APE: providing physical conditions for chemical models and synthetic observations

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Chemical models and synthetic observations are of paramount importance to interpret and predict observations. Coupled together they offer a great opportunity to increase our understanding of the processes involved in star formation.

The new publicly available Analytical Protostellar Environment (APE) code has been designed for this purpose. It allows simulations and synthetic observations to be perfomed at low computational cost, providing a powerful approach to interpret and predict observations. APE use a semi-analytical model describing dynamically the formation and the evolution of the protostar and its environment from the onset of the prestellar collapse to the end of the Class I stage. It includes the central object, the envelope, the protoplanetary disk and the outflow. The code is provided with interfaces to other publicly available codes to perform chemical simulations (Nautilus), radiative transfer calculations (RADMC-3D) and synthetic interferometry imaging (Imager). The APE code itself directly allows to work with different modes to either produce density and temperature maps at a given time, or to follow the physical history of individual particles.

To date, APE has been used for diverse applications. We produced synthetic observations of several molecules that are in agreement with the observations of the Class I protostar IRAS 04302+2247 carried out by Podio et al. 2020. We also studied the impact of the environment (initial density, temperature, cosmic ray ionization rate, mass of the protostar, prestellar phase duration) on the abundance of COMs in protoplanetary disks. Finally, we studied the effect of luminosity outbursts on the chemistry of protostellar envelopes. With this poster, we will introduce the code, present the first results obtained with APE and discuss the possibilities it offers regarding the studies on star formation.