Chalmers ISM, Star and Planet Formation Day
Friday 12th January 2018 --- Onsala --- OSO Seminarierum

10.00am Welcome and introductions

10.05am Jouni Kainulainen - The PROMISE survey: arcsecond-resolution column density mapping of the Galactic plane

10.30am Juan Farias - Star Cluster dynamics during formation - An alternative approach

11.00am Rene Liseau - High-n recombination lines - prospects for observation with ALMA?

11.30am Daria Dall'Olio - Magnetic fields in the massive star forming region G9.62+0.20

12pm Lunch

1pm Hannah Calcutt (NBI, Copenhagen Univ.) - The Protostellar Interferometric Line Survey: Probing star formation with complex organic molecules

1.40pm Magnus Persson - On the evolution of water in protostellar evolution

2.10pm Per Bjerkeli - Resolving star formation with ALMA

2.40pm - Coffee Break

3pm - Boy Lankhaar - Methanol maser excitation on the hyperfine level

3.30pm - Jonathan Tan - New Views of Massive Star Formation

4pm - Discussion, including overview of Chalmers-Virginia Initiative of Cosmic Origins partnership

7pm - Dinner (location TBD)

Per Bjerkeli

Resolving star formation with ALMA

In the “Resolving star formation with ALMA” program we use ALMA to observe the wind launching region and the inner disk regions towards a sample of protostars. The central questions to answer, are how winds are launched and how the final accretion takes place. This is of importance in understanding both star formation and the initial conditions for planet formation.

Hannah Calcutt

The Protostellar Interferometric Line Survey: Probing star formation with complex organic molecules

The detection of complex organic molecules (COMs) is critical to understanding the chemical development of star-forming regions and exploring the link between the early stages of star formation and the formation of Solar System bodies. In recent years, it has become easier to systematically survey star-forming regions and take an unbiased inventory of the COM content at high-resolution, exploring the chemical evolution on solar system scales. This talk presents recent results of such a survey, the Protostellar Interferometric Line Survey (PILS). PILS uses ALMA data in Band 7 to survey the molecular content of the solar-type protostellar binary IRAS 16293-2422, at an unprecedented spectral and spatial resolution. The data have enabled a survey of oxygen, nitrogen, and sulphur bearing species and their isotopologues in both sources, allowing detailed comparisons to other objects and comets. It has also facilitated detections of a number of molecules for the first time in the ISM, including the biologically significant molecules methyl isocyanate (CH3NCO) and methyl chloride (CH3Cl). I will present the key constraints this survey has placed on the formation routes for a number of molecules in this source, as well as constraints on luminosity, physical structure, and evolution.

Daria Dall'Olio

Magnetic fields in the massive star forming region G9.62+0.20

The role played by magnetic field during the formation of high-mass stars is not yet completely understood. Models show that magnetic fields have significant effects in preventing fragmentation, slowing cloud collapse, influencing accretion disk, and feedback phenomena. However the magnetic field parameters are still poorly constrained in the initial steps of the massive star formation. The magnetic field morphology around massive protostars can be probed at different scales by observing dust polarized emission. I will present some results of our ALMA polarization observations of G9.62+0.20, which is a massive star forming region presenting several cores at different evolutionary stages. I will show the magnetic field morphology in different cores and how it can be interpreted within an evolutionary sequence.

Juan Farias

Star Cluster dynamics during formation - An alternative approach.

Most of stars tend to form in clustered environment inside molecular clouds. However, the transition from dense star-forming clump to a naked star cluster is not yet well understood. This process is quite complex and involves several physical processes that are not possible to model all at once. Most of numerical studies on star cluster formation have focused on the complex dynamics of the as with great advances on the inclusion of stellar feedback, turbulence, radiative feedback, magneto-hydrodynamics among others. However, most of these studies are quite expensive numerically and make assumptions for the dynamics of the stars, e.g. can not follow binary stars accurately (or at all), and even if they could they can only have a very small sample of cases. We have proposed an alternative approach, on which we focus on the

stellar dynamics and statistics. We made assumptions for the behavior of the gas based on observations and theoretical models and accurately follow the stellar dynamics including high binary populations during star cluster formation. We look for dynamical signatures that can constrain the star cluster formation properties like it timescale, star formation rate or primordial binary populations, with enough simulations to obtain statistically significant results. I will present the first results of such approach on which stars are introduced gradually on the simulations, in contrast to the standard approach of assuming instantaneous star cluster formation.

