Discovery of the Zeeman Effect in the 36 and 44 GHz Class I Methanol Maser Lines with the EVLA

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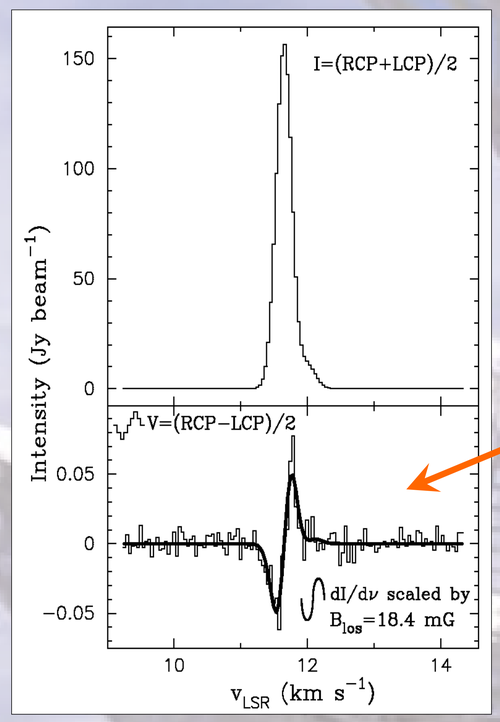
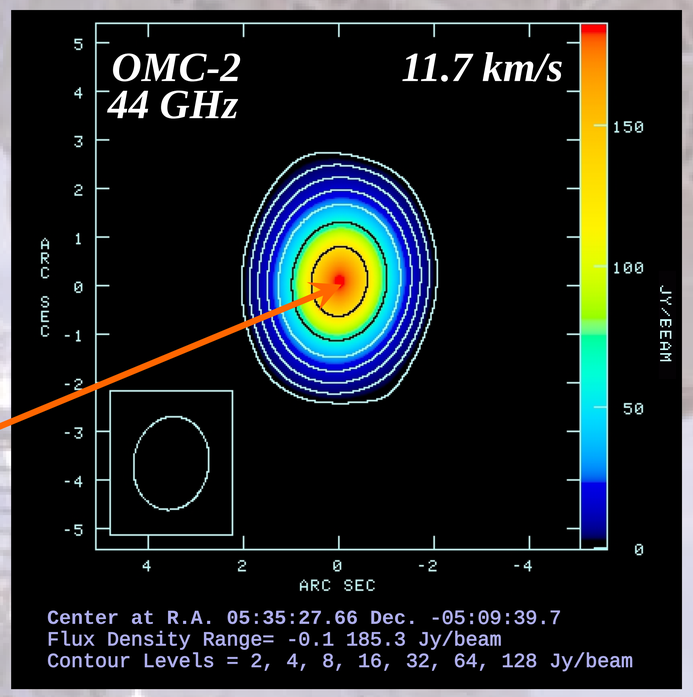
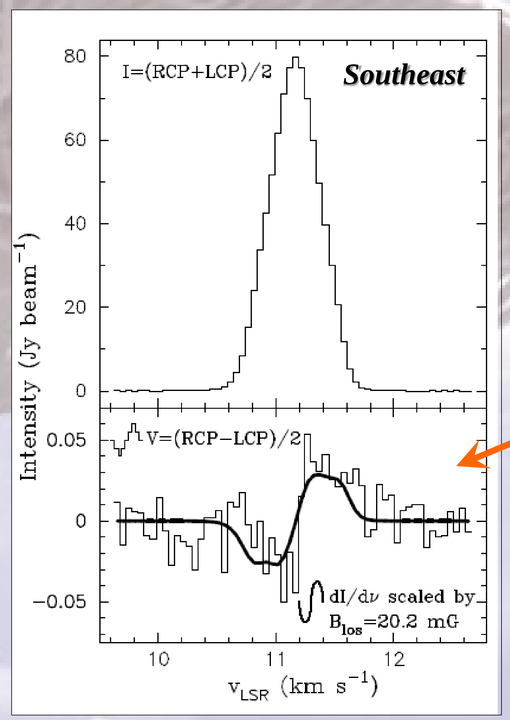
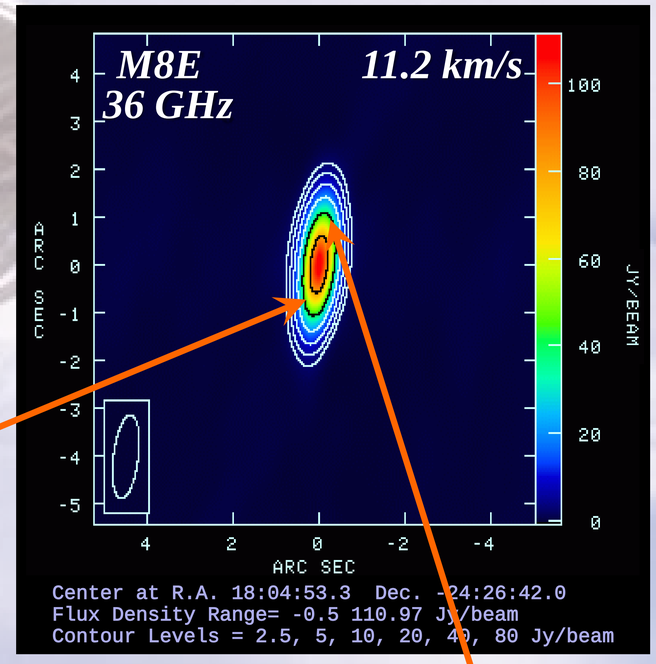
Abstract

