

WALLABY Memo 14: Performance of the ASKAP 12 (ADE) configuration for H I observations

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1 Overview

We simulated H I observations with the ASKAP 12 (ADE) configuration proposed in CSIRO’s “Early Science with ASKAP” memo dated 3 July 2013. For this purpose, we created an empty mock visibility data set with the MIRIAD task UVGEN, assuming an hour-angle coverage of ± 4 h, a declination of -30° , a telescope efficiency of $\eta = 0.8$, a spectral channel width of 18.5 kHz, and an observing frequency equal to the rest frequency of the H I line of about 1420 MHz. Next, we Fourier-transformed the visibility data to form images with different combinations of weighting and tapering, including uniform weighting ($R = -\infty$), robust weighting ($R = 0$), natural weighting ($R = +\infty$), and uniform weighting with a Gaussian taper of 1.28 km FWHM. The resulting beam sizes and sensitivity limits are summarised in Table 1. The corresponding synthesised beam images are presented in Fig. 1. In addition, we generated visibility data and images with robust ($R = 0$) weighting at different declinations of -60° , -30° , -10° , and 0° to investigate the varying beam pattern and sidelobe levels. These are shown in Fig. 2.

Table 1: Specifications for an 8 h H I observation with ASKAP 12 (ADE) with different weightings and tapers. The columns denote: weighting scheme used, FWHM of Gaussian taper used, FWHM of the major and minor axis of the synthesised beam, maximum sidelobe level, rms noise of the image (in mJy and K) assuming a telescope efficiency of $\eta = 0.8$, H I mass sensitivity for point sources at a distance of $d = 10$ Mpc, and H I column density sensitivity for emission filling the beam. The figures for mass and column density sensitivity assume a signal of $10 \times$ rms across $\Delta v = 40 \text{ km s}^{-1}$.

Weighting	Taper (m)	Beam size (")	Max. S.L.	rms (mJy)	rms (K)	$M_{\text{H I}}$ (M_\odot)	$N_{\text{H I}}$ (cm^{-2})
uniform	–	20.4×14.8	12.4%	4.4	8.8	6.6×10^6	10.5×10^{20}
robust 0	–	20.7×14.9	12.7%	4.4	8.6	6.6×10^6	9.6×10^{20}
natural	–	26.9×17.7	17.3%	4.1	5.3	6.1×10^6	6.0×10^{20}
uniform	1280	35.7×26.1	21.0%	5.7	3.7	8.5×10^6	4.2×10^{20}

