Amplitude Calibration of ALMA

Bryan J. Butler, National Radio Astronomy Observatory

The Atacama Large Millimeter Array (ALMA) is a major ground based project for millimeter and submillimeter astronomy to be realized during this decade. It is an interferometer composed of 64 telescopes of diameter 12 meters, each equipped with ten receiver bands covering the atmospheric windows from 30 to 950 GHz. Baselines up to several kilometers will allow sub-arcsecond resolution. The ALMA array will be located on a high-altitude (5000 m) plateau in the Atacama Desert in Northern Chile. The project is a joint venture of Europe and North America (USA and Canada) with Japan intending to join later on.

The specification for amplitude calibration for ALMA is 1% at millimeter wavelengths and 3% at submillimeter wavelengths. This is significantly more precise than current millimeter and submillimeter instruments, and presents a significant design challenge. Major elements involved in the calibration of the amplitude include: focus, delay, pointing, bandpass, sideband gain ratio, atmosphere (including decorrelation), and receiver.

The atmosphere (excluding decorrelation) and receiver can be calibrated by an extension of the traditional chopper wheel method. There are several variants being studied, but the two most promising are the dual-load (current design has them in the subreflector), and the semi-transparent vane techniques. Each of these has advantages and disadvantages, and these are currently being studied, both theoretically, and by testing prototype systems at millimeter observatories.

I will discuss the current status of the amplitude calibration of ALMA, including all of the elements of the calibration framework, but focusing on recent developments and measurements involving the dual-load and semi-transparent vane calibration devices.