Discovery of a New Population of HI Clouds in the Galactic Halo

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SUMMARY

The new 100-meter Green Bank Telescope (GBT) has been used to measure the HI halo of the Milky Way in 21cm emission at the tangent points in the inner Galaxy. With the resolution and sensitivity of this instrument a new population of halo clouds has been discovered which may contain a significant fraction of the neutral gas far from the plane. The velocities of the clouds are determined largely by Galactic rotation. Their location near the tangent points means that their distance is known with reasonable accuracy, and thus it is possible to get good estimates of their size, mass, density and other properties. The halo cloud population extends to at least 1.5 kpc from the Galactic plane.

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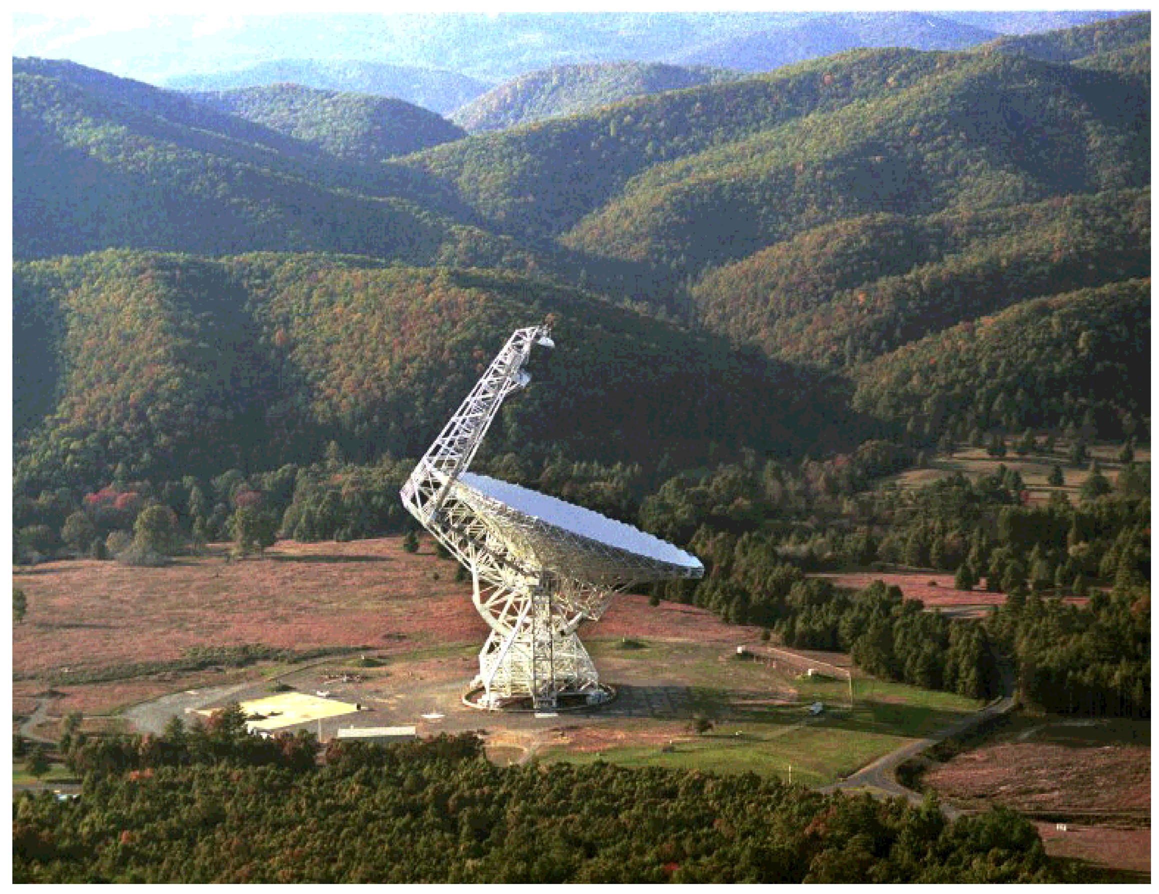
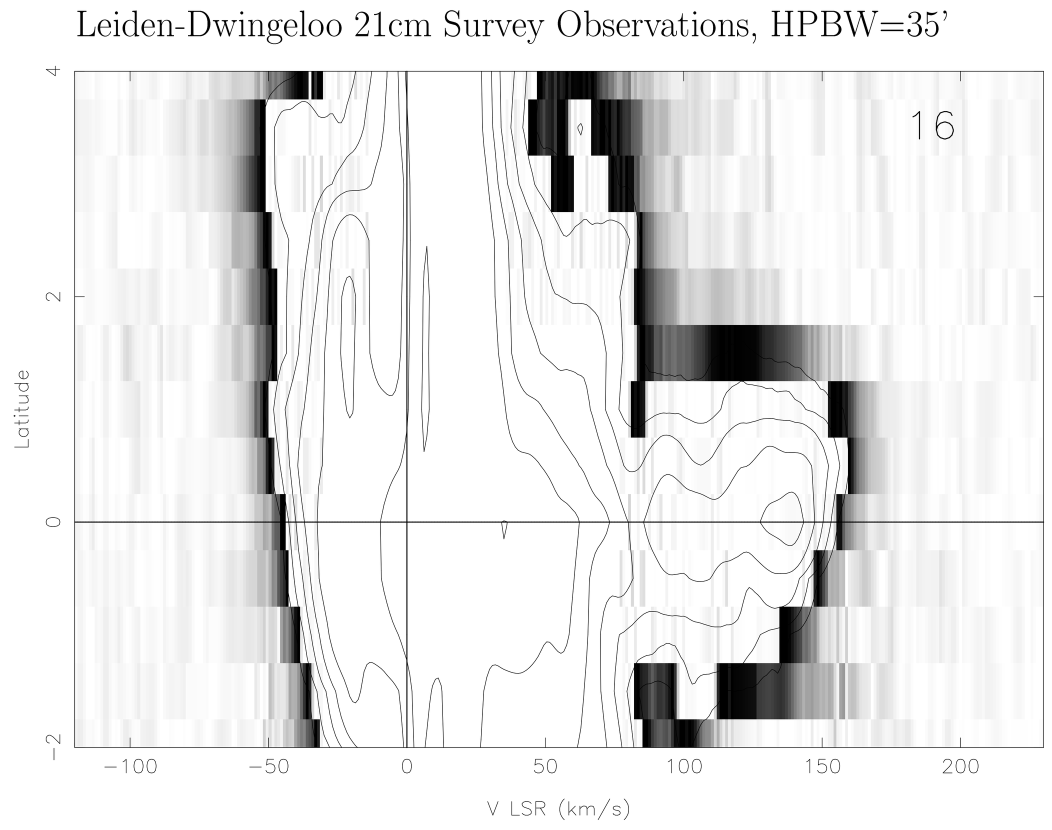
The Green Bank Telescope



