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# DR21: Highlights over 25 years

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CO observations in the 1970s and 1980s revealed a giant molecular cloud and a very massive, energetic young stellar bipolar outflow associated with the DR 21 continuum source. Recent HI observations with the VLA at 5″ resolution show one of the widest absorption lines in our Galaxy and pinpoint the origin of the bipolar outflow. Measurements of the Zeeman splitting of the HI line reveal a magnetic field of several hundred microgauss in this outflowing molecular gas close to the HII core.

## INTRODUCTION

DR 21 is a radio continuum source located behind the Cygnus rift at a distance of ~2 Kpc. Observations made in 1973-4 with the NRAO 11-m radio telescope at a resolution of ~70″ by Dickel, Dickel, & Wilson (1978) revealed a giant molecular cloud associated with this continuum source and large line wings in CO and other molecules toward the continuum peak.

Observations of the HCN emission with the Hat Creek interferometer in 1982-3 at a resolution of ~14″ showed a dense molecular clump in which the compact HII regions of DR 21 appeared to be partially embedded (Dickel, Ho, & Wright 1985). Indications of an outflow were seen in low resolution images of the emission in the CO wings (Fischer, Righini-Cohen, & Simon 1980). Higher resolution (20″) infrared observations of shock-excited $H_2$ made at 2 $\mu$m with the UKIRT by Garden *et al.* (1986) showed this to be the most massive and energetic young stellar bipolar outflow in our Galaxy. Subsequent observations of several isotopes of CO made with the Nobeyama 45-m telescope at 15″ resolution by Garden *et al.* (1991) indicate a mass of $> 3000\ M_\odot$ and energy $> 2 \times 10^{48}$ ergs for this outflow. HI emission is also associated with the outflow (Russell *et al.* 1992).

## HI absorption toward DR 21

DR 21 was imaged in HI at high resolution (~5″) in both left and right circular polarization with the VLA by us in 1992. The continuum emission is nearly totally absorbed with $\tau > 6$ over about 20 km s$^{-1}$; the line is unusually wide with FWHM ~ 35 km s$^{-1}$. At least three components are present: two narrow ones at $V_{LSR} = -5$ km s$^{-1}$ and +10 km s$^{-1}$ and a negative-velocity wing whose opacity can be measured out to $V_{LSR} = -30$ km s$^{-1}$ in some places (see Fig. 1a). No positive velocity wing is detected. The negative-velocity wing is detected over most of the HII region core except near HII region D in the north and in the very southwest corner (see Fig. 1a). The HI gas appears to be accelerating from this southwest position which is close to that of the $H_2O$ maser (large cross, see Genzel & Downes 1977). This location for the origin of the outflow is consistent with that inferred from the CO observations, indicated by the circle (Garden *et al.* 1991).

**HI Zeeman measurements toward DR 21**

Zeeman measurements were made toward the DR 21 compact HII region core. No magnetic field (B $<$ 50 $\mu$G) is detected in the narrow line component at $V_{LSR}$= +10 km s$^{-1}$; a strong magnetic field of a few hundred microgauss is seen over much of the HII core in the HI gas at negative velocities. Fig. 1b shows both the Stokes $I$ and $V$ spectra. The derivative of the intensity scaled by the derived line of sight magnetic field strength B has been fit to the $V$ spectrum for the negative velocities and gives a $7\sigma$ fit.

**Main Points**

The DR 21 star-forming region has:

- the most massive and energetic young stellar bipolar outflow in our Galaxy
- HI absorption lines which are broad (FWHM ~35 km s$^{-1}$) and deep ($\tau > 6$)
- HI absorption with negative-velocity wings associated with the outflow
- HI gas which is accelerating from a position close to the $H_2O$ maser source
- a strong magnetic field of a few hundred microgauss detected in HI gas at negative velocities but B $<$ 50 $\mu$G for the component at $V_{LSR}$= + 10 km s$^{-1}$.