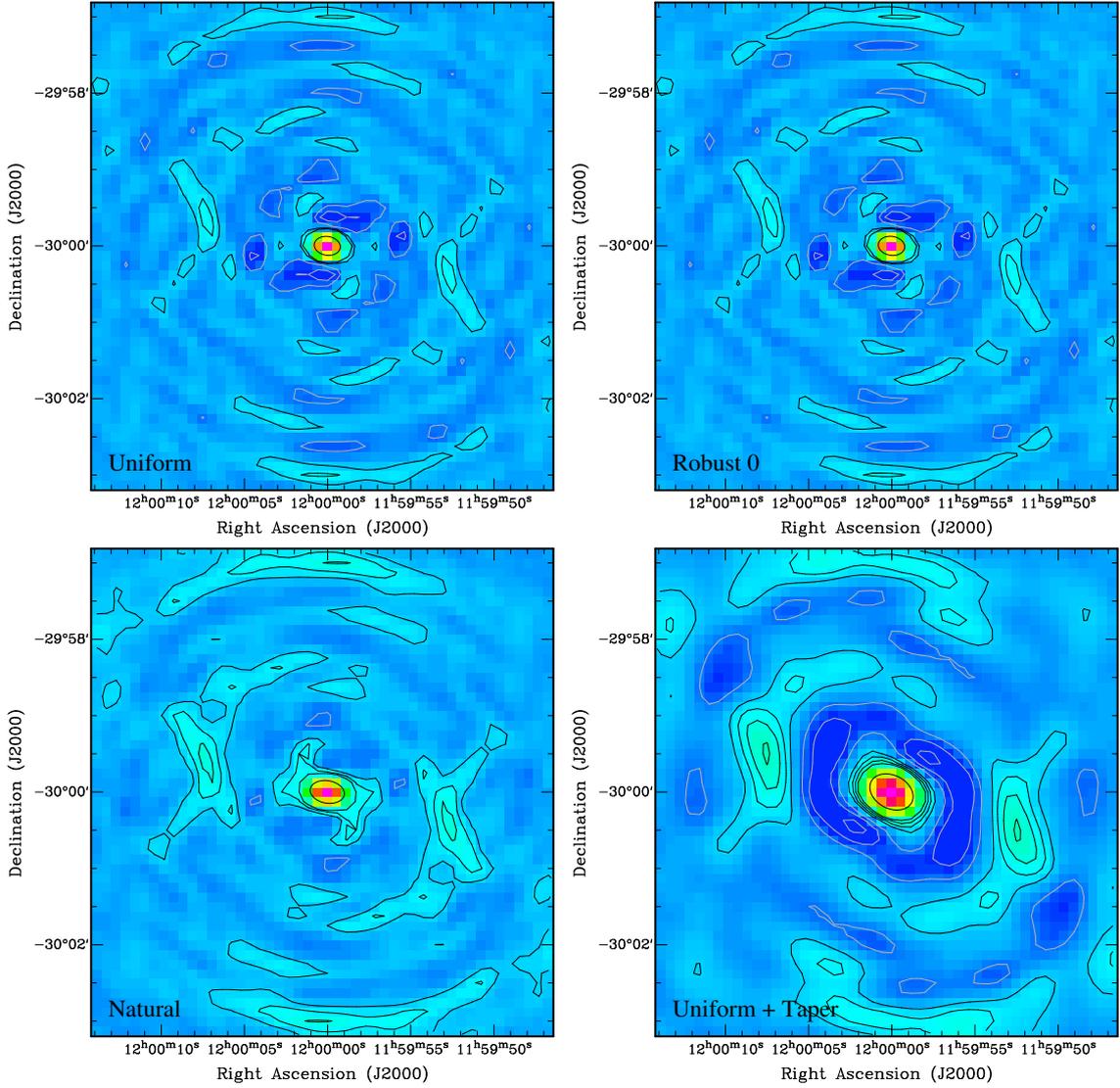


Figure 1: Synthesised beams of a simulated HI observation with ASKAP 12 (ADE), assuming a declination of -30° , an hour-angle coverage of ± 4 h, and different visibility weighting and tapering schemes, namely uniform weighting ($R = -\infty$), robust weighting ($R = 0$), natural weighting ($R = +\infty$), and uniform weighting with a Gaussian taper of 1.28 km FWHM. Positive (black) and negative (grey) contour levels were drawn at $\pm 5\%$, $\pm 10\%$, $\pm 15\%$, and $+20\%$ as required. The black ellipse in the centre marks each beam's FWHM and orientation based on a Gaussian fit.

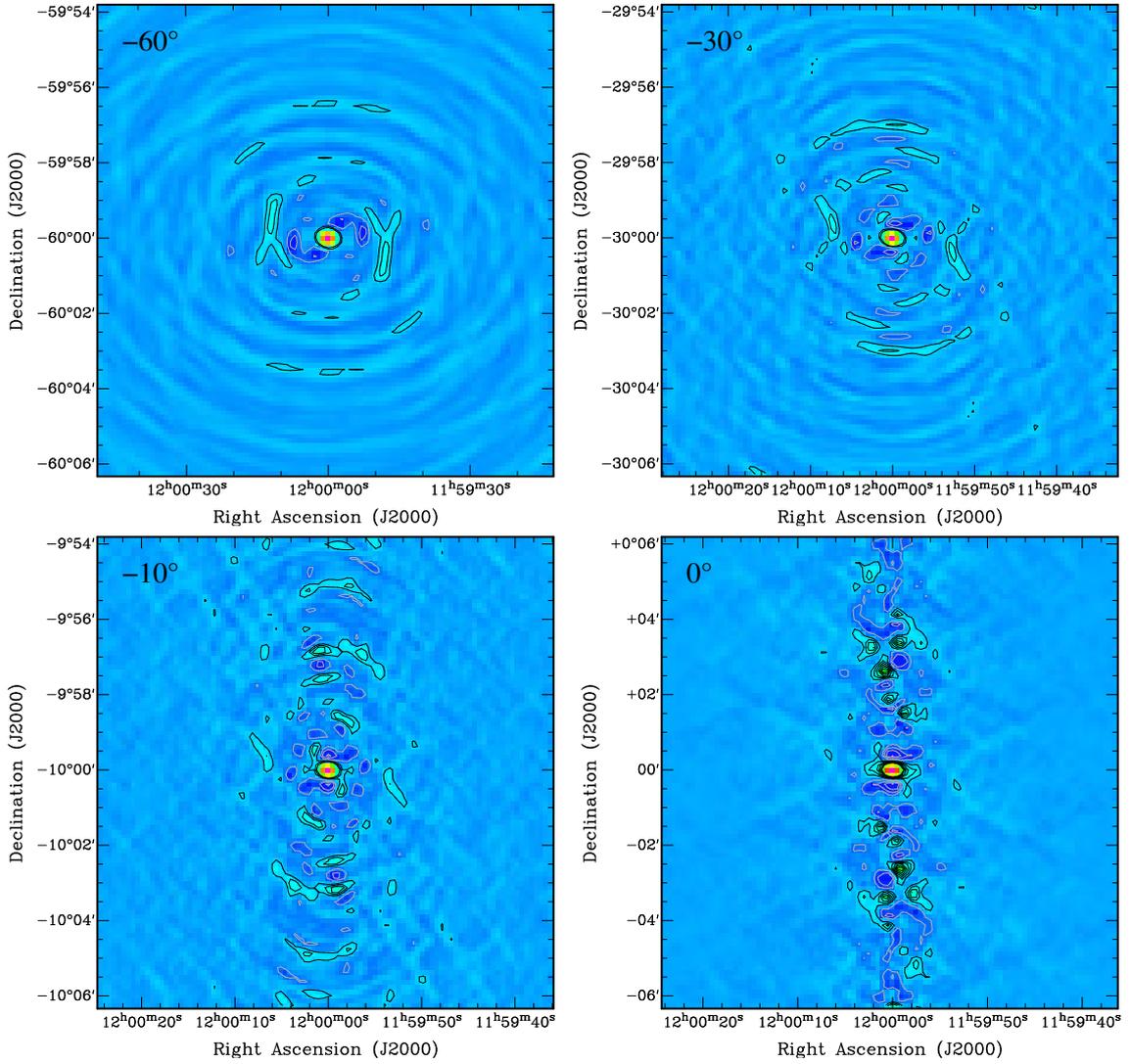


Figure 2: Synthesised beams of a simulated HI observation with ASKAP 12 (ADE) at different declinations of -60° , -30° , -10° , and 0° , assuming an hour angle coverage of ± 4 h and robust weighting with $R = 0$. Positive (black) and negative (grey) contour levels were drawn at $\pm 5\%$, $\pm 10\%$, $\pm 15\%$, $\pm 20\%$, $\pm 25\%$, and $\pm 30\%$ as required.