The Sulphur depletion problem in molecular clouds: the H_2S case.

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Sulphur is one of the most abundant elements in the Universe [1] and plays a crucial role in biological systems. It is therefore of great interest to track its chemical history in space. However, sulphuretted molecules are not as abundant as expected in the ISM – the Sulphur depletion problem – and there is no clear answer of where the missing Sulphur is yet. To shed light onto this open question, we focus our attention on the chemistry of H_2S in dark clouds. This molecule is thought to be an important reservoir of Sulphur [2], mainly in solid state, locked in grain ices.

Using a subset of the GEMS IRAM Large Program data, which comprises IRAM 30m telescope millimeter observations of CS, SO and H_2S, in this work [3] we have determined the physical conditions and modeled the H_2S chemistry in the TMC 1-C, TMC 1-CP and Barnard 1b cores. The NAUTILUS chemical code is used to model the sulfur chemistry and explore the impact of photo-desorption and chemical desorption on the H_2S abundance. Our results show that chemical desorption is the main formation mechanism of H_2S in dark cores. Our results, at densities $n(H) < 2 \cdot 10^4$ cm^{-3}, are well fitted assuming the chemical desorption efficiency as proposed by [4] for bare grains. For higher densities, our model overestimates the H_2S abundance, suggesting that chemical desorption becomes less active. According to our model, the decrease of the H_2S chemical desorption occurs when the abundance of H_2O and CO ices achieves their maximum value in both molecular clouds. We propose that this change in the chemical desorption efficiency is related to a change in the chemical composition of grains, produced by the formation of a thick H_2O and CO ice mantle on their surfaces when $n(H) > 2 \cdot 10^4$ cm^{-3}. Therefore, H_2S might be tracing the snowline of dark clouds. Additionally, our model predicts that H_2S is the main reservoir of S in icy mantles, with a similar abundance in both targets of around one fifth of the Sulphur cosmic abundance. Finally, our model yields an elemental abundance of S/H of around the cosmic value within a factor of ten.

References

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