Interaction between giant protostellar jets and the interstellar magnetic field

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Introduction

Interstellar turbulence and magnetic fields are important mediators of the process of stellar formation. However, in many aspects these components of the interstellar medium are not well understood. In particular, the origin of the turbulence is still debated. A possible explanation is related to the injection of energy by jets and outflows existing in the evolutionary stages of young stellar objects. In this poster, we present an on going work, which is being carried out as a master project. The objective is to determine the direction and dispersion of the interstellar magnetic field around giant protostellar jets close to giant protostellar jets using optical polarimetry techniques. Since the dispersion of the magnetic field is related to the turbulence, we intend to investigate if the properties of the turbulence in the interstellar medium are changed in the presence of the ejection of jets from protostars.

Background

- **Alignment of the polarization vector and the interestellar magnetic field**

  In optical bands, radiation from background stars passing through a medium of aligned grains become polarized due to dichroic absorption. This polarization is parallel to the magnetic field vector, as shown in the figure below.

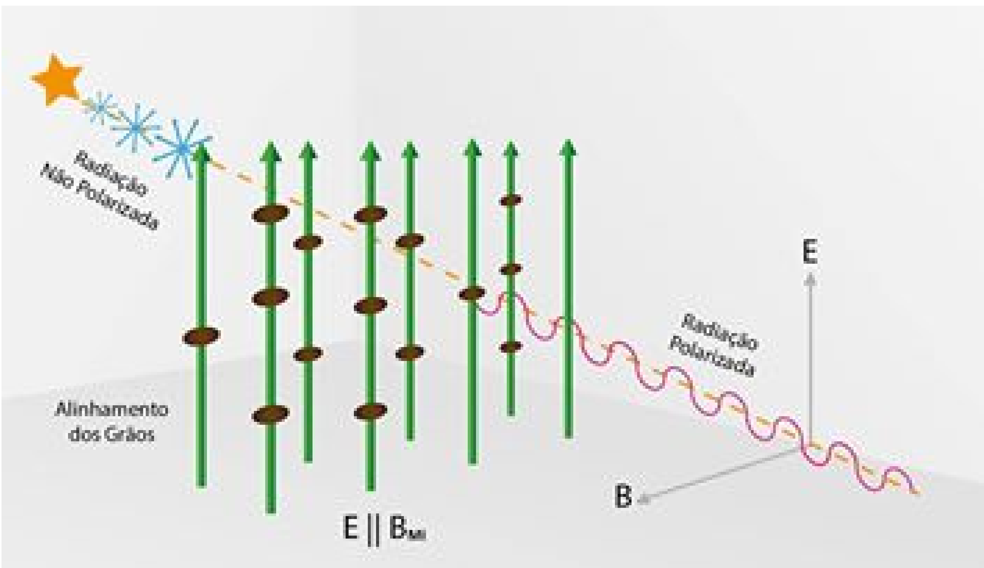

Figure 1: Representation of the polarizing mechanism of the radiation from background stars due to the presence of interstellar grains that align the magnetic field parallel to polariation vector.

- **The relationship between magnetic field dispersion and turbulence**

  The method estimated by Chandrasekhar-Fermi (CF) is based on the fact that turbulent motions will lead to irregular magnetic fields and the mean magnetic field is expressed by:

$$B = \left(\frac{4\pi\rho}{3}\right)^{\frac{1}{2}} \frac{\sigma_v}{\sigma_b}, \qquad (1)$$

  where B is the strength of the magnetic field perpendicular to the line of sight (in Gauss), ρ is the mass density of the gas ($g\ cm^{-3}$), σ_v is the dispersion of gas velocities (in $cm\ s^{-1}$) and σ_b is the dispersion of the polarization angles (in radians). This method shows that there is a clear relationship between magnetic field dispersion and turbulence.

Goals

From a polarimetric sample around Herbig-Haro (HH) objects (Targon et al., 2011), we noticed a clear change in the direction of polarization along the protostellar giant jet associated with the HH90 object (Figure 2). We intend to investigate if: (1) the change of direction also happens in other protostellar giant jets; (2) the dispersion of the magnetic field (and thereby turbulence) varies spatially around giant jets.

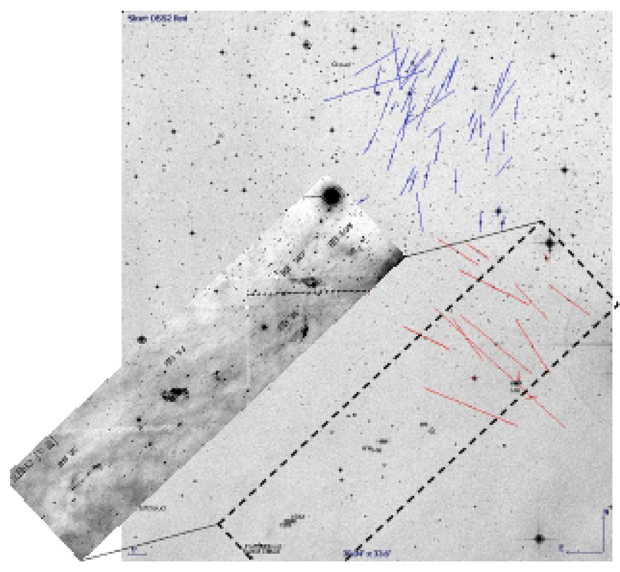

Figure 2: Example of variation of magnetic field morphology around the giant protostellar jet associated with HH90.

