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COMMERCIAL* QUALITY FLUXES FOR K-BAND

Patrick Palmer
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K-band provides a special problem for calibration because most of the "good" (i.e. compact, flat spectrum) sources are highly variable on a timescale of months. There have been no systematic remeasurements of these fluxes at the VLA for about three years. This means that even the few K-band fluxes given in Section III of VLA Calibration Manual must be regarded as fairly uncertain. To provide a starting point for calibrations, I measured the fluxes of 14 strong sources scattered around the sky. The measurements are not claimed to be particuliarly accurate and all of the sources (except 3C286 and 3C48) are well known variables, so one should not attempt to use these values in place of measurement of a primary flux calibrator. Rather, these values can to be used to help choose phase calibrators and, for the next few months perhaps, for consistancy checks.

Fluxes were measured at 2 frequencies in K-band in 100MHz bands centered at 23660MHz (near the (1,1) NH_3 line) and at 22460MHz (near the default K-band frequency and the H_2O line). The primary calibrator was 3C286 which was assumed to have the flux given in the Calibration Manual. (The adopted values for 3C286 are given in parantheses in Table 1.) The measurements were made in two sessions separated by 34 hours: 9 August between 11AM and 1PM MST and 11 August between 11PM and 2AM (12 August). The weather was mediocre, some overcast, but no rain. The results are given in Table 1. (The dashed line divides the two sets of measurements.) The VLA was in the C array.

A few comments about the reductions may be useful. First, the fluxes were corrected for atmospheric extinction using the absorption coefficient derived from a tipping curve recorded during the session. Second, since pointing may be a problem at K-band, I tried to minimize its effect by identifying and ignoring antennas that pointed poorly. This was done by having the operator run STUPID for a while and by inspecting the results of a pointing run that had been done a few days previously. Two antennas had noticeable errors (about 45") so they were dropped. Third, phase coherence across the array can be less than perfect in practical integration periods for noisy signals. I used the VECTOR average in ANTSOL for this reason. Although this produced larger residuals in the ANTSOL solution than did the AMPSCALAR average, it also produced larger fluxes (by an average of 8%). I also compared the results with those obtained when imposing UVLIMITs of 4930nsec (about 1500 meters which is about 1/2 of the maximum baseline in the C array). The formal errors decreased slightly, but on the average the fluxes changed negligibly (+0.2%). Hence I give the results for no UVLIMITs and VECTOR averaging.

* Meat comes in three grades: prime, choice, and commercial. (K.Johnston).

The extinction was measured at the default K-band frequency (so that the noise tube values are more likely to be correct). The raw output of the tipping program shows a fair amount of scatter. For example, on 9 August the mean value of the Zenith opacity for If A was 0.134+.029. However, if one uses only the 8 antennas measured in 1985 (and throws out one obviously discrepant value caused by an LO problem), he obtains 0.145+.009, exactly equal to the If C result for these antennas. For 11 August, the value obtained in this way is 0.155+.003.

Perhaps the strongest caution is obtained by comparing the second row of Table 1 with the last row: 3C48 measurements made 36 hours apart. Since 3C48 is a primary calibrator, I assume that it does not really do evil things on a 36 hour timescale. Yet, the values differ very significantly compared with the formal errors: they are scattered by $\pm 15\sigma$ around the mean.

Several factors may contribute to this:

1. 3C286 was at low elevations on both days as was 3C48. (Attributing the difference to extinction requires coefficients more than twice as large as those measured, which I already regard as uncomfortably high.)
2. Gain variation of the telescope may enter. This requires that the telescope gains decrease by 30% while going from 33°.5 to 21° elevation. This seems rather excessive also.
3. Variation of opacity during the night of 11 August looks suggestive since 3C286 was measured at 11PM while 3C48 was measured at 2AM while the sky was, in fact, improving.
4. Noise: one sigma is about 0.05Jy in each determination, so this factor should be negligible.

For lack of a clearer explanation, I have chosen 1 through 3 in a proportion left to the reader to decide. The real conclusion is that the reader should take all this as a caution about the accuracy of his K-band fluxes.

Finally, it is interesting to note that 3C48 should be 1.04Jy at 22460MHz and 1.10Jy at 23660MHz, i.e. the average is 1.07Jy compared with an average measured value of 2.1Jy. Thus, it seems likely that either 3C48 or 3C286 has varied. (Probably both, the way things go.)

TABLE 1

Source	Elevation (degrees)	Flux (Jy) (measured) 22460MHz	Flux (Jy) (measured) 23660MHz	Flux (Jy) (corrected for extinction) 22460MHz	Flux (Jy) (corrected for extinction) 23660MHz
3C286	26	--	--	(2.53)	(2.425)
3C48	23	1.14	1.25	1.7	1.8
0224+671	37.5	.86	.89	1.1	1.1
3C84	41.5	46.0	45.7	57.3	56.9
0355+508	47.5	5.93	5.90	7.2	7.2
0528+134	52.5	2.99	2.94	3.6	3.5
0926+392	71.5	2.84	2.66	3.3	3.1
1226+023	22.5	21.8	24.0	31.9	35.1
3C286	21	--	--	(2.53)	(2.425)
3C345	55	16.1	16.4	19.5	19.8
NRAO530	33	8.36	9.22	11.1	12.3
1741-312	16	0.54	0.61	0.9	1.1
1921-293	25	10.7	12.2	15.4	17.7
2005+403	82	4.97	5.00	5.8	5.8
2134+004	53.5	8.69	8.75	10.5	10.6
BLLAC	73	2.34	2.31	2.8	2.7
2251+158	57.5	12.5	12.7	15.0	15.2
3C48	33.5	1.80	1.77	2.4	2.4