MeerKAT Legacy Local Universe Survey: Verifying the SDP Products for HI imaging

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Introduction

The MeerKAT Legacy Local Universe Survey (LLUS) is a eXtra Large Proposal (XLP) project to observe 133 galaxies within 20 Mpc at a declination below -20° with stellar masses above 10^9 M_{Sun}. The survey will consist of 4.5 hours on source for each target using the 54 MHz, 32k correlator mode of MeerKAT for the HI data. The proposed data reduction plan involves taking the L1 SDP data products from the SARAO archive, doing a uv continuum subtraction, and then imaging the galaxies. This approach differs from other, previous LSPs (e.g. MHONGOOSE, MeerKAT Fornax Survey, LADUMA), which use CARACal to do the calibration and imaging. In this report, we compare the resulting images from the same observation processed in CARACal and from the SDP.

The Data

For this test, we used a single, 5.5 hour MHONGOOSE observation of J0459-26 (NGC 1744). This is a single 5.5 hour track from MHONGOOSE that is processed with CARACal as described in de Blok et al. (2024). We worked with the resulting "r05_t0" cube, which has a beam of 15″x10″ and a velocity resolution of 1.4 km/s. This was our reference cube.

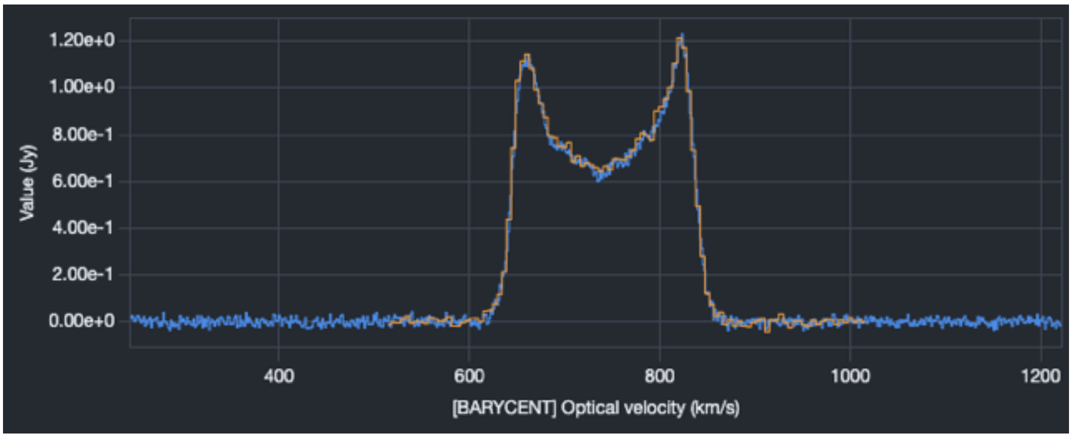
For comparison, we downloaded the L1 data for the same target from CBID 1698263487. These data were acquired on 25-26 October 2023 from 19:52-01:25 UTC. We only downloaded the HH,VV polarizations and channels 22509-27103 (1410-1425 MHz); so a small fraction of the total 107 MHz band used from the observations. The data have native velocity resolution of 0.7 km/s (3.265 kHz).

Imaging

The L1 data were run through the PHANGS imaging pipeline (Leroy et al. 2021), which extracts an even narrower bandwidth of interest of 1415.7-1418.1 MHz, which is then rebinned to 4.8 km/s resolution. We then did a first order continuum subtraction with uvcontsub in CASA and then used CASA's multiscale tclean with frequent major cycles to make a cube with a beamsize of 11"x10". While neither the beam nor the velocity resolution was identical to the MHONGOOSE maps, it is close enough for our purposes here.

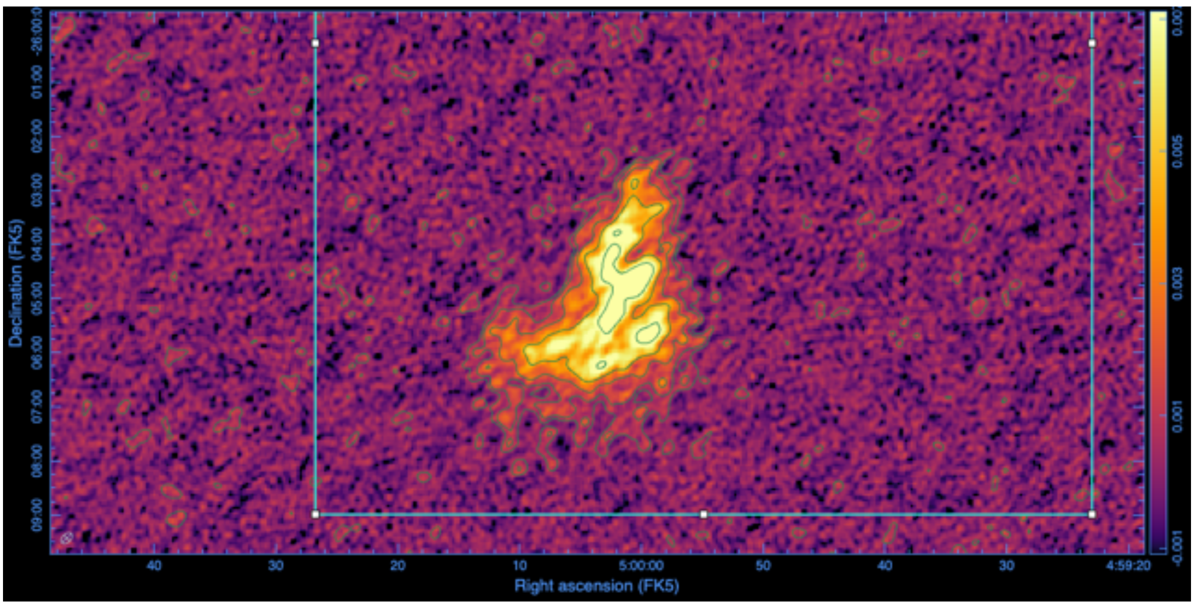
Results

We made three comparisons of the two cubes. In the figure below, the orange line is the SDP product, the blue is the CARACal reduction.



First off, if we compare the global HI profiles, we see that the flux density as a function of velocity for both cubes are consistent within the noise. The integrated profiles agree to within 2%, which is consistent within the noise of the cubes. Secondly, we can see that the baselines for both cubes are at zero indicating good continuum subtraction.

We can further compare the morphology of the two maps, keeping in mind that there will be differences due to the varying resolution of the two reductions. In this case, we share one channel map, where the contours are from the MHONGOOSE cube at the levels of 0.5 mJy/bm+0.5 mJy/bm*2n overlaid on the SDP cube. It is evident that both cubes show the same structures, even at the lowest levels.



Conclusions

Overall, we find that for HI observations over a relatively narrow bandwidth where the source is not too extended nor too bright, the SDP L1 products produce results consistent with a standard data reduction pipeline, such as CARACal.

References

de Blok, W.J.G., et al., 2024, A&A, 688, A109 (https://ui.adsabs.harvard.edu/abs/2024A%26A...688A.109D/abstract)

Leroy, A.K., et al., 2021, ApJS, 255, 19 (https://ui.adsabs.harvard.edu/abs/2021ApJS..255...19L/abstract).