Contribution ID: **37** Type: **not specified**

Unveiling Central ortho-H2D+ Depletion at Sub-kau Scales in Prestellar Core G205.46−14.56 M3

Friday 29 August 2025 09:40 (20 minutes)

Prestellar cores represent the initial conditions of star formation. The Orion B prestellar core G205.46 M3 has been reported to exhibit two substructures, B1 and B2, which have been proposed as the stellar embryos of a future protobinary system. At this stage, heavy molecules such as CO are significantly depleted in these cold, dense environments, limiting our ability to probe core centers. In contrast, deuterated molecular ions, particularly oH2D+, emerge as key tracers due to enhanced deuterium fractionation at low temperatures. We present the ALMA oH2D+ and 820um continuum maps at ~300au resolution, showing oH2D+ depletion in the prestellar core G205.46 M3. We identify a significant oH2D+ depletion zone of ~600au in diameter toward B1. Chemo-dynamical modeling reproduces the observed deuteration profiles with a core age of approximately 0.42 Myr, comparable to the free-fall time. This suggessts that the substructures formed via turbulent fragmentation through rapid contraction rather than through slow, quasi-static contraction. Our observations also reveal that the gas between B1 and B2 exhibits nearly thermal velocity dispersion, which is consistent with a turbulent scenario in which turbulence dissipates in no more than a few free-fall times. Our results highlight the critical role of deuterated ions in probing both the chemical evolution and dynamical state of dense cores.

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Session Classification: Interactions with the environment