The 1st “Seminar on Star Formation and Astrochemistry in Toruń” (SFAT)

organized by MA-LAB

March 22, 2019, Institute of Physics NCU Toruń

I) Program

10:45 - 11:05 Welcome coffee and snacks (next to COK S2)

11:05 - 11:10 Introduction - Agata Karska (NCU Toruń)

keynote talks (25 min including short discussion)

11:10 - 11:35 “High resolution spectroscopy of weak molecular lines” Katarzyna Bielska (NCU Toruń)

11:35 - 12:00 “Dust attenuation recipies - infuence on the estimated stellar masses” Katarzyna Małek (NCBJ, Warszawa)

12:00 - 13:00 Lunch break at the Institute of Physics (Atrium COK)

10 min talks + 5 min discussion

13:00 - 13:15 “Young Stellar Objects in the Central Molecular Zone” Alya Amirah Azman (NCU Toruń)

13:15 - 13:30 “Collisional effects on spectral line-shapes: ab initio calculations” Hubert Jóźwiak (NCU Toruń)

13:30 - 13:45 “Dust production in galaxies at z > 6” Aleksandra Leśniewska (UAM, Poznań)

13:45 - 14:00 Break

14:00 - 14:15 “Single-reference Coupled Cluster theory for multi-reference problems” Aleksandra Łachmańska (NCU Toruń) - TBC

14:15 - 14:30 “The isotopic substitution in reactions of ultracold atom-molecule mixtures: a statistical approach” Maciej Kosicki (NCU Toruń)

14:30 - 14:45 “VUV Absorption cross section at high temperature and warm exoplanetary atmosphere modeling” Ngân Lê (NCU Toruń)

14:45 - 15:00 “Ammonia in circumstellar envelopes of AGB stars” Bartosz Etmański (CAMK PAN, Toruń)

15:00 End of the official part of the meeting

II) Selected abstracts and presenting authors

“Young Stellar Objects in the Central Molecular Zone”

Alya Amirah Azman

The Galactic Center environment provides unique and extreme conditions for star formation within the Milky Way. Candidate young stellar objects (YSOc) in the Galactic Center have previously been identified using 24 micron emission using Spitzer Space Telescope. Star formation rates determined directly from YSOc counts are much higher than the value estimated from other methods. In addition, the YSOc distribution shows a puzzling asymmetry such that they are preferentially located at negative galactic longitudes, while the molecular gas distribution is mostly concentrated to positive longitudes. To resolve the nature of these YSOc, we have conducted spectral line observations of these sources with submillimeter telescope APEX at 230 GHz, located at Atacama desert in Chile. We have detected the presence of dense gas traced by $C^{18}O$, H_2CO, and even more complex organic molecules. Interestingly, based on our spectral line analysis, we find no evidence for the previously reported asymmetry in source distribution. We conclude that some previous YSO catalogues were likely affected by contaminants, resulting in biased estimates of the star formation rate and its spatial distribution in the Galactic Center.

“Dust production in galaxies at $z > 6$”

Aleksandra Leśniewska

Dust production is a very important issue in galaxy evolution. Unfortunately, we are still unable to determine its formation mechanism. I will present the investigation of dust production in nine galaxies at the redshift of $z > 6$, for which dust emission has been detected. In recent years, more accurate measurements were made using the most powerful instruments, eg ALMA, which contributed to better estimates of luminosities and sizes, and thus to determine the masses of gas, dust and stars in the studied galaxies. I conclude that asymptotic giant branch (AGB) stars did not contribute to the dust formation significantly in these Early Universe galaxies, and that supernovae are unlikely to produce the bulk of the dust mass.

“The isotopic substitution in reactions of ultracold atom-molecule mixtures: a statistical approach”

Maciej B. Kosicki

The main limitation of most ultracold chemistry studies to date is the lack of an analysis of reaction products. Chemical reactions alkali metal dimers in the absolute ground state might produce energy ranging from dozens to hundreds of wavenumbers, while an elementary atom exchange reaction in trimers - one order of magnitude more. Similarly, chemical reactions of calcium and strontium monofluorides are strongly exoenergetic. This makes the trapping of reaction products impossible. In this study, using the statistical approach adopted by González Martínez et al. to ultracold molecular collisions, we investigate the isotope-substitution reactions in ultracold molecules such as alkali-metal dimers and alkaline-earth monofluorides in their absolute ground states and extend it to atom+diatom collisions in a static electric field. For these chemical reactions, ultracold atomic and molecular reactants are experimentally available, as well as, the small released kinetic energy (hundreds of mK) allows to trap products. We show that molecules after reaction can be produced in only a few the lowest rotational states. We also show how the electric field can be used to control their reactivities by blocking of the reaction channels and by tuning product state distributions. Although we focus here on the electric field control, one could imagine a similar scenario with the magnetic field for paramagnetic molecules or microwave radiation fields.

“Ammonia in circumstellar envelopes of AGB stars”

Bartosz Etmański

The HIFI instrument on board of the Herschel Space Observatory (HSO) has been very successful in detecting molecular lines from circumstellar envelopes around evolved stars, like massive red supergiants, Asymptotic Giant Branch (AGB) and post-AGB stars, as well as planetary nebulae. Among others, ammonia has been found in circumstellar envelopes of C-rich AGB stars in amounts that significantly exceeded theoretical predictions for C-rich stars. Few models have been proposed to resolve this problem: formation of ammonia behind the shock front, photochemical processes in the inner part of the envelope partly transparent to UV background radiation due to the clumpy structure of the gas, and formation of ammonia on dust grains. Careful analysis of observations may help to put constraints on one or another mechanism of formation of ammonia. Here, we present details of the non-LTE radiative transfer modeling of ammonia transitions including a crucial process of radiative pumping via v2 = 1 vibrational band (10 μm) for selected stars from the sample of C rich stars observed with the HIFI instrument.