral H can completely mediate the transition and impose a charge exchange length scale on the structure, making the solar-wind-LISM interaction effectively bow-shock-free. The charge exchange of fast and hot heliospheric neutral H therefore provides a primary dissipation mechanism at the weak heliospheric bow shock. Both super-fast magnetosonic models produce a sizeable H-wall. We find that (1) a sub-fast magnetosonic LISM flow cannot model the observed Ly-alpha absorption profiles along four sightlines corresponding to upwind, sidewind, and downwind; and (2) both the super-fast magnetosonic models can account for the Ly-alpha observations, with possibly the bow-shock-free 3µ G model being slightly favored.

Primary author: Dr ZANK, Gary (University of Alabama in Huntsville)

Presenter: Dr ZANK, Gary (University of Alabama in Huntsville)

**Session Classification:** Modeling the Lyman-alpha backscatter observed by Voyager 1 and 2 in the outer heliosphere and the structure of the heliospheric bow shock - Gary Zank, U of Alabama-Huntsville

Track Classification: Gary Zank