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TITLE: Water and complex organic chemistry in the cold dark cloud Barnard 5: Observations and Models

ABSTRACT BODY:

Abstract Body: Studies of complex organic molecule (COM) formation have traditionally been focused on hot cores in regions of massive star formation, where chemistry is driven by the elevated temperatures - evaporating ices and allowing for endothermic reactions in the gas-phase. As more sensitive instruments have become available, the types of objects known to harbour COMs like acetaldehyde (CH_3CHO), dimethyl ether (CH_3OCH_3), methyl formate (CH_3OCHO), and ketene (CH_2CO) have expanded to include low mass protostars and, recently, even pre-stellar cores. We here report on the first in a new category of objects harbouring COMs: the cold dark cloud Barnard 5 where non-thermal ice desorption induce complex organic chemistry entirely unrelated to local star-formation.

Methanol, which only forms efficiently on the surfaces of dust grains, provide evidence of efficient non-thermal desorption of ices in the form of prominent emission peaks offset from protostellar activity and high density tracers in cold molecular clouds. A study with Herschel targeting such methanol emission peaks resulted in the first ever detection of gas-phase water offset from protostellar activity in a dark cloud, at the so called methanol hotspot in Barnard 5.

To model the effect a transient injection of ices into the gas-phase has on the chemistry of a cold, dark cloud we have included gas-grain interactions in an existing gas-phase chemical model and connected it to a chemical reaction network updated and expanded to include the formation and destruction paths of the most common COMs. Results from this model will be presented.

Ground-based follow-up studies toward the methanol hotspot in B5 have resulted in the detection of a number of COMs, including CH_2CO, CH_3CHO, CH_3OCH_3, and CH_3OCHO, as well as deuterated methanol (CH_2DOH). Observations have also confirmed that COM emission is extended and not localised to a core structure. The implications of these observational and theoretical studies of B5 will be discussed in the context of the gas-grain interaction in dark clouds and its relation to the chemistry of the earliest phases of low-mass star formation.

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