Supporting Online Material for

**A Magnetized Jet from a Massive Protostar**
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Materials and Methods

Observations and Calibration of the Data

Data of continuum emission at 6 cm were obtained using the Very Large Array (VLA) of the National Radio Astronomy Observatory (NRAO). Observations were divided into two runs during 2009 August, 12 and 22. Total on-source time was \( \sim 10 \) hours (\( \sim 5 \) hours in each run). The phase center of the observations was \( \alpha(J2000) = 18^h 19^m 12.102^s, \delta(J2000) = -20^\circ 47' 30.61'' \). We used as phase calibrators 1751\,-\,-253, in the first run, and 1924\,-\,-292, in the second run. The amplitude calibrator was 3C 286 in both runs. Data editing and calibration in amplitude, phase and polarization were carried out using the Astronomical Image Processing System (AIPS) package of NRAO, following the standard VLA procedures.

The polarization calibration was performed using the observations of the amplitude calibrator to determine the absolute polarization angle, while the observations of the phase calibrators were used to determine and correct the antenna-based leakage terms that produce instrumental polarization. The polarization of the phase calibrator will rotate in the sky with parallactic angle while the instrumental polarization will stay constant. We followed the standard VLA procedures described in chapter 4 of the AIPS cookbook.

In order to check the quality of our polarization calibration, we measured the polarization degree and polarization angle of the phase calibrators used in our calibration. We found that these parameters are consistent with those previously found by (1) and those tabulated in the VLA Polarization Database for the same calibrators.

Once calibrated, data from both runs were concatenated using the DBCON task of AIPS. Images of all of the four I, Q, U, and V Stokes parameters were made using the task IMAGR of AIPS. In order to emphasize extended emission, a tapering of 20 k\( \lambda \) was used for each image. The rms of the images was 0.013 mJy beam\(^{-1}\), and the synthesized beam was \( 13'' \times 8'' \) with a position angle of 2\(^\circ\).

We detected emission associated with the HH 80-81 jet in the images of the I, Q, and U Stokes parameters. An image of the total linear polarization emission, \( P = \sqrt{Q^2 + U^2} \), was obtained using the task COMB of AIPS. Even when the detected polarized emission is relatively weak (3 to 7 \( \sigma \)), there is an element that gives it additional credibility: the polarized emission is observed only from the non-thermal lobes of the radio jet, with spectral indices of \(-0.8\) to \(-0.4\), and not from the much brighter central source (the thermal jet) or from the nearby radio sources.
SOM Text

Other Possible Emission Mechanisms

There are two other mechanisms (besides synchrotron radiation) that could produce the linear polarization observed in the jet of HH 80-81. However, it can be shown that they are too weak to be detected since their optical depths are negligible at radio wavelengths.

A first possibility is that we are observing Thomson (i.e. electron) scattering of the radio emission from the central source. This mechanism would produce a polarization pattern similar to that observed. Assuming that part of the radio continuum emission is thermal, optically-thin free-free, and that the region is at a distance of 1.7 kpc (2) an upper limit of $n_e \leq 10^3$ cm$^{-3}$ is obtained for the electron density in the polarized lobes of the radio jet. From the observed source size of $R \sim 3 \times 10^{17}$ cm ($\sim 12''$), and since the Thomson cross section is $\sigma_T = 6.65 \times 10^{-25}$ cm$^2$, we obtain an upper limit of $\tau_T = n_e R \sigma_T \leq 2 \times 10^{-4}$, for the Thomson opacity, clearly insufficient to produce the observed polarized emission, since an opacity several orders of magnitude higher is required to produce the observed polarized intensity in the lobes of the radio jet. A rough estimate for the radiation dispersed by this process is given by the flux density of the core of the jet ($\sim 5$ mJy), multiplied by the fraction of solid angle subtended by the scattering region as seen from the core of the jet ($\Omega/4\pi \leq 0.1$) times the Thomson opacity ($2 \times 10^{-4}$). The resulting flux density ($\leq 0.1 \mu$Jy) is very small and clearly insufficient to be detectable.

A second mechanism that could produce a polarization pattern similar to that observed in the jet of HH 80-81 is dust dispersion. The region surrounding IRAS 18162–2048 has large dust extinction. The H$_2$ column density is $\sim 3 \times 10^{22}$ cm$^{-2}$ (3), that translates into an opacity at optical wavelengths of $\tau_V \simeq 30$. However, the cross section for dust scattering scales as $\lambda^{-4}$ (4) and its effect is negligible at centimeter wavelengths.
SOM Tables

**Table S1:** Flux densities and sizes of knots used to estimate the magnetic field strength and the energy.

<table>
<thead>
<tr>
<th>Knot</th>
<th>Source</th>
<th>Flux Density (mJy)</th>
<th>Size (arcseconds)</th>
<th>B (mG)</th>
<th>E (erg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>15</td>
<td>2.76 ± 0.14</td>
<td>1.62 ± 0.05</td>
<td>1.38 ± 0.21</td>
<td>12</td>
</tr>
<tr>
<td>S</td>
<td>13</td>
<td>1.43 ± 0.18</td>
<td>0.95 ± 0.07</td>
<td>...</td>
<td>12</td>
</tr>
</tbody>
</table>

**Notes.** Flux densities and source names from (5). The 6 cm flux densities are consistent with those obtained in our new observations.

REFERENCES AND NOTES


