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Methanol masers and magnetic field in IRAS18089-1732

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Abstract. Theoretical simulations have shown that magnetic fields play an important role in massive star formation: they can suppress fragmentation in the star forming cloud, enhance accretion via disc and regulate outflows and jets. However, models require specific magnetic configurations and need more observational constraints to properly test the impact of magnetic fields. We investigate the magnetic field structure of the massive protostar IRAS18089-1732, analysing 6.7 GHz CH_3OH maser MERLIN observations. IRAS18089-1732 is a well studied high mass protostar, showing a hot core chemistry, an accretion disc and a bipolar outflow. An ordered magnetic field oriented around its disc has been detected from previous observations of polarised dust. This gives us the chance to investigate how the magnetic field at the small scale probed by masers relates to the large scale field probed by the dust.

Keywords. stars: formation, magnetic field, masers, polarization

1. Introduction

The importance of the magnetic field in high mass star formation (HMSF) is not yet fully clear and there are still many open questions concerning its role in the accretion processes and generation of jets and outflows. In the past few years, masers have been successfully used to study the magnetic field at few AU scales around massive protostars. Thanks to their narrow and strong spectral lines and through their polarized emissions, it is possible to reconstruct the morphology and the strength along the line of sight of the magnetic field, by measuring linear polarization angles and Zeeman splitting (Vlemmings *et al.* 2010; Surcis *et al.* 2015). This can be done on scale comparable to circumstellar discs ($\sim$ 100 au). In order to improve our models and to build a complete picture of the magnetic field evolution, we need more observational constraints; in particular we need to verify that the magnetic field at small scales probed by masers traces the field at larger scales, probed, for example, by the dust, and not small-scale fluctuations. Currently, few observations of both masers and dust polarisation exist towards the same regions (e.g. Surcis *et al.* 2014). IRAS18089-1732 is a well studied high mass star forming region, showing a hot core chemistry and a disk-outflow system. Previous observations of polarized dust made with SMA revealed an ordered magnetic field oriented around the disk at large scales ($\sim$ 5000 au, Beuther *et al.* 2010).

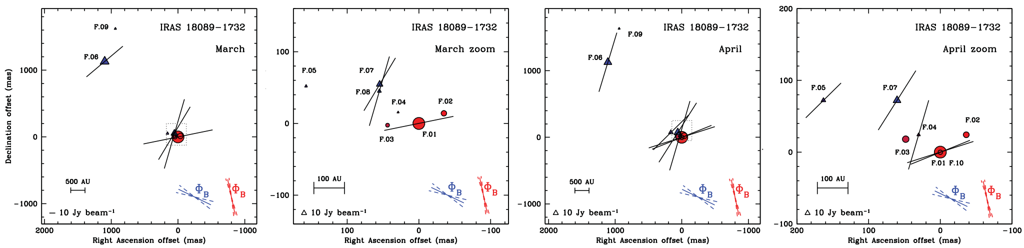

Figure 1. Masers identified in March (left) and April (right). The zoom is made on the region marked by the dashed grey boxes. Triangles and circles represent masers of the blue and of red group respectively. The different sizes of the triangles and the circles represent the intensity. Line segments mark the direction of the polarisation angle for the maser features that show linear polarisation. The average direction of the resulting magnetic field Φ_B obtained for two groups of masers is indicated in the bottom right corners of each panel.

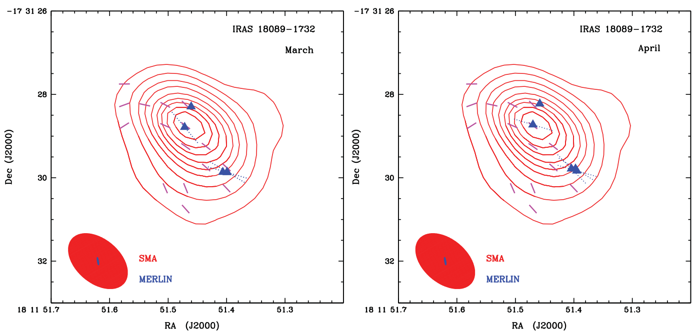

Figure 2. The figure shows that the magnetic field in the maser regions (triangles and long dashed segments) presents the same orientation as observed from the dust tracing the disc (contours and isolated short segments). The orientation is preserved in the two epochs March (left panel) and April (right panel).

2. Masers and dust probe the same large-scale magnetic field

From the analysis of a three-epoch MERLIN observations of the 6.7 GHz CH_3OH masers, Dall'Olio *et al.* 2017 identified two groups separated in velocity and polarisation angles as showed in Fig. 1. The blue group tracing the disc (triangles) show a velocity range between 30.0–36.4 km s^{-1}, and an orientation of the magnetic field $62° \pm 3°$. The red group that is tracing a cloud of gas close to the outflow (circles) shows a velocity range between 37.7–39.2 km s^{-1}, and an orientation of the magnetic field $14° \pm 4°$. From the analysis of the group of masers generated in the same region of the disc, Dall'Olio *et al.* 2017 obtained the first polarised map of the masers for IRAS 18089-1732 and showed that the small-scale magnetic field probed by the masers is consistent with the large-scale magnetic field traced by the dust. This confirms that methanol masers trace the large scale field, and that the large scale field component, even at the AU scale of the masers, dominates over any small scale field fluctuations Fig. 2.

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