ALMA and SMA observations of the magnetic fields in the youngest solar-type protostars

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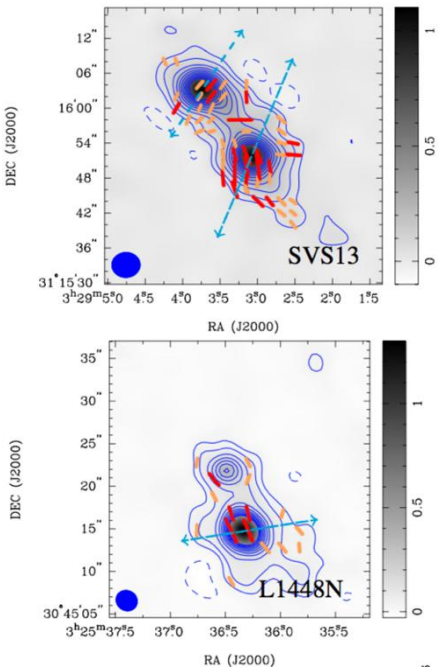
Magnetic fields are believed to redistribute angular momentum efficiently during the collapse and could explain the order-of-magnitude difference observed between the large angular momentum of the protostellar envelope and that of a zero-age main sequence star. The Class 0 phase is the main accretion phase during which most of the final stellar material is being collected into the protostellar embryo: the role of the magnetic fields during that key stage is still unclear but might very well have a key impact on the later evolution of the young star and its surrounding protoplanetary disk before it reaches the main sequence. The position angle of linearly polarized submm dust emission is often used to probe the magnetic field. In order to study the structure of B from 50 to 2000 AU scales, we have acquired polarization observations of 9 low-mass protostellar cores with the SMA and for one of the objects, B335, with ALMA. Our sample contains 9 Class 0 protostars and includes single objects as well as close and wide multiples. Polarization is detected in all objects, with polarization degrees ranging from 1-10%. I will discuss how the polarization fraction varies with the source intensity. I will also analyze how the magnetic field lines align or not with the object outflow and show that a relation might exist between the orientation of the magnetic field and the rotational energy at the envelope scale. I will finally show how the magnetic field orientation varies with wavelength. On the small scales traced with ALMA in B335, we detect a large-scale poloidal magnetic field in the outflow direction and a strongly pinched B in the equatorial direction. Our results suggest that the magnetized collapse has a high level of organization from the 2000 AU down to 50 AU scales. Our approach, confronting the most state-of-the-art observations of B at various resolutions allows us to directly address the phenomenon of magnetic braking during protostar formation and give key clues on the pristine properties of B fields in star-forming material.



SMA 850um continuum maps of two Class 0 protostars. The blue arrows indicate the outflow orientations. B-field vectors are overlaid with red (3-σ detections) and orange (2-σ) vectors.