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Magnetic fields in prestellar cores: a new perspective from meter-wavelength radio data

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Magnetic fields in starless, prestellar cores are crucial for understanding the formation of stars, as these cores mark the initial gravitationally bound stage in the star-formation process. Typically, these cores accumulate gas from their molecular cloud environments until they overcome magneto-turbulent support and collapse into protostellar objects. Traditional studies of magnetic fields in these cores have primarily used indirect methods, such as infrared dust polarization and molecular-line Zeeman splitting. However, these methods have significant limitations, including large uncertainties and issues like magnetic-field dilution due to beam averaging.

In this talk, I propose a novel technique complementary to the infrared band, utilizing non-thermal synchrotron emission detectable in the radio spectrum to trace magnetic fields in prestellar cores. This approach builds on theoretical studies suggesting that cosmic-ray electrons interacting with magnetic fields can produce detectable synchrotron radiation at low radio frequencies (Padovani+2018). I will present an extensive statistical analysis using the LOFAR telescope at 144 MHz, focusing on the median stacking of a large sample of more than 300 prestellar cores in the Perseus molecular cloud (Bracco+2025). While we only achieved upper limits on magnetic field strengths on the order of 100 uG—due to current telescope sensitivity—this method promises a new avenue for studying magnetic fields in molecular clouds with upcoming advanced radio telescopes like the Square Kilometer Array, which could detect such emissions within a few hours of observation.

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