Beam Pattern Modeling of ALMA Single-Dish Antenna and its Deconvolution

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We have investigated the beam pattern of the ALMA single-dish antenna, the so-called PM antenna for single-dish observations of the Sun. The Sun is an extended and strong radio source that requires a parameterization of the extended sidelobes, which have never been derived. The beam pattern of the telescope was modeled as a sum of Gaussian functions combined with the numerically-derived inner sidelobes. Then, the best model was derived using the solar limb, which is considered to be a sharp edge. We found that a simple sum of Gaussian functions can reconstruct the observed limb structure. The derived beam pattern was 10-40 times broader than the main beam. The real shape of the Sun was reconstructed through deconvolution of the derived beam pattern from an observed map. The deconvolution using maximum-entropy-method improved the image resolution, while the CLEAN algorithm does not show significant change after the deconvolution. The deconvolution image suggests that the observed solar limb should be lower by about 1000 K at Band 3 (107 GHz) and 800 K at Band 6 (248 GHz) than the actual limb.

Keywords: Sun, Chromosphere, Sun: radio radiation, ALMA, Single dish observation, Image deconvolution

