SFB 1601 Student Seminars – Winter 2026

Date & Time: *9th November, 2026 (Monday), 14:30 - 17:00+*
Venue: Kosma room, Main Physics building, University of Cologne [map]
Social event: *from 17:00*

14:30 - 14:35	Welcome + Introduction	
14:35 - 14:55	A modelling perspective on observations of Faraday rotation	Leonard Kaiser (PH1)
14:55 - 15:05	Questions	
15:05 - 15:25	Developments for MHD simulations of the Galactic ISM on GPU-accelerated platforms	Mervin Yap (PH1)
15:25 - 15:35	Questions	
15:35 – 15:55	MMGPS-OH survey towards galactic high-mass star-forming regions	Ying-Chi Hu (PH1)
15:55 – 16:05	Questions	
16:05 - 16:25	**Coffee break**	
16:25 - 16:45	Investigating chemical diversity in protostars with deuterium fractionation	Morgan Owen (PH1)
16:45 - 16:55	Questions	
16:55 - 17:15	Hot core chemistry in the Outer Galaxy: impact of metallicity on the formation of COMs	Youxin Wang (MPIfR)
17:15 - 17:25	Questions	
17:25 - 17:45	Open discussion about the Student Council & its activities + Feedback	
17:45 -	Snacks and Social Event	

Coffee and drinks will be provided during the seminar. You can bring your own cup of coffee.

Abstracts on the next pages.

List of Abstracts

1. A modelling perspective on observations of Faraday rotation

Speaker: Leonard Kaiser (PH1)

Abstract: Faraday rotation of polarised emission is a powerful tracer of the galactic magnetic field. How can simulations of the ISM improve our observations of this important phenomenon? In this talk, we will approach this question using the SILCC IX simulations. These simulations capture the ISM physics in environments ranging from our quiescent Milky Way neighbourhood to violent starburst galaxies. We demonstrate how environmental properties and star formation influence the structure of the magnetic field and discuss how these effects impact the reconstruction of the magnetic field from Faraday rotation.

We find that the correlation length of the magnetic field is on the order of several tens of parsecs, independent of the larger-scale environment. This coincides with the typical length between sign reversals of the parallel magnetic field component, which causes Faraday rotation. Hence, Faraday tomography requires a line-of-sight resolution $\sim$ 10 pc to accurately resolve the galactic magnetic field structure. Further, we show that the correlation length decreases with increasing star formation rate and associated turbulence, but grows with the local magnetic field strength.

We find that the magnetic field strength reconstructed from observations of Faraday rotation can be off by a factor of ten, even under ideal conditions where the electron column density is known. However, the reconstruction is not strongly affected by the slight correlation between electron density and magnetic field strength found in our simulation data.

2. Developments for MHD simulations of the Galactic ISM on GPU-accelerated platforms

Speaker: Mervin Yap (PH1)

Abstract: Astrophysical simulations of the interstellar medium (ISM) require the accurate modelling of complex magnetohydrodynamic (MHD) processes across a wide range of spatial and temporal scales. As simulations grow in scale and complexity, computational performance and scalability increasingly limit the scope of astrophysical problems that can be investigated. Although advances in numerical methods and high-performance computing offer opportunities to overcome these limitations, efficiently exploiting modern GPU architectures requires careful consideration of both the underlying numerical algorithms and structure of existing codes.

In my talk, I will give a brief introduction of the numerical algorithms implemented in the astrea code for multi-dimensional MHD simulations, before moving on to talk about how my PhD project aims to enable large-scale MHD simulations of the Galactic ISM through GPU acceleration and improved scalability of the DISPATCH code.

