I am 許博智 from NCU, I am in the AGN group of Radio Astronomy Cource in NTNU. For the SMA observation target, we plan to change to NGC 7479 (ICRS coordinate is 23 04 56.64 +12 19 22.35), whcih is a Seyfert 2 galaxy. This target have similar redshift (Z~0.007) with the one (NGC 1386, z~0.003) i previos found. Therefore, integration time of the source will still be 2 hours.

Sub-mm Broad Band Emission Line Observation of NGC 1386 by SMA

Po Chih Hsu, Ching-Fang Chen, and Chun-Yu Ku

We propose SMA observations with extended array configuration (EXT) towards NGC 1386, which is a Seyfert 2 galaxy found from Maia, Machado & Willmer (2003). We would like to investigate how the carbon monoxide (CO) molecular associate with the center region of the galaxy. The detailed observational setup and analysis plan are explained in the following:

Target sources and ancillary data. NGC 1386 has angular size of 3.4' × 1.3', however, in this study, we only focus on the most center region of this Seyfert galaxy. NGC 1386 has z = 0.003810 (HIPASS collaboration), which distance is about 16.80 Mpc. With small redshift, meaning that this galaxy is located in the local Universe. Nevertheless, it haven't been observed by SMA 230 GHz before.

Gomez-Guijarro et al. compared the morphologies of nearby active galactic nuclei of their sizes measured by Chandra soft x-ray and narrow line region by Hubble Space telescope [O III]. The set of NGC 1386 from Gomez-Guijarro et al. are shown in figure 1. However, CO molecular gas morphology around the core was still remain unclear.

Spectral setup. By using SMA EXT configuration, it is likely to spatially resolve the galaxy we proposed to observed. We propose to use the spectral set up of $LO_{R\times A}$ = 230 GHz and $LO_{R\times B}$ = 230 GHz. This spectral setup will cover multiple CO emission lines ranging from 219 GHz, i.e., ^{18}CO(2-1) to 230 GHz, i.e., ^{12}CO(2-1).

Angular resolution. The expected angular scales of the central region is about 6" × 10", which region is less than 0.8 kpc ($R \lesssim 0.8$ kpc). The angular resolution is about 1.47" at 230 GHz. The maximum angular recoverable angular scale is about 24.81".

Observing time. We found a similar redshift Seyfert galaxy, which is NGC 3227 (z = 0.003763, from Haynes et al.), showing distance of 16.6 Mpc. Gomez-Schinnerer, Eckart & Tacconi measured the ^{12}CO(1-0) and ^{12}CO(2-1) lines of NGC 3227 in 1997 January and February, by using IRAM PdB interferometer (PdBI) with 5 antennas in differnet configurations, providing 30 baselines, which distance ranging from 40 to 408 m. For ^{12}CO(2-1) line measurement, they have angular resolution of 0.7" × 0.5" at λ=1.3 mm (230 GHz). After cleanning procedure, they reconvolved data with a CLEAN beam of FWHM 0.6" for the ^{12}CO(2-1). The integrated intensity maps (moment-zeroth maps) of the ^{12}CO(1-0) and ^{12}CO(2-1) of NGC 3227 are shown in figure 2.

By owing peak integral intensity (9.18 Jy beam^{-1} km s^{-1}) of ^{12}CO(2-1) from the right panel of figure 2, with beam size of 0.6", we could estimate source intensity of our own. We multiply peak integral intensity with the ratio of our beam area with them, and divided by the bandwidth of their observation, which is 364 km s^{-1}. The estimate intensity of our source is about 147 mJy.

With SMA EXT configuration, we set hour angle of our source stars from -3 hours, and ends at +3 hours, the total on-source time is about 4.02 hr (including observation time, and calibration time).. With bandwidth of 100 km s^{-1}, expected sensitivity is about 10.8 mJy/beam. Detail information of the beam calculation and sensitivity estimation can be seen at figure 3, which is obtain from

Table 1: Observation time estimation.

Source name	RA, DEC (ep=J2000)	Expected intensity (mJy/beam)	Estimated Observation Time (min)
NGC 1386	00 48 47.14, +31 57 25.043	147	90 (SNR = 8)

SMA Multi-config Beam Calculator & Sensitivity Estimator). To fulfill at least 8σ detection of the ^{12}CO(2-1) at 100 km s^{-1}, we request 90 minutes on-source observation time, with expected noise intensity about 10.8 mJy/beam.

Table 1 list out the information of NGC 1386, including ICRS coordinate (ep=J2000), source expected intensity, and estimated observation time.

Reference

[1] Maia, Machado & Willmer, 2003, ApJ, 126, 1750
[2] HIPASS collaboration, 2004, MNRAS, 350, 1195
[3] Gomez-Guijarro et al., 2017, MNRAS 469, 2720
[4] Gomez-Schinnerer, Eckart & Tacconi, 2000, ApJ, 533, 826
[5] Haynes et al., 2018, ApJ, 861, 49

Figure 1: A set of image of NGC 1386 taken by Chandra Space Telescope and Hubble Space Telescope (HST) from Gomez-Guijarro et al. figure 1. Top left panel is Chandra soft X-ray contours overlap with HST [O III] image; top middle panel is Chandra soft X-ray overlap with HST continuum images; top right panel is HST [O III] contours overlap with HST [O III]+continuum images. Bottom left panel is Chandra soft X-ray contours overlap with HST [O III]+continuum image; bottom middle panel is HST [O III] contours overlap with HST continuum images; bottom right panel is Chandra hard X-ray contours overlap with Chandra soft X-ray images

Figure 2: The integrated intensity maps of the ^{12}CO(1-0) and ^{12}CO(2-1) of NGC 3227 from Haynes et al. figure 1. Left panel shows moment-zeroth map of ^{12}CO(1-0); right panel displays the moment-zeroth map of ^{12}CO(2-1). The contours in the right panel is the ^{12}CO(2-1) map at a resolution of 0.6" are in 5, 10, 20 to 100%, with the peak intensity of 9.18 Jy beam^{-1} km s^{-1}.

Figure 3: Expected beam estimation and noise level of NGC 3227 from SMA Multi-config Beam Calculator & Sensitivity Estimator.