1. Observations and Data Analysis

Observations were made on 2001 May 09–10 using an array consisting of 10 geodetic antennas (AL, HH, KK, MA, MC, NY, ON, TS, WF & WZ) along with the 10 antennas of the VLBA (Napier *et al.* 1994) of the National Radio Astronomy Observatory (NRAO)[1]. Eight IFs (frequency channels) were recorded simultaneously, each eight MHz wide, with four at S–band (2.23, 2.26, 2.35, & 2.37 GHz) and four at X–band (8.41, 8.48, 8.79, & 8.90 GHz) for a total bandwidth of 32 MHz in each frequency band. Observations were made in a dual–frequency bandwidth synthesis mode to facilitate delay measurements for astrometry. The multiplicity of channels allows for the determination of a precise group delay (Rogers 1970), while simultaneous observations in two bands allows for an accurate calibration of the frequency dependent propagation delay introduced by the ionosphere. Results of the precise astrometry afforded by these observations will be presented elsewhere. Observations in this mode also allow simultaneous dual–frequency imaging, which is the focus of the work discussed here.

A total of 93 sources had sufficient data for imaging from observations made using short duration "snapshots" over a number of different hour angles to maximize the (u, v) -plane coverage.

The raw data bits were correlated with the VLBA correlator at the Array Operations Center in Socorro, New Mexico. The correlated data were calibrated and corrected for residual delay and delay rate using the NRAO Astronomical Image Processing System (AIPS). Initial amplitude calibration for each of the 8 IFs was accomplished using system temperature measurements taken during the observations combined with observatory supplied gain curves. Fringe–fitting was done in AIPS using solution intervals equal to the scan durations and a point source model in all cases. After correction for residual delay and delay rate, the data were written to FITS disk files. All subsequent processing was carried out using the Caltech VLBI imaging software, primarily DIFMAP. After phase self–calibration with a point source model, the 4 second correlator records were coherently averaged to 12 second records and then edited.

Amplitude calibration was improved through observations of a compact source at each frequency band. A single amplitude gain correction factor was derived for each antenna for each IF, based on fitting a simple Gaussian source model to the visibility data of the compact source after applying only the initial calibration based on the measured system temperatures and gain curves. Gain correction factors were calculated based on the differences between the observed and model visibilities. The resulting set of amplitude gain correction factors was then applied to the visibility of all sources. The absolute flux density scale of the data has not been investigated but is estimated to be within 10–20%.

The visibility data for each frequency band were self–calibrated, Fourier inverted, and CLEANed using DIFMAP in an automatic mode (Shepherd, Pearson, & Taylor 1995). DIFMAP combines the visibilities for each IF of an observation in the (u, v) plane during gridding, taking into account frequency differences. However, DIFMAP makes no attempt to correct for spectral index effects. The spanned bandwidth of the four IFs in each band are relatively small (0.1 GHz [6% fractional bandwidth] at S–band and 0.5 GHz [6% fractional bandwidth] at X–band), so we assume that source structure and flux density variations across each of the two frequency bands are negligible. The data were self–calibrated following the hybrid–mapping technique (Pearson & Readhead 1984) to correct for residual amplitude and phase errors. The data were initially phase self–calibrated and mapped using uniform weighting in the (u, v) plane before switching to natural weighting after several iterations.

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