3. MMGPS-OH survey towards galactic high-mass star-forming regions

Speaker: Ying-Chi Hu (PH1)

Abstract: As a powerful diagnostic tracer of molecular hydrogen, the hydroxyl radical (OH) has been detected in a wide variety of star-forming environments, including diffuse and translucent clouds, as well as molecular envelopes surrounding (ultra-)compact H II regions. We present 18 cm OH ground-state observations toward 13 Galactic high-mass star-forming regions (HMSFRs) obtained with the MeerKAT L-band receiver in the spectral-line survey of the MPIfR-MeerKAT Galactic Plane Survey (MMGPS). By combining these observations with 2.5 THz OH observations from the SOFIA Legacy Program HyGAL, we constrain the physical properties of the OH-bearing gas using the non-LTE radiative transfer code pythonradex. Leveraging the full-Stokes capability of MeerKAT, we also present Stokes V spectra and identify signatures of OH Zeeman splitting toward these regions.

4. Investigating chemical diversity in protostars with deuterium fractionation

Speaker: Morgan Owen (PH1)

Abstract: Protostellar environments have previously been distinctly classified as either warm carbon-chain chemistry (WCCC) sources, exhibiting spectra dominated by unsaturated carbon chains, or hot corinos (HCs) rich in complex organic molecules (COMs). However, recent high-resolution observations increasingly reveal hybrid systems where both chemistries can co-exist, albeit on different spatial scales. The physical and chemical drivers behind this diversity - and whether they are determined by initial conditions, evolutionary stage, or local environment - remain unresolved. Factors such as temperature, UV radiation fields, and cosmic ray fluxes are likely key drivers of chemical differentiation, but their relative roles are unclear. Deuterium fractionation, a highly temperature-sensitive process, can serve as a powerful diagnostic of the underlying physical conditions and chemical processes. We have therefore explored the large-scale hybrid chemical environment of IRAS 18148-0440, a Class 0/I transitioning low-mass protostar, with APEX and IRAM 30m observations. IRAM 30m on-the-fly mapping observations reveal variations in the spatial distributions of deuterated, hydrogenated, and 13C-substituted isotopologues of numerous species over a region of 2’ x 1.5’. These also reveal two distinct regimes of deuteration via different chemical pathways in this system. Principal component analysis (PCA) was conducted on a subset of identified molecular species, in order to further reveal (anti-)correlations in their spatial distributions. Interferometric observations with NOEMA, to be completed this cycle, will be crucial for resolving and interpreting these variations on sub-1000 au scales, bridging both single-dish and existing ALMA observations of this system. This work is complementary to ongoing projects concerning high-mass star formation within the SFB 1601: the emergence of chemical diversity during the process of star formation is a fundamental question whose answers are significant across mass regimes.

5. Hot core chemistry in the Outer Galaxy: impact of metallicity on the formation of COMs

Speaker: Youxin Wang (MPIfR)

Abstract: Many complex organic molecules (COMs) in star-forming regions are believed to form in the ice mantles of dust grains. The reduced metallicity and dust-to-gas ratio of the outer Galaxy are thus expected to influence the chemical composition of these regions. In order to probe this, we have performed a spectral survey of three outer-Galaxy hot cores with NOEMA. The chemical composition of all three sources correlates well with that of two well-studied hot cores, one in the inner Galaxy and another one further away in the outer Galaxy. However, the observed decrease in molecular abundances relative to methanol with increasing Galactocentric radius suggests a significant influence of metallicity on COM formation. We compared the observational results to predictions of the astrochemical model MAGICKAL. The model predicts that sensitivity to reduced metallicity and dust-to-gas ratio varies among molecules, with carbon chains and nitriles most negatively affected. The lower dust-to-gas ratio slows down adsorption onto grains, allowing more carbon to remain in the gas phase and become locked in CO. At the same time, slower adsorption promotes more efficient hydrogenation of CO on grain surfaces, enhancing several CO-related COMs beyond simple metallicity-scaling expectations. These model predictions agree relatively well with the observed abundance trends, but notable discrepancies remain for several species. Together, our observations and astrochemical modeling suggest that metallicity does influence COM chemistry in star-forming regions.