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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 ( $\text{CH}_3\text{CHO}$ ), dimethyl ether ( $\text{CH}_3\text{OCH}_3$ ), methyl formate ( $\text{CH}_3\text{OCHO}$ ), and ketene ( $\text{CH}_2\text{CO}$ ) 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  $\text{CH}_2\text{CO}$ ,  $\text{CH}_3\text{CHO}$ ,  $\text{CH}_3\text{OCH}_3$ , and  $\text{CH}_3\text{OCHO}$ , as well as deuterated methanol ( $\text{CH}_2\text{DOH}$ ). 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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