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DETECTION OF MAGNETOHYDRODYNAMIC SHOCKS IN THE L1551 OUTFLOW

M. BARSONY
Harvard-Smithsonian Center for Astrophysics

N. Z. SCOVILLE and C. J. CHANDLER
Owens Valley Radio Observatory

ABSTRACT

We report the results of CO J=1→0 mapping of portions of the blue outflow lobe of L1551 with $\sim 7''$ (N-S) $\times$ $4''$ (E-W) resolution, obtained with the 3-element OVRO millimeter array. Comparison of our interferometer mosaic with lower resolution single-dish data shows that we resolve the strongest single-dish emission regions into filamentary structures, such as are characteristic of shock fronts mapped via their near-infrared H_2 emission in other outflow sources.

We detect a continuous velocity gradient across the brightest filamentary structure in our maps. The projected, deconvolved, FWHM of this feature is 1–2 $\times$ 10^{16} cm, similar to that predicted in theoretical models of C-shocks. Combined with the velocity gradient, this suggests that the emission originates from within a magnetohydrodynamic shock front, possibly resulting from the interaction of a stellar wind with dense, ambient material. In contrast, the discontinuous J-shocks expected in regions with low or no magnetic field should have a thickness $\leq 10^{15}$ cm, which would be unresolved at our spatial resolution. Based on the shock models of Draine and co-workers, the magnetic field strengths required to account for the structure are in the range 10 to 30 μG. We suggest future high spatial resolution mapping of this feature in its near-infrared CO and H_2 emission, to characterize further the temperature and density structure of the neutral gas within the shock.

A more comprehensive account of this work will is the subject of an article by us which will appear in the 20 May 1993 issue of the Astrophysical Journal.

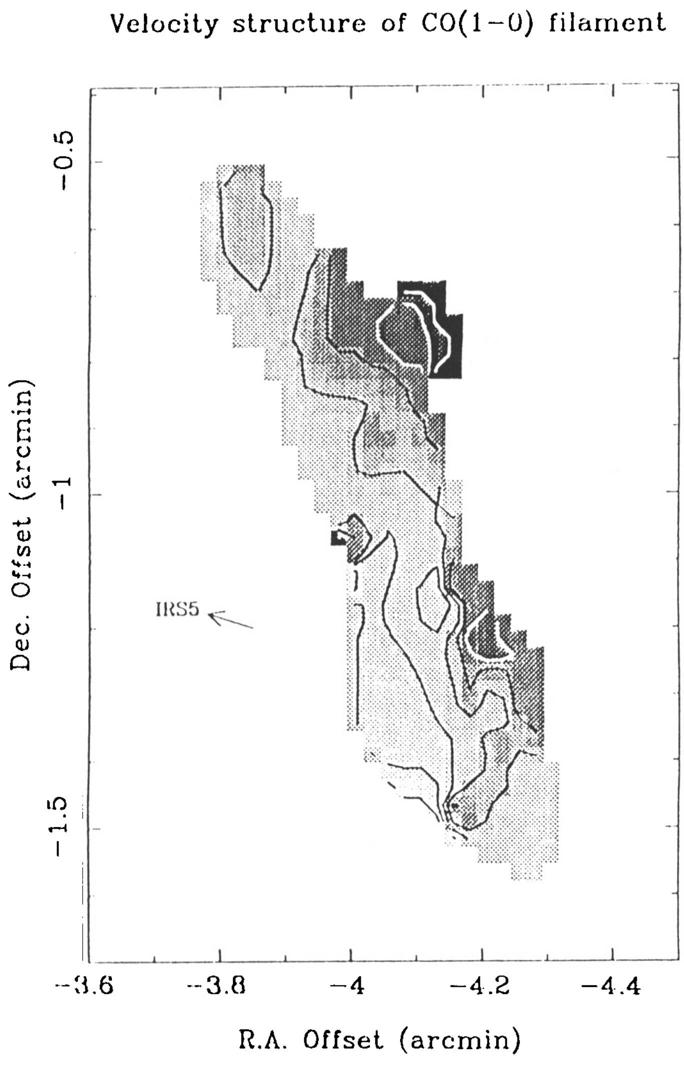

Figure 1

This is a first-moment map of the strongest CO (J=1→0) emission feature detected in the 20 interferometer fields we mapped. The greyscale and contours depict the values of the LSR velocity, with lighter grey indicating the most blue-shifted gas relative to the cloud rest velocity of V_{LSR} = 6.5 km s^{-1}, and darker grey indicating velocities progressively closer to the cloud rest velocity. The contours span the velocity interval 1 km $s^{-1} \leq V_{LSR} \leq$ 8 km s^{-1} going from southeast to northwest, spaced at 1 km s^{-1} intervals. Such a coherent, smooth velocity structure is a defining characteristic of magnetohydrodynamic shocks.