Methodology

- **Instrumental configuration**: The observations were obtained using the Boller & Chivens 0.6-m telescope located in the Pico dos Dias Observatory using the IAGPOL polarimeter(Magalhaes *et* al.,1996) with the CCD camera IKON 10127.
- **Polarimetric data**: We observed 67 fields of 11×11 square arcmin each, which compose mosaics for each region. The reduction were performed using the IRAF external package PCCDPACK (Pereyra, 2000), with adaptations made by the polarimetry group at INPE.

Preliminary Results and Discussions

We present a preliminar result for the giant protostellar jet containing HH46/47. Figure 3 shows the polarization map from starlight background radiation. Figure 4 and Figure 5 present histograms of one field near the jet and in the most remote regions. In this region, the polarization map and histograms indicate the existence of a preferred alignment of polarization vectors around the giant protostellar jet and there is no clear change in the direction of polarization along the protostellar giant jet associated with the HH90 object. Table 1 presents the values of the mean polarization angle and mfull width at half maximum. The full width at half maximum angle was corrected following the method used by (Magalhaes *et* al.,2006).

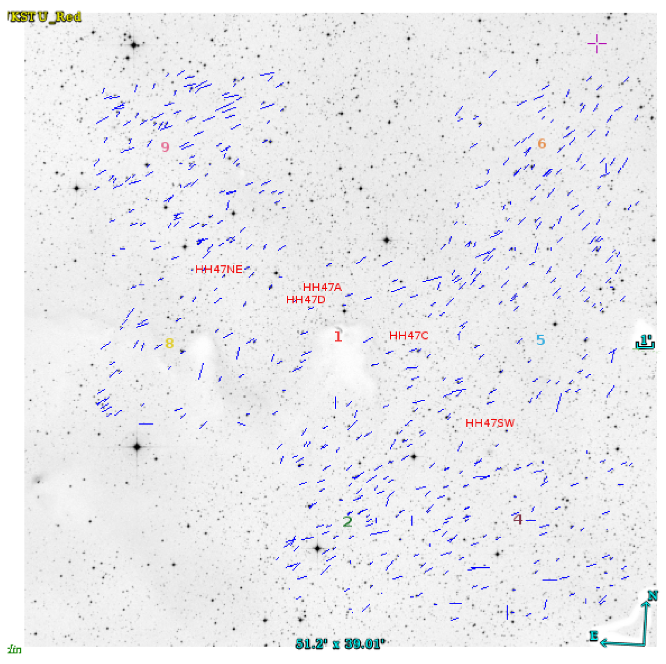

Figure 3: Polarization map in the I_C band showing a preliminary results for one field around the giant protostellar jet associated with HH46/47

Fields	$<\theta>$ (deg)	$FWHM_{corrected}$ (deg)
Field 1	118	18.5
Field 2	123.6	30.8
Field 4	114.1	22.7
Field 5	135.38	26.5
Field 6	132.0	23.7
Field 8	128.9	27.9
Field 9	122	32.9

Values of mean polarization angle and full width at half maximum corrected for differents fields of HH46/47 jet.

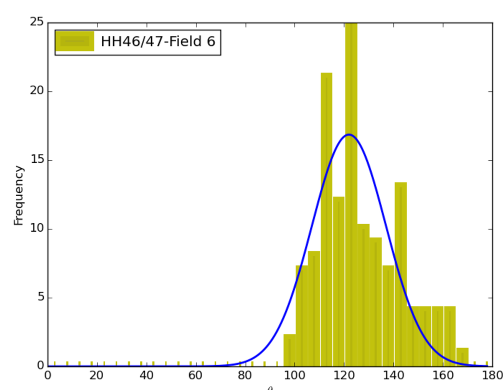

Figure 4: Histogram of polarization for region that has the highest mean dispersion value for the region of the HH 46/47.

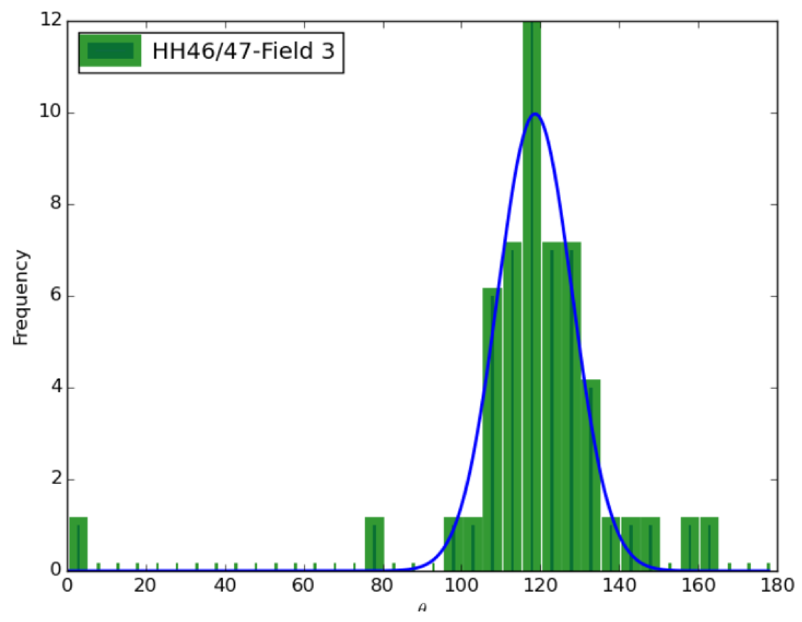

Figure 5: Histogram of the polarization degree for one field of the HH 46/47 region.

References

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Acknowledgements

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