Master's thesis project in Space, earth and environment

3D modeling of proto-stellar magnetic fields

Background

Magnetic fields play an important role during the formation of stars and planets. They are for example involved in outflow launching and could be responsible for the stability of the accretion disk. Polarization observations are the main tools for measuring magnetic field strengths and morphologies. Unfortunately, polarization observations around proto-stars are hard to interpret. Polarization of dust grain has been the main source of magnetic field information, but recent advances with the ALMA telescopes have shown that other mechanisms (such as scattering of radiation) can also produce polarization, making the polarization interpretation uncertain.

Potentially a better probe of magnetic fields is the polarization of molecular lines through the so-called Goldreich-Kylafis effect. Still, to properly interpret molecular line observations, which will soon be available from ALMA, detailed modeling of this effect is required.

We have recently developed the 3D polarization radiative transfer code PORTAL (Lankhaar et al., in prep.). This MSc thesis project focuses on investigating a variety of proto-stellar disk and outflow models, with different molecular line tracers, in order to derive the polarization characteristics.

Task description

The student will construct parameterized models of proto-planetary disks and outflows. Radiative transfer of typical molecular lines will be produced and their polarization characteristics will be analyzed. Observations of these models as would be made with ALMA will then be simulated. Results will be used to optimize planned ALMA observational projects. A comparison will also be made with the recently published SiO polarization in the outflow of a young star (Lee et al., Nature Communications 9, 2018). In the case of interest from multiple students, it will be possible to apply the modeling to a variety of different astrophysical environments, such as stellar envelopes, molecular clouds or even whole galaxies.

Required education and potential course requirements

The courses "Interstellar medium and Star Formation" (RRY041) and "Radio Astronomical techniques and interferometry" (RRY131) are highly recommended for this Master's research project. Programing skills, are helpful, but may also be developed as part of this thesis.

Credits

30 or 60 credits

Contact information to supervisor

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