Elias 29: a Class I Low-Mass Protostellar Source Rich in S-bearing Species

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In the star-formation process, the chemical evolution from the interstellar space to planets is of interest as well as the physical evolution. So far, the chemical composition of the envelope gas is known to show significant diversity among sources; two distinct cases are hot corinos rich in saturated complex organic molecules (COMs) and warm carbon-chain chemistry (WCCC) sources rich in unsaturated carbon-chain molecules [1]. However, it is still important to study chemical compositions of low-mass protostellar sources under various environmental conditions in order to reveal a whole picture of chemical diversity.

Elias 29 (WL15) is a Class I low-mass protostellar source in the L1688 dark cloud in Ophiuchus. It is known to be strongly irradiated by the nearby bright star HD147889. We observed Elias 29 in the CS, SO, SO_2, SiO, COM, and carbon-chain molecular lines with ALMA (Cycle 2). We found that both of COMs and carbon-chain molecules are faint. CS is also faint around the protostar, while it traces a southern ridge apart from the protostar. On the other hand, the SO and SO_2 lines are bright near the protostar, and show a velocity gradient perpendicular to the outflow blowing along the east-west direction [2]. This velocity gradient likely represents the rotation motion around the protostar (Fig. 1).

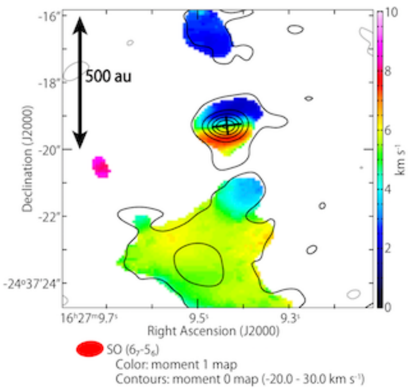

Figure 1: Moment 1 map of the SO line (6_7-5_6). SO traces the rotating motion around the protostar shown by a black cross.

The chemical characteristics of Elias 29 is quite peculiar; only the SO and SO_2 lines are prominent. This can be explained qualitatively by the relatively high dust temperature (~20 K; [3]) of the parent core of Elias 29 caused by strong external irradiation. For this reason, CO does not deplete onto dust grains, which prevents formation of COMs on dust grains. Similarly, the S atom does not deplete onto dust grain, either, and is subject to the gas phase reaction to form SO and SO_2.

So far, hot corino chemistry and WCCC provide an apparent 'axis' of chemical diversity, which would be caused by the different duration time of the starless core phase. However, the above result suggests that sulfur chemistry can be another important 'axis' of the diversity caused by the different temperature condition. More systematic studies are awaited.

References

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