Direction des Sciences de la Matière
IRFU
Service d'Astrophysique

Soutenance de thèse du Service d'Astrophysique

IONIZATION IMPACT ON MOLECULAR CLOUDS AND STAR FORMATION NUMERICAL SIMULATIONS AND OBSERVATIONS, AND SUB-MILLIMETRE SITE TESTING IN ANTARCTICA.

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SAp

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Salle Galilée – bât 713

We present a new model for the formation of dense clumps and pillars around HII regions based on shocks curvature at the interface between a HII region and a molecular cloud. UV radiation leads to the formation of an ionization front and of a shock ahead. The gas is compressed between them forming a dense shell at the interface. This shell may be curved due to initial interface or density modulation caused by the turbulence of the molecular cloud. Low curvature leads to instabilities in the shell that form dense clumps while sufficiently curved shells collapse on itself to form pillars. When turbulence is high compared to the ionized-gas pressure, bubbles of cold gas have sufficient kinetic energy to penetrate into the HII region and detach themselves from the parent cloud, forming cometary globules.

Using computational simulations, we show that these new models are extremely efficient to form dense clumps and stable and growing elongated structures, pillars, in which star formation might occur. The inclusion of turbulence in the model shows its importance in the formation of cometary globules. Globally, the density enhancement in the simulations is of one or two orders of magnitude higher than the density enhancement of the classical "collect and collapse" scenario. The code used for the simulation is the HERACLES code, that comprises hydrodynamics with various equation of state, cooling and heating.

Our recent observations with Herschel and SOFIA and additional Spitzer data archives revealed many more of these structures in regions where OB stars have already formed such as the Rosette Nebula, Cygnus X, M16 and Vela, suggesting that the UV radiation from massive stars plays an important role in their formation. We present comparisons between the simulations described above and recent observations of these regions. For this purpose we extracted column density profiles around the ionized region and constrained the dynamic thanks to spectral line data. Furthermore, we used probability density functions of the gas around the HII regions to study the impact of the compression on the large-scale structure of the clouds.

We also present other works that have been done in parallel of this PhD: the charge exchange in colliding planetary and stellar winds in collaboration with Prof. E. Chiang during the ISIMA summer school 2011 in Beijing; and the sub-millimeter site testing at the Concordia station in Antarctica with the CAMISTIC team (PI: G. Durand).