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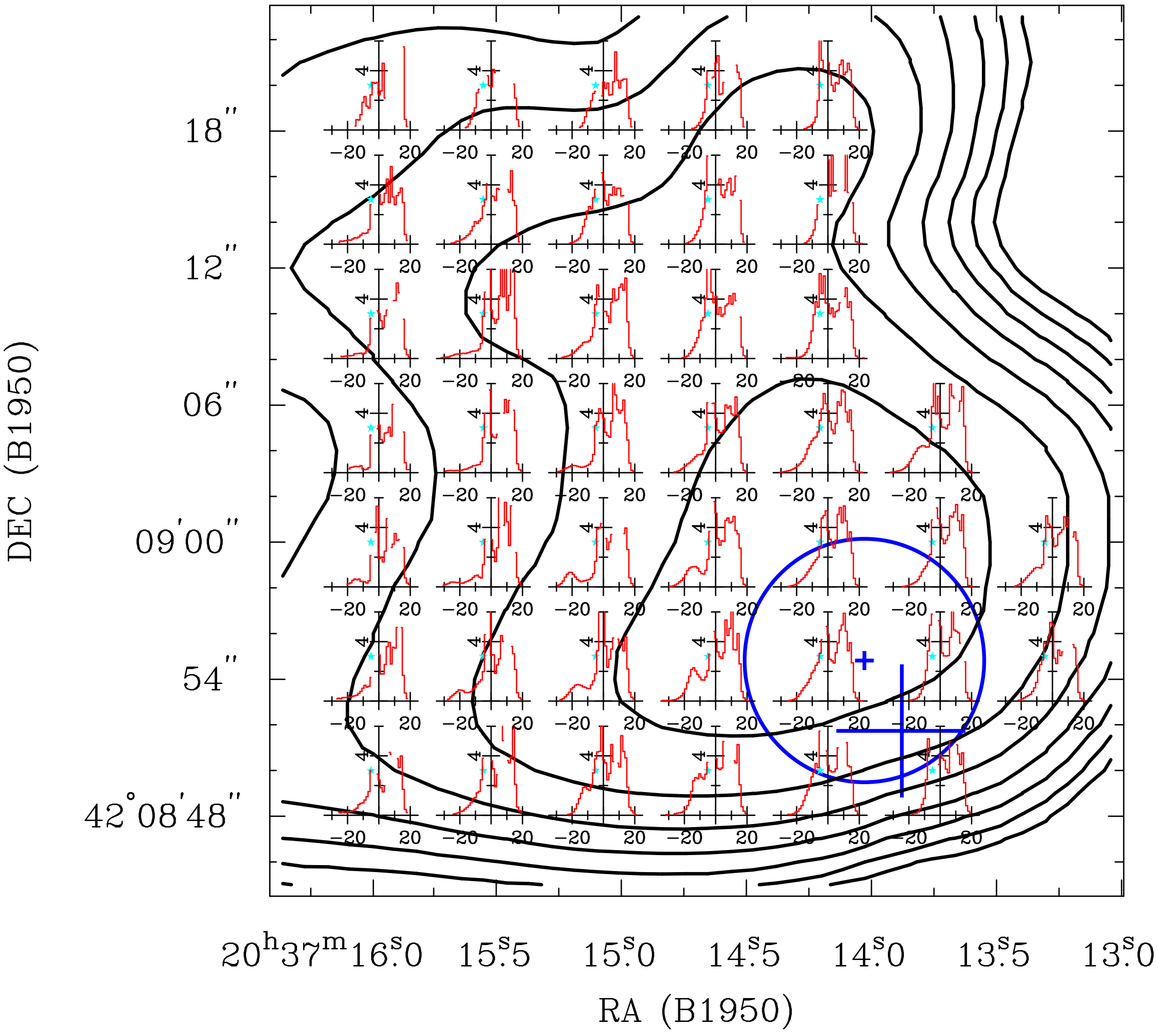


**Fig. 1a** — A contour representation of the 21 cm continuum with opacity spectra superposed across the bright HII regions in the western portion of DR 21. The spectra are sampled every 5″(≈ the beamsize) and are independent. The continuum contours shown are at 8, 16, 32, 64, 128, 256, and 512 mJy beam$^{-1}$. The positions where the profiles were taken are marked by a star. The large cross marks the location of the $H_2O$ maser (Genzel & Downes 1977) and the large circle marks the location of the origin of the CO outflow (Garden *et al.* 1991).

