Understanding the CN emission lines from protoplanetary disks

Undergraduate internship at IPAG
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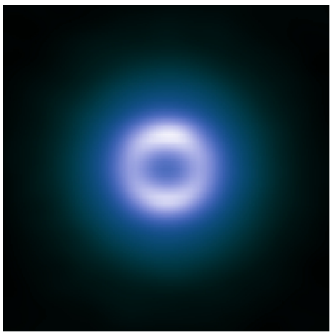

Protoplanetary disks around low-mass stars are analogs of the primitive solar system and provide unique opportunities to understand the formation and chemical composition of planets and solid bodies such as comets. Disks are being observed with unprecedented sensitivity and details with the ALMA interferometer located in Atacama desert in Chile. Deriving the physical and chemical structure of such disks is a fundamental milestone towards a comprehensive understanding of planet formation and, hence, to answer the question whether the solar system is unique or not.

In an effort to understand the origin of nitrogen in protoplanetary disks, we have obtained very high signal-to-noise ratio of the emission of the CN radical from the transition disk TWHya (~ 8 Myr old). This disk is viewed face-on and the CN emission is distributed in a ring (see Figure, and Hily-Blant et al 2017 A&A). We have very strong arguments indicating that the emission originates from the cold and dense molecular layer which is intermediate between the upper, irradiated layer, and the disk midplane. However, the most recent chemical models predict that CN emission comes from the upper layers of disks at variance with our observations. This may indicate that important processes have been neglected in those models.

To solve the discrepancy, we wish to model the emission of these lines using radiative transfer code. On the other hand, we want to analyse CN emission datasets available in the ALMA archive. We propose an internship to perform these two tasks. The work will consist in numerical models and ALMA data processing. The calculations will be performed on the local CIMENT cluster. The intern will work at IPAG, a leading institute in star and planet formation studies, in an international environment, with many graduate and PhD students and post-docs. The intern will be a member of the team SPECTRE.

The proposed work will consist in

- Perform radiative transfer calculations of the CN emission lines, including the hyperfine splitting, and compare with our ALMA maps.
- Retrieve and process data of CN, HCN in protoplanetary disks from the ALMA archive in order to generalize the findings in TWHya and propose new observations.

Methods and working environment

- Numerical modeling using existing codes ; the intern will have to handle the codes and may have to develop small routines;
- We expect the intern to develop a good understanding of radiative transfer and radiation-matter interaction processes;
- The intern will participate to the weekly scientific meeting of the SPECTRE team and will present the progress of the work;
- Another meeting with the co-investigators of the project will be organized on a weekly basis;

Duration

- up to 4 months

Bibliography

- Hily-Blant et al 2017 A&A