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# Dense Molecular Knots in the Crab Supernova Remnant

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## Abstract

Molecular emission was imaged with ALMA from numerous components located at or near bright H<sub>2</sub>-emitting knots and/or absorbing dust globules in the Crab Nebula. These observations provide insight into how energetic photons and particles produced in a young supernova remnant interact with gas, cleanly differentiating between competing models. The four locations targeted show contrasting properties. Our successful observations are contrasted with Cloudy models of these knots. We suggest that the Crab filaments present an exotic environment in which H<sub>2</sub> emission comes from a mostly-neutral zone probably heated by cosmic rays produced in the supernova. We detect carbon monoxide emission from many clumps distributed throughout the regions imaged with characteristics consistent with predictions based on the CLOUDY photoionization model of one of the dust globules in the nebula. Emission from HCO<sup>+</sup> (J=4-3), SiO (J=8-7), and SO (89-78) transitions was also observed from the strongest CO-emitting region. The molecular knots in the Crab present a novel very young phase of the ISM representative of many important astrophysical environments.

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