EPSC Abstracts
Vol. 14, EPSC2020-803, 2020
https://doi.org/10.5194/epsc2020-803
Europlanet Science Congress 2020

Gas extent in protoplanetary disks of the Lupus star forming region

Enrique Sanchis[1,2]
[1]European Southern Observatory, Office for Science, Germany (esanchis@eso.org)
[2]Universitäts-Sternwarte, Ludwig-Maximilians-Universität, München, Germany

I will present a demographic study of the gas content in protoplanetary disks of the Lupus star-forming region, based on the previous ALMA surveys of the region.

Planets form around stars during their pre-main sequence phase, when still surrounded by a circumstellar disk of dust and gas. Setting observational constraints on the gas and dust properties of protoplanetary disks is crucial in order to understand what are the ongoing physical processes in the disk. These processes shape the planet formation mechanisms, and ultimately tell us about the disk's ability to form planets.

The advent of ALMA allowed us to characterize dust properties in large populations of disks in several star-forming regions. Nevertheless, demographic studies of the gas content in these disk populations are scarce and generally incomplete, due to the fewer detections, and other difficulties when studying gas content.

In this work, we were able to assemble a large and homogeneous sample of disks from the Lupus region, all detected in ^{12}CO and dust continuum. Gas emission profiles and sizes are estimated on 43 disks of the Lupus region. The profiles are inferred from the integrated emission maps of the ^{12}CO transition line in ALMA Band 6. The observed emission is modeled using empirical functions: either the Nuker profile or an elliptical Gaussian for more compact sources. The gas size, defined as a certain fraction (e.g. 68%) of the total flux, is inferred from the modeled emission profiles.

These gas properties are then compared to the dust properties of the same objects, estimated from ALMA surveys in Band 7 and using analogous methodology.

The relative size of gas and dust is a key diagnostic of dust evolution. Large dust grains are decoupled from gas and drift inwards. Thus, if dust growth is prominent in these disks, the detected dust continuum emission in sub-mm wavelengths are expected to be several times smaller than the gas extent.

The results of our extensive sample confirm the larger gas size when compared to the dust size. The gas disk size is on average 2.6 times larger than the dust disk. This size difference can be explained by effective drifting of dust, but also by the optical depth difference between ^{12}CO and dust continuum. Disentangling between these two effects is in general difficult; only large size ratios (typically beyond 4) unequivocally exhibit prominent dust evolution.

Only a small fraction (~18%) of the disk population has a size ratio larger than 4. Radial drift is intimately linked to grain growth, both are crucial processes to form the cores of planets. Our results might suggest that dust evolution is less common than previously thought.

We also investigated possible trends of the size ratio with stellar and disk properties, e.g. stellar mass, disk mass, integrated CO flux; no clear correlation can be found. Interestingly, the only Brown Dwarf of the sample with characterized gas and dust disk sizes shows a relatively large ratio of 3.8. On the other stellar mass range end, disks around stars with mass > 0.8 M_{sun} have a tentative lower ratio of 2.1. Larger samples in the low mass regime and in the rest of stellar mass ranges are needed in order to discern possible trends between spectral types or other properties of the host stars.