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

Project title:
The origins of chemical variability in the protostellar environment

1.1 Project goals

1. To determine how the physical properties of star forming regions affect the chemical variability observed in these regions.
2. To reduce and analyse observational data of molecular emission.
3. To construct spectral and chemical models of star-forming regions.
4. To map the physical extent and velocity structure of the molecular emission in protostellar environments.
5. To develop skills in communication, coding, observational astronomy, scientific analysis and research dissemination.

1.2 Outline

The environments in which stars form are known to contain a rich chemistry. The development and complexity of this chemistry is tied to the physical properties of theh star-forming region, especially its evolutionary stage (Calcutt et al. 2020, 2014, Jørgensen et al. 2020).
The aim of this project is to significantly expand our understanding of chemical variability in galactic star-forming regions. The main part of the research will be identifying molecules in star-forming regions that have not previously been identified (Calcutt et al. 2018a, 2018b. The molecular abundances and excitation temperatures will be computed and compared in different objects and star-forming regions, to build a picture of chemical variation within different families of molecules and in different physical conditions. This will involve single-dish and interferometric observational data reduction and analysis using spectral and chemical modelling methods.

1.3 Work plan

1. Mastering single-dish and interferometric data reduction

2. Mastering line identification and spectral modelling analysis to determine molecular abundances and excitation temperatures

3. Generating spatial emission maps and maps of velocity structure

4. Implementing chemical modelling of protostellar systems and expanding the chemical network for newly identified molecules, including adding formation and destruction pathways.

5. Comparing the results from the observational data and chemical modelling to build a picture of chemical evolution across the Galaxy.

1.4 Literature

Calcutt et al. 2020, A&A;
Calcutt et al. 2018, A&A, 617, A95;
Calcutt et al. 2018, A&A 616, A90;
Calcutt et al. 2014, MNRAS, 443, 3157;
Jørgensen, J. K., et al. 2020, ARAA, 58, 727-778;

1.5 Required initial knowledge and skills of the PhD candidate

- Analytical thinking
- Eager to learn new skills
- Basic knowledge of astronomy and star formation
- 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, observational and theoretical astrochemistry and an understanding of the frontier of star formation research. The candidate will also develop skills in communication and dissemination of research to different audiences and through different formats (e.g. publications, talks, outreach). Programming and coding skills as well as coding design and management will also be developed. The project involves collaboration with scientists in Sweden, Copenhagen and the USA, offering possibilities to develop skills in teamwork, international collaboration and provide a platform of visibility in the wider research field.