Cold dust in the barred spiral galaxy M83

Abstract

This document summarizes the APEX Large APEX Bolometer Camera (LABOCA) observation in the project 081.C-0827(A) of M83. This nearby barred galaxy is viewed almost face-on and the bar is aligned with the major axis (Lundgren et al 2004). The observations were conducted during June 2008. The atmospheric window of 870 µm, where LABOCA operates, provides the opportunity to study the dust in the interstellar medium and the grain size distribution. The center of the galaxy was clearly detected at a signal to noise level of 47 and the inner spiral arms were detected with a signal to noise level of more than 3.

Overview of Observations

The 870 µm data were obtained with the Large APEX Bolometer Camera (LABOCA, Siringo et al. 2009), a 295-pixel bolometer array for continuum observations, operated at the Atacama Pathfinder Experiment 12 m-diameter telescope (APEX) (Güsten et al. 2006) at Chanjantor, Chile. The observations are centered on the nucleus of M83: 13:37:01 -29:51:58 (J2000) and the field-of-view is 900"x900", but the noise level increases towards the edge.

Source	RA (J2000)	Dec (J2000)	Intensity at the nucleus (mJy/beam)	RMS (mJy/beam)	S/N
M83	13:37:01	-29:51:58	470	10	47

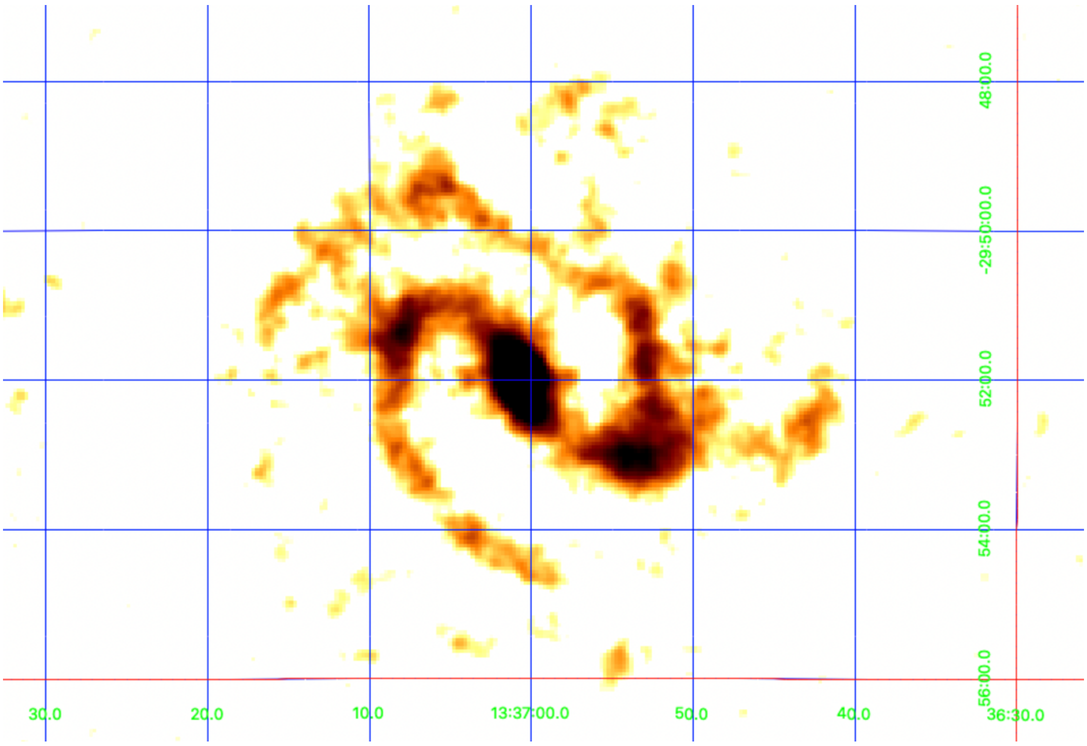

Figure 1: M83 in 870 µm continuum emission. Grey scale ranges from 10 mJy/beam (1 sigma) to 100 mJy/beam (10 sigma, black). At the nucleus the flux is 470 mJy/beam. Beam size is 20.3".

Release Content

The observations were carried during 6 nights between 2008-06-19 and 2008-06-30 and 235 data sets were obtained.
The precipitable water vapor for the individual runs were:

1. 2008-06-19/20, PWV = 0.7 – 1.7 mm, median 0.91 mm, 3.5 h on source
2. 2008-06-20/21, PWV = 0.6 – 1.5 mm, median 1.10 mm, 4.1 h on source
3. 2008-06-21/22, PWV = 1.1 – 1.3 mm, median 1.15 mm, 0.9 h on source
4. 2008-06-23/24, PWV = 0.7 – 1.1 mm, median 0.94 mm, 2.4 h on source
5. 2008-06-28/29, PWV = 0.1 – 0.2 mm, median 0.13 mm, 3.9 h on source
6. 2008-06-29/30, PWV = 0.1 – 0.2 mm, median 0.10 mm, 1.1 h on source

In order to provide a uniform coverage of this relatively large galaxy (about 600” across) the observations were conducted using two different spiral patterns:

- A 2x2 pattern with xlen=ylen=500”, xtsep=ystep=500”, time=30 s
- A 9x9 pattern with xlen=ylen=1000”, xtsep=ystep=500”, time=30 s

Which together created a 13 point regularly spaced (3-2-3-2-3) pattern (see Figure 2) which with ease covers the entire galaxy.

