Contribution ID: **74** Type: **Poster**

Investigating Chromospheric Holes in the Millimeter Continuum

Studies of the solar chromosphere are an important component of our understanding of heating and energy transfer in the solar atmosphere — however, the predominance of non-equilibrium and non-LTE physics there complicates numerical simulation of this region. In contrast, the millimeter continuum serves as a "linear thermometer" of the chromosphere, allowing it to serve as a crucial observational constraint on such models.

Recent high-resolution observations of the Sun at 1.3 mm and 3 mm from the Atacama Large Millimeter Array (ALMA) have shown the presence of extended, long-lived cold regions termed *chromospheric holes*. While an archival study of ALMA data shows that these regions appear predominantly in magnetically active regions of the chromosphere, the mechanism of their formation is currently unknown.

To study the formation and evolution of these chromospheric holes, we present new observations of the quiet and active Sun at 1.3 mm and 0.9 mm, which represent the first high-resolution observations of the sub-millimeter Sun with ALMA. Additionally, simultaneous observations of these regions in the 4.7 um molecular band of carbon monoxide are used to constrain the formation height of the holes seen at 1.3 mm. Lastly, we compare the observed chromospheric holes to similar features seen in numerical simulations of the chromosphere, and discuss how high-resolution ALMA observations can be used to constrain magneto-hydrodynamic modeling of the chromosphere.

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Session Classification: Posters

Track Classification: Chromosphere