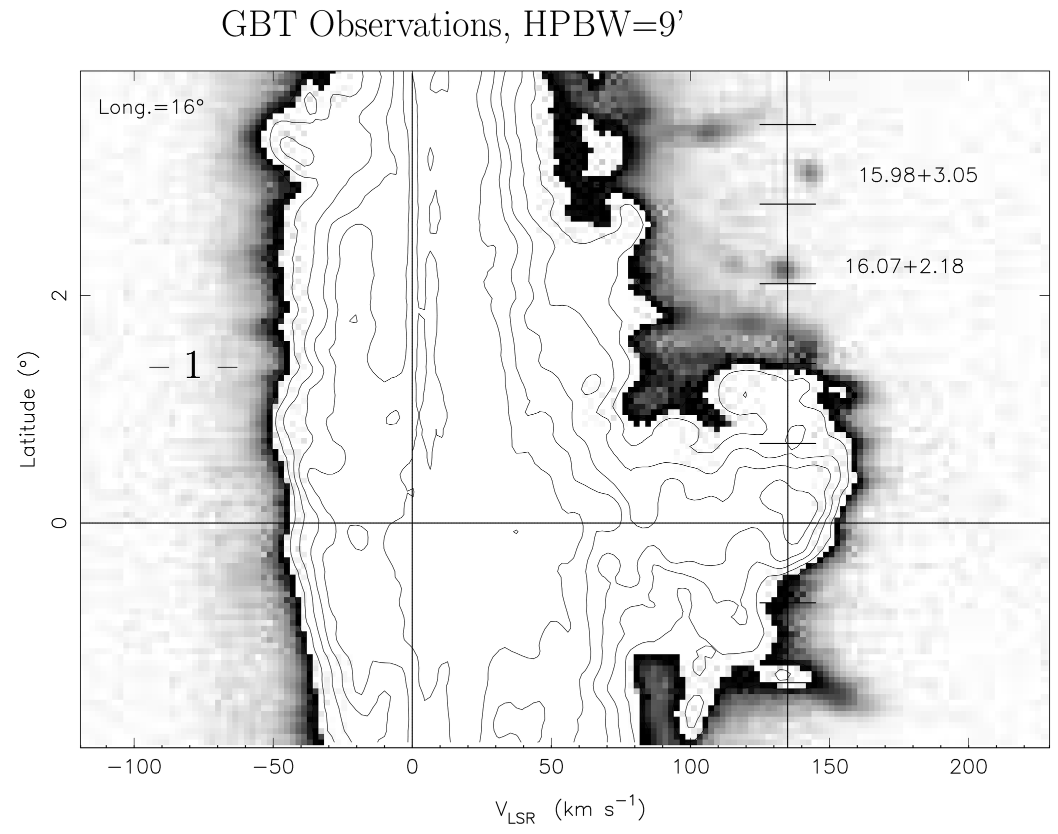
This experiment was one of the first done on the new Robert C. Byrd Green Bank Telescope of the NRAO. The unique clear aperture design of the GBT gives it very high dynamic range, making it the ideal instrument to use when looking for faint halo HI in the presence of the bright HI from the nearby Galactic plane.
The GBT has an angular resolution of about 9' in the 21cm line. At the distance of the tangent points in the first quadrant of the Galaxy, this corresponds to a linear resolution of about 20 pc, almost identical to the linear resolution of the WYN telescope at the distance of the galaxy NGC 891.