The individual spirals had a start radius of 120 arcsec, a radial velocity of 1.5 arcsec/s, and were alternately conducted in clockwise and anti-clockwise directions. This rendered maps with a constant rms out to a radius of 600”. The total on-source integration time was about 15,9 h and the telescope time was 17.9 hours.

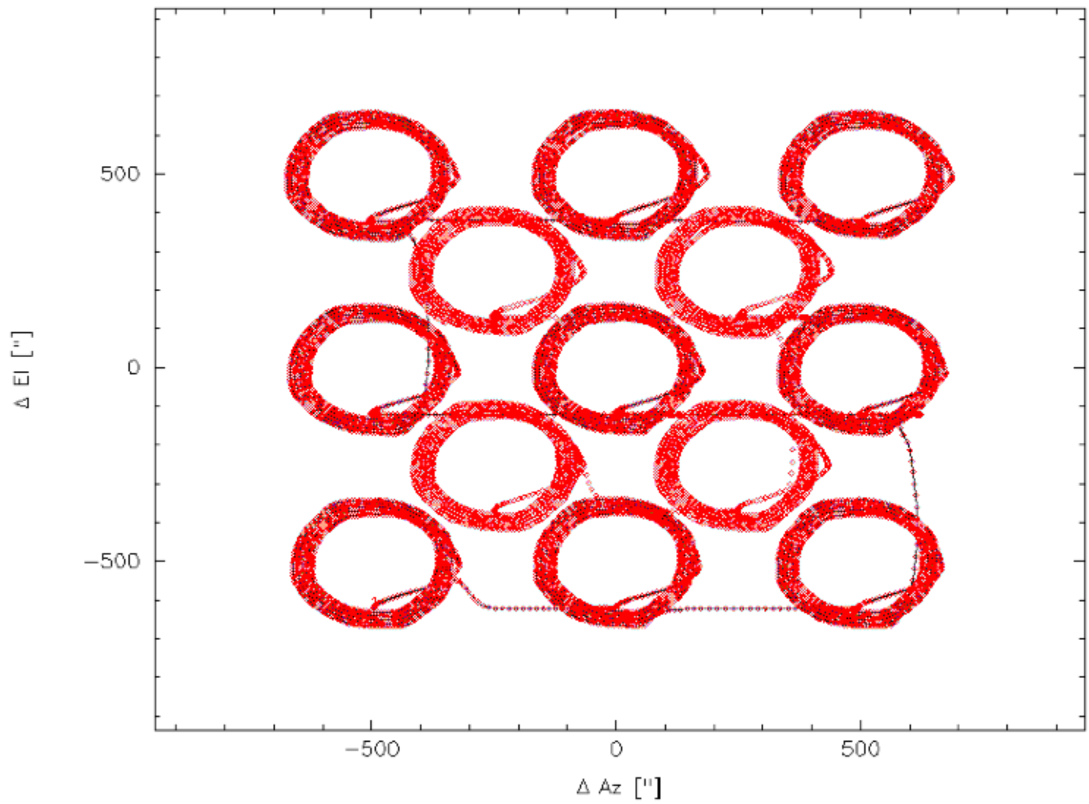

Figure 2: The azimuth vs elevation offset for one of the 295 LABOCA elements.

Release Notes

Data Reduction and Calibration

The flux calibration was done using two methods: skydips and calibrator sources. First, the zenithal opacity at the wavelength of the observations is measured every 2-3 hours, using skydip observations. The opacity is then used to scale the measured fluxes to their values above the atmosphere. Furthermore, primary calibrators (Mars, Uranus and Neptune) as well as secondary calibrators (J1246-258, B13134, and IRAS16293) were observed every 1-2 hours in order to correct for mis-calibration based on the sky opacity only. As a result, the uncertainty on the flux measurements is of the order of 15%.
The astrometry is also checked during the observations by observing nearby quasar J1246-258 every 1-2 hours and the position uncertainty, as measured by the dispersion of the offsets measured on pointing sources, is generally below 2".

The reduction of the LABOCA data has been done using the BoA software (Schuller 2012). The main steps in the data reduction are flagging of bad or noisy bolometers, removal of correlated sky-noise, de-spiking, baseline subtraction, and gridding of the data into a map.

42 maps with obvious problems during data taking or with a map sensitivity above 100 mJy $s^{0.5}$ were dropped.

The remaining images were combined and weighted by the squared rms noise. The resulting map was smoothed by 10" and used as a source model for next round, where positions with a flux greater than a signal-to-noise of 2 were flagged in the time sequence of each data set. This method enables disentangling source emission from skynoise fluctuations. Each stage produced an image, which was used as the next source model. This process was iterated 15 times until the flux and appearance of structures stabilized and difference in total flux between successive maps was less than 2%.

