On ALMA Solar Observing Program

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Abstract

The Atacama Large Millimeter/submillimeter Array (ALMA) is designed to operate at millimeter and submillimeter wavelengths. It will open a new window on solar physics studies in complementary to ground- and space-based facilities to explore the key science problems including the heating and dynamics of chromosphere; the origin of fast solar wind; filaments and coronal cavities, precursors to coronal mass ejections; sunspots and active regions; mysterious "sub-tera Hz" component of some solar flares; radio recombination lines in solar corona; etc. An international Team has been organized and supported to develop and prioritize the solar observing modes using existing ALMA hardware, to develop calibration procedures, to develop ALMA solar use cases, to define requirements for online and offline solar observing software, and to make recommendations for the initial suite of solar observing modes supported by ALMA science operations for Cycle 3 observing. We will introduce this program.

Introduction

The Atacama Large Millimeter/submillimeter Array (ALMA) is designed from roughly 350 microns to 9.6 mm to operate at millimeter and submillimeter wavelengths. It therefore fills in the gap between optical/infrared telescopes, and radio telescopes. The radiation at mm and submm wavelengths is caused by different physical mechanisms than that produced at longer and shorter wavelengths. And it originates in different regions of the solar atmosphere. Mm and submm observations therefore give us a new probe of physical processes on the Sun.

The key scientific objectives of ALMA solar observations include the following contents (Bastian 2013). Mm wavelength observations provide the only technique to measure the temperature directly. It therefore challenges the chromospheric heating problem. However, the dynamic chromosphere at sub-arc-second resolution must rely on ALMA snapshot imaging capabilities. The emission mechanism of an inverted spectrum at frequencies of a few hundred GHz in some flares (Kaufmann, P. et al. 2004) remains unknown and its identity is an important science objective for ALMA (Krucker 2004). Early attempts failed to yield detections of Radio recombination lines (RRLs) in the solar atmosphere. Successful detections of HI RRLs in the 350μ and 450μ bands (Clark et al. 2000) indicate a new diagnostic tool near solar limb.

Solar observing is an important component of ALMA science program and the instrument has been designed to support such observations by appropriate design of antenna surface and a solar filter in optical path to attenuate signal. solar observing at mm wavelength has unique problems that require development well beyond the hardware needs. It is expected to develop and prioritize the solar observing modes employing the existing ALMA hardware, to develop the solar calibration procedures, to develop ALMA solar use cases, to define requirements for online and offline solar observing software, and to make recommendations for the initial suite of solar observing modes supported by ALMA science operations for Cycle 3 observing (Bastian 2013).

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