Extragalactic SMA

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Submillimeter Array Advisory Committee Meeting

Wednesday 13th, October 2010
NEARBY GALAXIES: CO 2-1 Mapping

BODEGA: Below 0 DEgree Galaxies (PI D. Espada)

Imaging of CO 2-1 in the central regions (1’) of the ~70 IR brightest nearby galaxies of the southern sky.

Completes the 150 sources with high angular resolution (<5’’) CO observations from surveys in the last 2 decades

SMA Capabilities
Fast 8 antenna mapping of bright objects (2-3 h per source)
NEARBY GALAXIES: CO 2-1 Mapping

BODEGA: Below 0 DEgree Galaxies (PI D. Espada)

Wide variety of morphologies (nuclear arms and bars, rings, and asymmetries)

86% show centrally peaked concentration in 0.5-1kpc scales (55% in BIMA-SONG)

SMA Capabilities
Fast 8 antenna mapping of bright objects (2-3 h per source)
NEARBY GALAXIES: 690 GHz

CO 6-5 Imaging (PI M. Krips)

Challenging observations due to the calibration difficulties at these frequencies…not only for SMA

Planets as gain calibrators. “Semester of oportunity”

\[
\text{CO } J=6-5 \\
E_u \sim 120 \text{ K} \\
N_{\text{crit}} > 10^7 \text{ cm}^{-3}
\]

Densest molecular material…associated with star formation?

SMA Capabilities
Only available facility for high resolution 690 GHz
NEARBY GALAXIES: 690 GHz

CO 6-5 Imaging (PI M. Krips)

Tracing the PDR around star forming sites but significantly enhanced in the presence of an AGN

SMA Capabilities
Only available facility for high resolution 690 GHz
Arp 220 1.3 mm line survey (PI S. Martin)

**Contribution to continuum in 40 GHz Band:**
- CO ~ 9 %
- CO + Other ~30 %

Sakamoto et al. 2008

SMA Capabilities
- 2x2GHz bandwidth
- 10 Half Tracks
- Low resolution (~5")

130 mJy
150 mJy
NEARBY GALAXIES: Chemistry

Arp 220 1.3 mm line survey (PI S. Martin)

More than 70 individual or groups of molecular transitions
15 species and 6 isotopologues
1.8 lines/Ghz = Partially confusion limited
Previously unidentified species: H$_{13}$C$_3$N, H$_2$O, $^{29}$SiO, CH$_2$CO
New detections in Arp220: NS, CH$_3$CCH, SO

HOT CORE CHEMISTRY
Vibrationally excited HC$_3$N and CH$_3$CN
Large Abundance of H$_2$O similar to that in Galactic hot cores

SMA Capabilities
2x2GHz bandwidth
At the time of the Survey

10 Half Tracks
Low resolution (~5")
NEARBY GALAXIES: Chemistry

Arp 220 1.3 mm line survey (PI S. Martin)

P-Cygni profiles at high angular resolution observations of HCO⁺ “OUTFLOWING MATERIAL”

Sakamoto et al. 2008

Sakamoto et al. 2009
BRI 0952 -0115 @ z=4.4337 (PI R. Maiolino)

Fine structure line [CII] at 158 um is generally the brightest emission line in galaxies.

Tool to detect star forming galaxies at high-z. BUT the $L_{[CII]}/L_{FIR}$ drops for $L_{FIR} > 10^{11.2} L_\odot$.

APEX first detection for a high-z source of $L < 10^{13} L_\odot$.

SMA Capabilities
System+Atmospheric stability
To detect faint high-z sources.
High Z: [CII]

BRI 0952 -0115 @ z=4.4337 (PI R.Maiolino)

SMA Capabilities

System+Atmospheric stability
To detect faint high-z sources

SMA confirmation using SC+C
Resolved out in VEX

SMA Capabilities
High Z: Spatially resolved

SMMJ2135-0102 (Eyelash) @ $z=2.3259$ (PI M. Swinbank)

**LENSING**
Galaxy magnification
Source stretching

Intrinsic 870 um flux $\sim 3$ mJy
Lense magnification $\sim 32$
Observed 870 flux = 106 mJy

Brightest SMG at that time

SMA beam 0.3”x0.2”
8 components

**SMA Capabilities**
High Resolution +
System Stability
High Z: Spatially resolved

SMMJ2135-0102 (Eyelash) @ z=2.3259 (PI M. Swinbank)

SMA imaging allowed source 4 components reconstruction

Luminosity density of SF regions:
- x100 brighter than GMC
- ~consistent with GMC cores

SMA Capabilities
High Resolution + System Stability
High Z: Bright SMG population

South Pole Telescope SMGs (PI D. Marrone)

1000 deg$^2$ SPT survey discovered a large number of extragalactic sources

1 order of magnitude than regular SMGs

9 detected with the SMA

Accurate astrometry is key to determine counterparts at other wavelengths

SMA Capabilities
Observing at dec~50°
High Z: Bright SMG population

South Pole Telescope SMGs (PI D. Marrone)

Evidence of lensing of these sources responsible for their brightness.

7.4”x1.4” restored with 1.4” beam

z=3.34 (VLT)

SMA Capabilities
Observing at dec~ -50°
Target of Opportunity: GRBs

GRB: Target of Opportunity at the SMA (PI S. Martin)

Sari et al. 1998
Willingale et al. 2004

Compact source releasing $10^{53}$ ergs within seconds

A forward shock ploughs into the medium producing the “afterglow” as the material decelerates.

Synchrotron Emission

SMA could catch the passing maximum at 345 GHz.
GRB: Target of Opportunity at the SMA (PI S. Martin)

April 19th

On April 18th 21:10 UT Swift Burst Alert Telescope triggered and located GRB 100418A

SMA observations started in April 19th 13:00 UT, two hours after the scheduler was informed.

Resulted to be the brightest submm flux ever detected for a GRB with 14 mJy
On April 18th 21:10 UT Swift Burst Alert Telescope triggered and located GRB 100418A. SMA observations started in April 19th 13:00 UT, two hours after the scheduler was informed. Resulted to be the brightest submm flux ever detected for a GRB with 14 mJy. It was followed down to 3.4 mJy, being the most detailed submm follow up of a GRB.