Accurate Antenna Gain Calibration

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Abstract

The accurate measurement of radio source fluxes depends on precise knowledge of the antenna gain. We describe a scheme for accurate antenna gain measurement that depends on having a stable interferometer and a calibrated standard gain horn. The standard gain horn is fastened to the side of one of the interferometer antennas and connected to a switch so that either the main feed horn of the antenna or the standard horn drives the receiver of the antenna. The interferometer is set to observe a strong radio source, and as the switch is flipped, the correlator output is the product of either the normal antenna pair signals or the standard horn signal and the other antenna signal. The ratio of the two correlator signals is the voltage ratio of the standard horn to that of the normally fed antenna. The main antenna gain is then that ratio (in db) added to the gain of the standard horn. It can be readily measured to an accuracy of the order of one percent. With a similar accuracy for the standard horn, one obtains an overall accuracy of about one percent for the main antenna. A number of issues must be carefully considered, including antenna pointing accuracy, antenna gain stability with elevation, angular size of the radio source, correlator linearity, atmospheric extinction, and cable delays. In this experiment, one of the BIMA array antenna gains is measured at 28.5 GHz using the planet Jupiter to an accuracy of 1%, and the brightness temperature of Jupiter is measured to an accuracy of 1.5%.

This is an invited paper for the special URSI joint session between J and F on Calibration, chaired by Jack Welch and Jeff Piepmeier.