Jouni Kainulainen

The PROMISE survey: arcsecond-resolution column density mapping of the Galactic plane

PROMISE is an ERC-funded project, shared between Chalmers and MPIA Heidelberg. One cornerstone of the project is a systematic study of the physical processes that shape molecular clouds in the Milky Way. To facilitate such a study, we have developed a new, dust extinction based column density mapping technique that delivers an arcsecond-resolution view towards thousands of molecular clouds in the Galaxy. Here, I introduce the PROMISE Galactic plane survey that exploits the new technique. The survey combines near-infrared photometric data from the VISTA Variables in the Via Lactea survey with Spitzer mid-infrared imaging data. I discuss the scientific drivers of the project and its main technical challenges. I demonstrate the scientific potential of the data using test fields and our earlier proof-of-concept works.

Boy Lankhaar

Methanol maser excitation on the hyperfine level

Maser observations of both linear and circular emission have provided unique information on the magnetic field in the densest regions of star forming regions. While linear polarization observations provide morphological constraints, the magnetic field strength determination is done by comparing the Zeeman-induced velocity shifts between left- and right-circularly polarized emission of molecular maser species. In particular, methanol is of special interest as it is the most abundant maser species and its different transitions probe unique areas of high-mass proto-stellar disks and outflows. Methanols Zeeman-parameters vary strongly for the different hyperfine components of a maser-line[1]. Moreover, the individual hyperfine-transitions cannot be individually resolved. It is therefore important to know the populations of the individual hyperfine levels of the torsion-rotation states involved in the methanol maser action[2]. This maser action is preceded by collisional and radiative de-excitation of higher torsion-rotation levels. We present the method to estimate relative hyperfine-state-specific collisional and radiational de-excitation rate coefficients. We give an outlook to a collaboratorive effort to compute the class I methanol maser-excitation at the hyperfine-level. [1] Lankhaar et al. 2016 JCP, 24, 145; [2] Lankhaar et al. 2018 Nature Astr., accepted

Rene Liseau

High-n recombination lines - prospects for observation with ALMA?

The feasibility of observing high-n recombination lines with ALMA of a nearby PDR (rho Oph) and of a nearby star (alpha Cen) is investigated. The physical conditions of the ISM and the stellar chromosphere/ corona are very different. However, model calculations are in non-LTE in both cases and pressure broadening is accounted for in the latter.

Magnus Persson

On the evolution of water in protostellar evolution

Water snowlines are important for providing sites for planetesimal formation. While water snowlines are near the central star around evolved disks, its location should be further out in their younger counterparts due to the higher luminosity. Water emission has been detected around Class 0 protostellar objects while it is highly depleted around Class II disks. The large Class I Keplerian disks provide the necessary region to trace the water evolution. I will present a search for warm water toward four Class I sources in Taurus and Ophiuchus using both the NOEMA and ALMA telescopes. The results point toward water depleted disk surface layers through grain growth (and settling). Furthermore the results provide an uninterrupted view of the evolution of water during the early protostellar stages.

Jonathan Tan

New Views of Massive Star Formation

I give a brief overview of two new projects that study the formation of massive stars. First, on the theoretical side, new astrochemical models are being calculated for the infall envelopes of massive protostars. These models will couple to a grid of physical radiative transfer models, recently released to the community (Zhang & Tan 2018). Second, I discuss ALMA follow-up observations of massive protostars of the SOFIA Massive (SOMA) Star Formation Survey.