1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

Project title: Linking outflow characteristics with protostellar evolution

1.1. Project goals

- To determine how outflow morphology changes between clustered and isolated star formation environments.
- To determine how does the difference in morphology of an outflow between the two lobes depend on the interaction with the surrounding medium.
- To determine if the asymmetries observed in outflow morphologies persists down to very small scales.
- To determine if the morphology of Class I protostars shows variability linked to evolution.
- To link the fundamental properties of outflows to the Class system of low-mass protostars.

1.2. Outline

Outflows are a fundamental structure essential to the formation of stars (Plunkett et al. 2018). Their morphology and characteristics are linked to the evolutionary stage of the protostar (Calcutt et al. 2018a, 2018b). The aim of this project is to explore the properties of outflows in a statistically significant way, linking the changes in outflows with other evolutionary characteristics such as the chemistry of the inner cores of the protostar. This will involve single-dish and interferometric observations of star-forming regions and analysis of continuum and spectral data.

1.3. Work plan

1. Mastering single-dish and interferometric data reduction
2. Using fits cubes to create spatial emission maps, velocity maps.
3. Measuring morphology indicators and computing the fundamental properties of outflows, such as opening angle, outflow mass loss rate, force, and luminosity.
4. Comparing the results from the observational analysis to other observational indicators of protostellar evolution.

1.4. Literature

Calcutt et al. 2018, A&A, 617, A95;
Calcutt et al. 2018, A&A 616, A90;
Plunkett et al. 2018 A&A, 615, A9;

1.5. Required initial knowledge and skills of the PhD candidate

- Analytical thinking
- Eager to learn new skills
- Basic knowledge of astronomy and star formaton
- Some experience in coding
- Programming skills

1.6. Expected development of the PhD candidate's knowledge and skills

The candidate will develop skills in submm data analysis, observatonal and theoretcal astrochemistry and an understanding of the fronter of star formaton research. The candidate will also develop skills in communicaton and disseminaton of research to diferent audiences and through diferent formats (e.g. publicatons, talks, outreach). Programming and coding skills as well as coding design and management will also be developed. The project involves collaboraton with scientsts in Sweden, Copenhagen and the USA, ofering possibilites to develop skills in teamwork, internatonal collaboraton and provide a platorm of visibility in the wider research feld.