GBT Observations (right) reveal a population of halo clouds not seen in previous data (left)

Leiden-Dwingeloo 21cm Survey Observations, HPBW=35'



GBT Observations, HPBW=9'



Latitude-velocity diagrams at $\ell = 16°$. With the sensitivity and angular resolution of the GBT we can see for the first time that there are small HI clouds in the halo at the terminal velocity (vertical line) far above the Galactic plane. Horizontal tics on the terminal velocity line are spaced every 100 pc from the Galactic plane, and thus the two clouds detected in this direction lie at distances of 310 and 430 pc from the Galactic plane. The linewidths are fairly narrow ($\lesssim 10$ km s^{-1}), so the clouds must be cool.

Halo Clouds in Longitude and Latitude

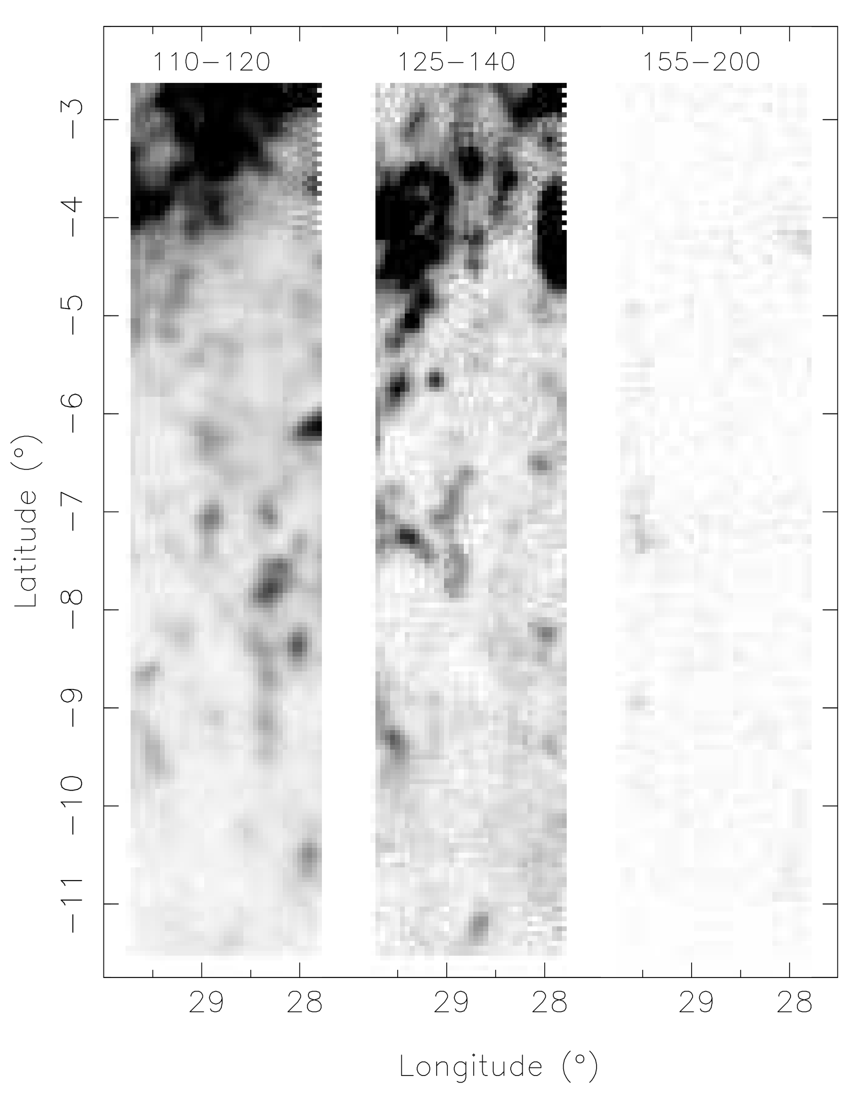


Table 1. Halo Clouds: $\ell \approx 29°$, $-12° < b < -4°$

Property	Median	90% Range
(1)	(2)	(3)
V_{LSR}	+118	$+105 \rightarrow +145$
z (pc)	−940	$-640 \rightarrow -1210$
T_L (K)	1.0	$0.4 \rightarrow 2.7$
Δv (km s^{-1})	12.2	$5.4 \rightarrow 26.3$
N_{HI} (10^{19} cm^{-2})	2	$0.7 \rightarrow 6.3$
Diameter (pc)	24	$< 19 \rightarrow 35$
$\langle n \rangle$ (cm^{-3})	0.25	$0.1 \rightarrow 0.9$
M_{HI} ($M_\odot$)	50	$12 \rightarrow 290$

The left panel shows HI emission in one area below the Galactic plane in three different velocity ranges (indicated above each panel). Here 1° in longitude or latitude corresponds to about 130 pc in linear scale. Properties of 38 clouds in this field are summarized in Table 1. The right panel shows an HI velocity slice in a different area, at positive latitudes. The two clouds at +7.6° are each about 1 kpc above the plane.