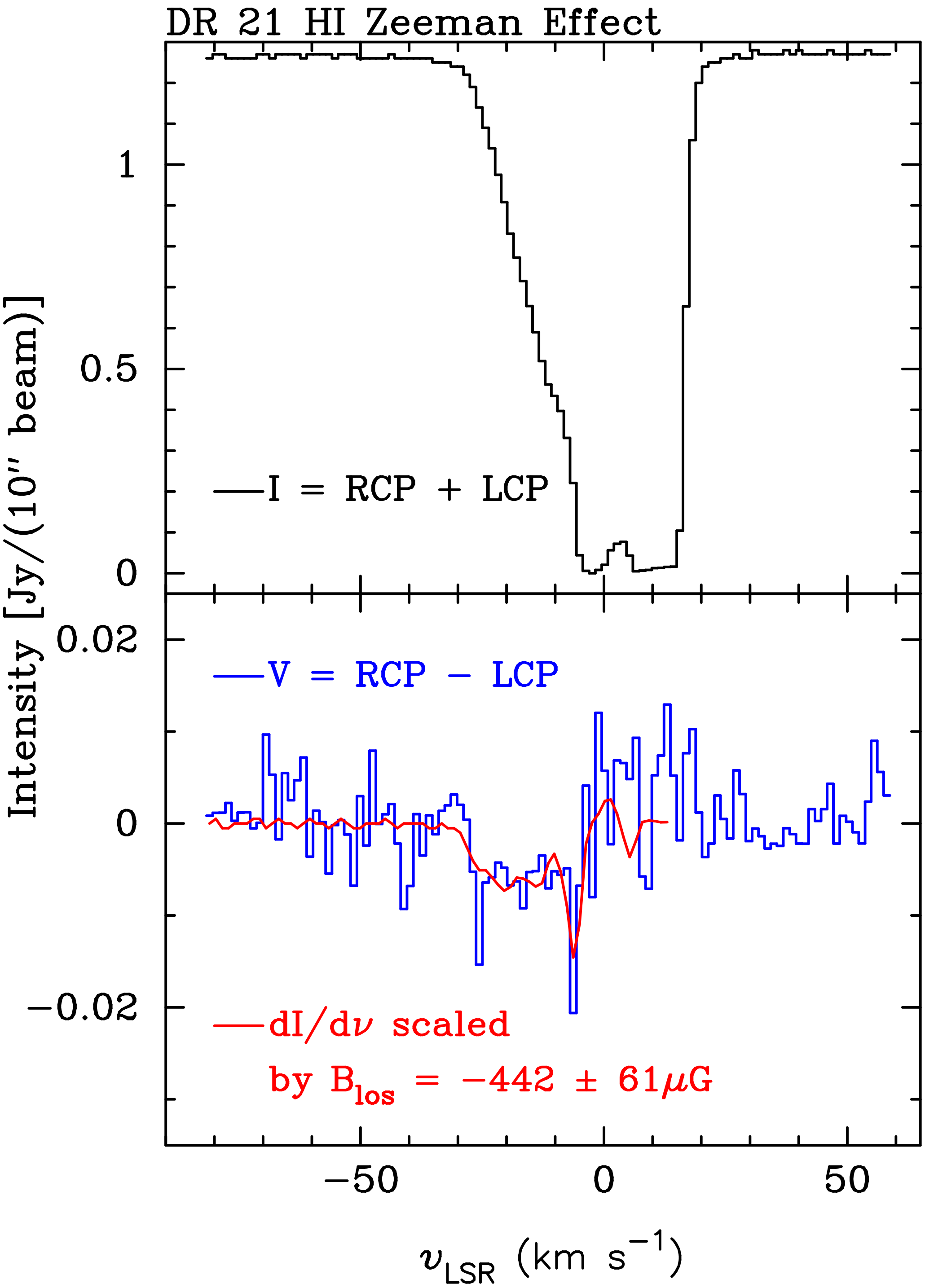


**Fig. 1b** — Profiles of Stokes $I$ ($top - histogram$) and $V$ ($bottom - histogram$) in the HI line smoothed to 10″ resolution at $\alpha_{1950} = 20^{\mathrm{h}}37^{\mathrm{m}}15.0^{\mathrm{s}}$, $\delta_{1950} = +42°09'4''$. The ragged line superposed on the $V$ spectrum is the derivative of $V$ spectrum scaled by the derived $\mathrm{B}_{\mathrm{los}}$.