Magnetic fields in the Smith Cloud

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Introduction

Infall of low-metallicity gas is needed to explain the observed star formation rate and mass-metallicity relationship in galaxies (Pagel 1994). High velocity clouds (HVCs) trace the interaction between galactic disks and the surrounding halo. However, the mechanism by which HVCs are incorporated into the galactic ISM remains unknown.

Hydrodynamical simulations suggest that HVCs will lose most of their neutral hydrogen content after traveling ~ 10 kpc through the halo (Joung et al 2012). However, the few simulations to date which have incorporated the effects of magnetic fields (Konz et al 2002) suggest that magnetic fields of a few microgauss could stabilize a cloud, making disruption more difficult. Therefore, measurements of the strength of the magnetic field and its role in the disruption of halo clouds are essential.

The Smith Cloud is one of the most studied examples of the active infall of new material onto the Galaxy. Its cometary morphology, with a head bright in both H I 21 cm and Hα emission and a more diffuse, fragmented tail extending away from the plane, indicates interaction with the upper atmosphere of the Galactic ISM.

Three independent distance measurements indicate that the cloud is 12.4 ± 1.3 kpc away (Putman et al 2003, Wakker et al 2008, Lockman et al 2008). All three components of its position in the Galaxy (approximately 3 kpc below the plane, near the Solar circle, on the far side of the Galaxy) and velocity are well constrained, as is its orbit (Lockman 2008). The cloud has a mass of at least 10⁶ M☉ in both neutral (Lockman et al 2008) and ionized (Hill et al 2009) gas.

Observations

• One of us (FJL) has obtained a deep H I spectroscopic map of the Smith Cloud (Figure 1), showing disrupted components of the crowd.

• Taylor et al (2009) derived a catalog of Faraday rotation towards extragalactic sources from the NRAO VLA Sky Survey (NVSS; Condon et al 1998). We use these data to estimate the Faraday rotation due to the Smith Cloud in Figure 1.

• An Hα spectroscopic map (Figure 2) over the region with the brightest H I using the Wisconsin H-Alpha Mapper (WHAM) traces the ionized gas, which accounts for as much mass as the H I in the Smith Cloud.

Results

• Figure 1 shows an excess of sightlines with large, positive (red) Faraday rotation along the calculated orbit of the cloud, suggesting the presence of magnetic fields in the cloud.

• The enhancements in Faraday rotation are not well-correlated with the H I emission.

• Figure 2 shows that the Faraday rotation is better correlated with Hα emission than the H I. In particular, the portion of the cloud near (l, b) = (40, -22) is relatively bright in Hα but has a relatively small H I column. The RM due to the cloud here is ~ 100 rad m⁻².

Future work

• We have obtained 1–2 GHz spectra of ~ 6 extragalactic point sources (six times the source density of the Taylor et al 2009 catalog) with the Jansky VLA data in order to derive RMs.

• We are conducting MHD simulations of magnetized HVCs interacting with a multi-phase Galactic disk in order to investigate the role the magnetic field plays in allowing infalling gas to join the ISM in the Galactic disk.

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References

Pagel (1994), in The Formation and Evolution of Galaxies, CUP

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