ALMA Astrometry of the Nuclear Star Cluster

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Atacama Large Millimeter/Submillimeter Array (ALMA) is promising to be a powerful tool for precision astrometry of the area around Sagittarius A* (Sgr A*) because of it's high angular resolution, high sensitivity, and wide field of view.

We have observed the area around Sgr A* including the Nuclear Star Cluster at 230 GHz with ALMA in October 2017. The angular resolution is ~0.03". We determined the positions relative to Sgr A* of ~70 compact objects in the area with the accuracy of ~0.001". We also analyzed the similar ALMA archival data obtained in June 2019. We determined the relative positions in these objects (**see Fig.1**) and derived the proper motions relative to Sgr A* by comparing these positions. The positions and proper motions are almost consistent with those by previous infrared observations. The derived proper motions are roughly described with both clockwise and counterclockwise rotations around Sgr A* **(see Fig.2).** The rotation velocities are reproduced by Kepler orbits bounded around Sgr A* without a few exceptions. Moreover, they include co-moving clusters for example IRS13E and IRS13N **(see Fig.3).** Therefore, they demonstrate that ALMA is a powerful tool for precision astrometry of the area. (see PASJ https://doi.org/10.1093/pasj/psac031)

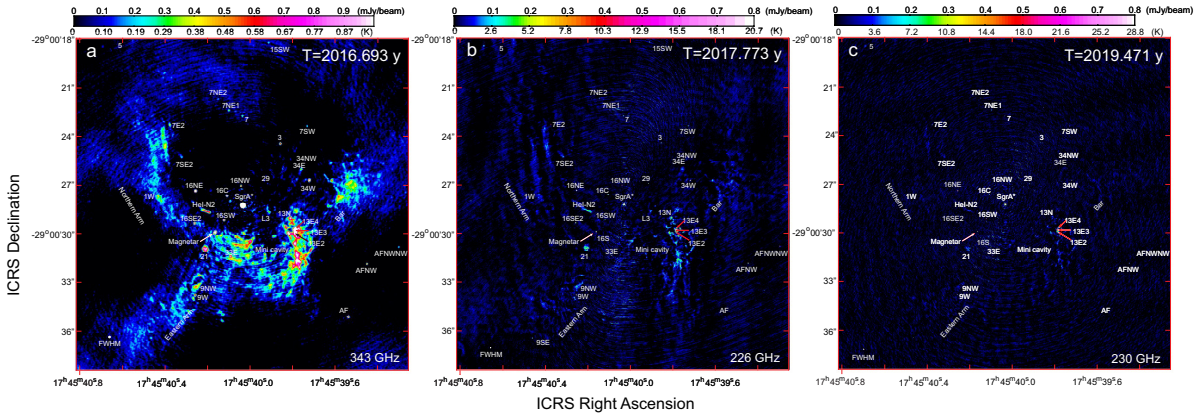

Fig.1. a Continuum map using Briggs weight at 343 GHz around Sgr A* in the ALMA Cy.3 program (2015.1.01080.S.) (see Tsuboi2017). The angular resolution is 0.107"x0.101" in FWHM. This is a finding chart of the objects around Sgr A*. **b** Continuum map using natural weight at 226 GHz around Sgr A* in the ALMA Cy.5 program (2017.1.00503.S.) (see Tsuboi2019). The angular resolution is 0.037"x0.025" in FWHM. **c** Continuum map using natural weight at 230 GHz around Sgr A* in the ALMA Cy.6 program (2018.1.001124.S.PI Murchikova, L.) (see Tsuboi2022). The angular resolution is 0.035"x0.023" in FWHM. The derived positions of these compact objects are shown in Tsuboi2022.

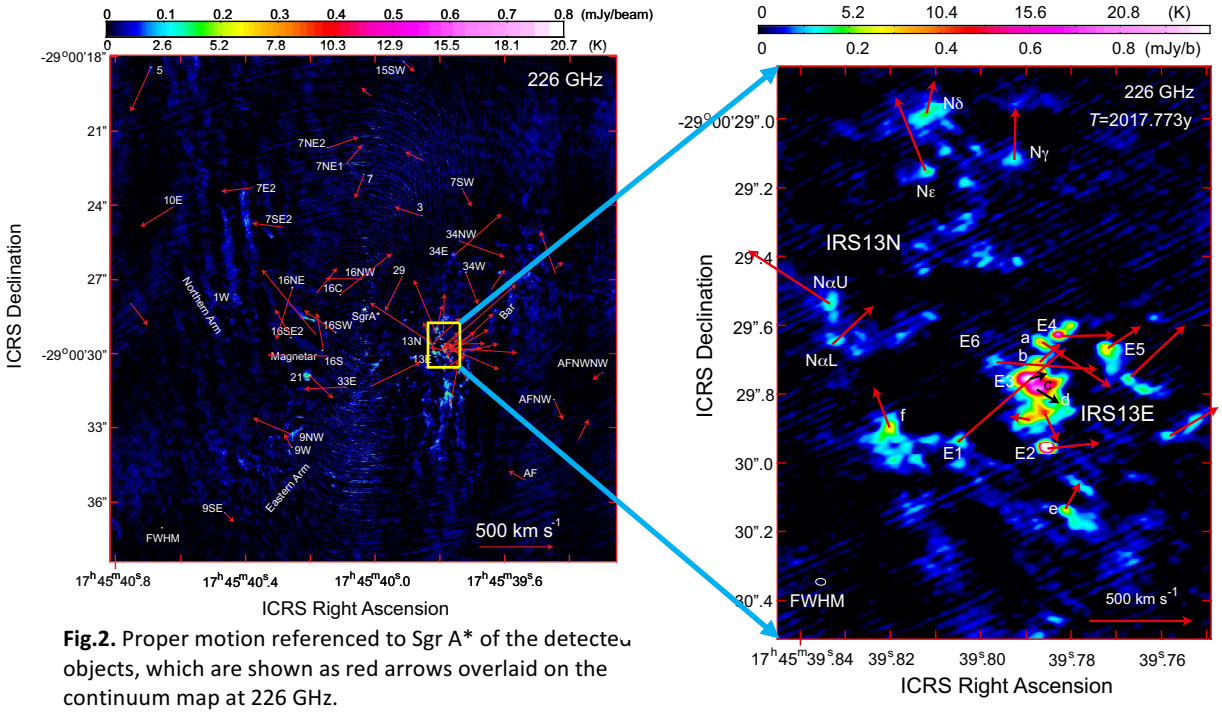

Fig.2. Proper motion referenced to Sgr A* of the detected objects, which are shown as red arrows overlaid on the continuum map at 226 GHz.

Fig.3 Proper motion of the Galactic Center IRS13E and IRS13N clusters, which are shown as red arrows overlaid on the enlarged continuum map at 226 GHz. The mean proper motion of the IRS13E cluster except IRS13E3 and IRS13Ec is estimated to be V_{Ra}= -218+/-30 km/s and V_{Dec}=73+/-30 km/s. On the other hand, the mean proper motion of the IRS13N cluster is estimated to be V_{Ra} =60+/-210 km/s and V_{Dec}=274+/-76 km/s.

References

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