The final map shown in Fig. 1.

Data Quality

The noise level is 10 mJy/beam within a radius of 300", below 15 mJy/beam within a radius of 600", and 20 mJy/beam within a radius of 800". At larger radii the noise level increases rapidly (see Figure 3)

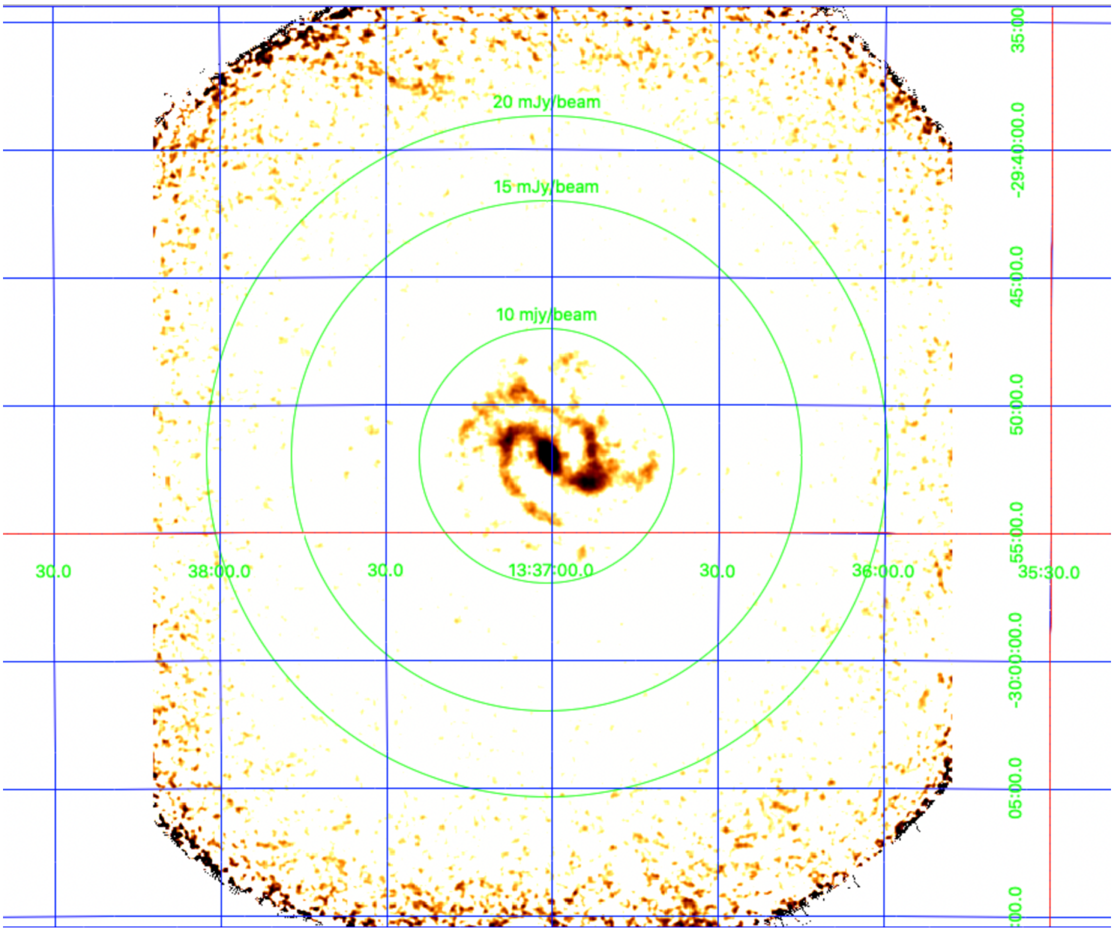

Figure 3: Full field-of-view map of the flux map. The rings indicate within which the noise levels are below 10, 15 and 20 mJy/beam, respectively.

Known issues

Since LABOCA is a total-power instrument and the observations are normally carried out in fast scanning mode, the data reduction relies on the correlated signal form the pixels to estimate and remove both atmospheric and instrumental noise. One drawback of this method is that it acts as a high-pass filter and makes the detection of extended structures (>140") difficult (see discussion in appendix of Belloche (2011)). In the case of M83, which has an extent of 600", a significant part of the total flux is therefore not detected. By comparing to other data, such as Herschel and Planck, we estimate that the LABOCA data detect about half of the total flux.

Previous Releases

No Previous release

Data Format

Files Types

The data set consists of two fits files, the intensity file M83_Flux-Phase3.fits and the noise map M83_RMS-Phase3.fits.

Acknowledgements

Please use the following statement in your articles when using these data:

Based on observations with the APEX telescope under programme ID E-081.C-0827A-2008. APEX is a collaboration between the Max-Planck-Institut fuer Radioastronomie, the European Southern Observatory, and the Onsala Observatory.

This research has made use of the services of the ESO Science Archive Facility.

References

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Belloche, A., Parise, B., Schuller, F., et al., 2011 A&A, 535, A2
Schuller, F. 2012, SPIE, 8452, 84521T