RESETTING CHEMICAL CLOCKS OF HOT CORES BASED ON SULPHUR-BEARING SPECIES

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Sulphur bearing species have been previously proposed and used as chemical clocks to probe the evolutionary stage of protostars, and more precisely of ”hot cores”. Hot cores are small regions which contain hot and dense gas where the iced mantles of dust grains evaporate in the gas phase. Sulphur, highly depleted in the pre-collapse phase, is injected in the gas phase in an unknown form. Up to recently, H_2S was supposed to be this form because hydrogenation is the main chemical process at the surface of the grains. The lack of an appropriate H_2S feature in the ISO spectra of high and low mass protostars has cast doubt on this basic assumption. Once in the gas phase, sulphur leads to an important warm chemistry evolving with time making the abundance of sulphur bearing species a nice function of time. Hence comparisons between observed and predicted abundances can give the ”age” of the hot cores since the mantles of the grains have evaporated.

We report the detailed study of the sulphur chemistry in hot cores with the aim to investigate the relevance of S-bearing species as chemical clocks. For this study, we developed a time-dependent chemical model with up-to-date reaction rate coefficients. The modeling shows that S-bearing abundance ratios depend very critically on the gas temperature and density, the abundance of atomic oxygen, and, most importantly, on the form of sulphur injected in the gas phase, which is very poorly known. Consequently, ratios of S-bearing molecules cannot be easily used as chemical clocks. However, detailed observations and careful modeling of both physical and chemical structure can give hints on the source age and constrain the mantle composition (i.e. the form of sulphur in cold molecular clouds) and, thus, help to solve the mystery of the sulphur depletion. The comparison of the available observations with our model suggests that the majority of sulphur released from the mantles is mainly in, or soon converted into, atomic form.