Distances to High velocity Clouds: A Forty-Year Mystery on the Way to Solution

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Overview

The authors observe high velocity clouds and attempt to determine the distance using the method of absorption line bracketing.

Summary

High velocity clouds (HVC) and intermediate velocity clouds (IVC) are HI clouds observed near our Galaxy which have velocities too high to be accounted for by galaxy rotation. There are multiple theories for the origin of these clouds, four of which the paper state to be: "low-metallicity gas from intergalactic medium, material left over form the original assembly of the Milky Way, cycling of gas between the Disk and the Halo in the Galactic Fountain, and tidally-stripped debris from passing dwarf galaxies." In an effort to constrain possible origins of the gas, size and mass need to be known. However, this is impossible to determine without knowing the cloud's distance. The authors use the method of absorption bracketing in order to constrain the distance to the clouds. In this method, probe stars (whose distances are well known) are observed in the line of sight of the cloud. If the star is behind the cloud, doppler shifted absorption lines will be present in the stellar spectrum due to absorption from the cloud. If a star is in front of the cloud, then there will be no absorption present from the cloud. In this way, an an upper and lower limit on the clouds distance is obtained. The authors were able to restrict the distances of three HVC and two IVC which are shown in table 1.

Table 1. Distance brackets and derived physical parameters of HVCs and IVCs observed.

HVC/IVC	Distance (kpc)	z (kpc)	H I Mass ($M_\odot$)	$\dot{M}$ ($M_\odot$ yr^{-1})
complex C	3.7-11.2	3-9	$0.7\text{-}6\times10^6$	0.1-2.5
Cohen Stream (CS)	9.3-11.4	(−6.4)-(−8.4)	$2.5\text{-}3.9\times10^5$	4×10^{-3}
g1	1.8-3.8	(−0.8)-(−1.7)	$< 1\times10^4$	–
complex GCP	9.8-15.1	(−2.5)-(−3.9)	1×10^6	–
IV-South	1.0-4.5	–	1×10^5	–

Cume Question

By what factor with the mass of a cloud differ if its true distance were found to be twice that of its assumed distance?

If we assume the cloud is spherical with constant density and radius r, located at a distance of d, and extends an angular size of Φ, then:

$r_1 = d^* \Phi$

$r_2 = 2d^* \Phi$

$M = p^*V$

$M_2/M_1 = (r_2/r_1)^3$

$M_2/M_1 = 8$

Question to authors

How do you determine a non-detection for a lower limit distance?

Followup project

With the distance of these clouds determined, is there a mass difference between HVC and IVC?

Ties to class material

We discussed high velocity clouds and their importance in star formation rates.