We report the first detections of the Zeeman effect in the 36 GHz and the 44 GHz Class I methanol maser lines. The observations were carried out with the Expanded Very Large Array (EVLA) toward the star-forming regions M8E (at 36 GHz) and OMC-2 (at 44 GHz). The detected line of sight magnetic field values are -31.3 ± 3.5 mG and 20.2 ± 3.5 mG to the northwest and southeast of the maser line peak in M8E, respectively, and 18.4 ±1.1 mG toward the peak of the maser line in OMC-2. The detected fields are comparable and are not significantly different from those measured in the 6.7 GHz Class II methanol maser line (Vlemmings 2008). This indicates that these masers may trace the large scale magnetic field, or that the magnetic field remains unchanged during the early evolution of star forming regions.









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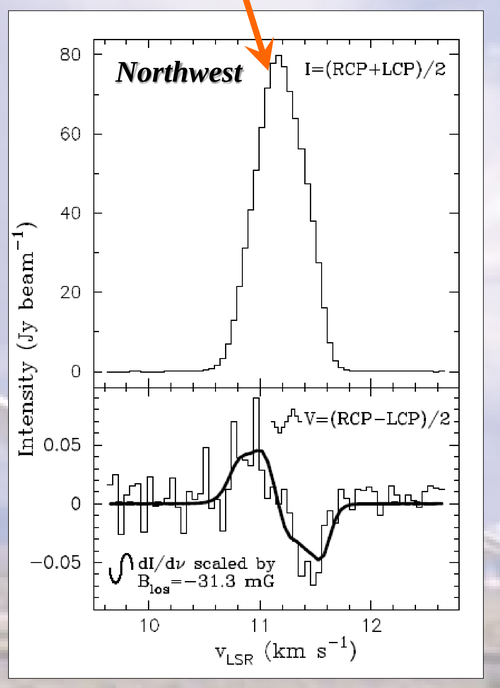

General Notes

- The Zeeman effect is the most direct method for measuring magnetic field strengths.
- Magnetic fields likely play an important role in the star formation process, but the exact nature of their role is still not understood; this is primarily due to the scarcity of observational data.
- The Zeeman effect is usually measured by fitting the Stokes V (the difference of the right and left circular polarizations) profile to the derivative of the Stokes I (total intensity) profile.
- Both Class I and Class II methanol masers trace an early stage of star formation. Class I masers in star forming regions are believed to be associated with regions shocked by outflows from the protostar.
- The measured magnetic field values in the 36 GHz methanol maser line in M8E and the 44 GHz methanol maser line in OMC-2 are comparable to those detected in the 6.7 GHz Class II methanol masers in other star forming regions (Vlemmings 2008).
- The above indicates that both classes of methanol masers may be tracing the large scale magnetic field, or that the magnetic field remains unchanged during the early evolution of star forming regions.
- With these discoveries, and to better understand magnetic fields in star forming regions, various projects are already being carried out with the EVLA to detect the Zeeman effect in a sample of Class I methanol masers at 25, 36, and 44 GHz.