Galaxies at High Redshift and Their Evolution Over Cosmic Time
Proceedings IAU Symposium No. 319, 2015
S. Kaviraj, ed.

doi:10.1017/S1743921315010327

Dusty Starbursts within a z=3 Large Scale Structure revealed by ALMA

Hideki Umehata[1,2]

[1]European Southern Observatory, Karl-Schwarzschild-Str. 2, D-85748 Garching, Germany
email: humehata@eso.org

[2] Institute of Astronomy, School of Science, The University of Tokyo, 2-21-1 Osawa, Mitaka, Tokyo 181-0015, Japan

Abstract. The role of the large-scale structure is one of the most important theme in studying galaxy formation and evolution. However, it has been still mystery especially at $z > 2$. On the basis of our ALMA 1.1 mm observations in a $z \sim 3$ protocluster field, it is suggested that submillimeter galaxies (SMGs) preferentially reside in the densest environment at $z \sim 3$. Furthermore we find a rich cluster of AGN-host SMGs at the core of the protocluster, combining with Chandra X-ray data. Our results indicate the vigorous star-formation and accelerated super massive black hole (SMBH) growth in the node of the cosmic web.

Keywords. galaxies: evolution, cosmology: large-scale structure of universe

1. Summary

We conducted ALMA observations to discover dusty starburst galaxies in SSA22. In this field a remarkable large-scale structure (across ∼1 deg) has been found at $z = 3.09$, which makes the field an unique laboratory to investigate galaxy formation and evolution at biased fields in the early universe. First we have conducted a 1.1 mm continuum follow-up of 45 SMGs discovered by the 1.1 mm AzTEC/ASTE survey (Umehata *et al.* (2014)) with ALMA in its Cycle 1 (PI. Umehata). We have achieved 1σ sensitivity of 0.07–0.16 mJy beam^{-1} and angular resolution of $0.6''$ to find 64 discrete sources with S/N$\geqslant$4.5. Second in ALMA Cycle 2 we have carried out a contiguous $2' \times 3'$ mapping observation at 1.1 mm (PI. Umehata) achieved by 103 point mosaic. The observations are done in several nights in 2014 and 2015. We observed 80 pointing fields in 2014 and the obtained image have 1σ sensitivity of 0.066–0.070 mJy beam^{-1} and angular resolution of $0.5''$, which allows us to detect dusty star-forming galaxies with $\mathrm{SFR_{IR}} \sim 60 M_{\odot}$/yr (if we assume β=1.5, Tdust=40 K, and Chablier IMF) at $z = 3.09$.

For the 64 SMGs discovered by the Cycle 1 survey, we extracted $z = 3.09$ candidate SMGs on the basis of optical to near-infrared photo-z and calculate the surface number density of $z = 3.09$ LAEs, selected by a narrow-band image, at the SMG position to define the local density environment. We compared our results with ECDF-S, which is a general field, and found that the SMGs preferentially reside in the most dense environment at $z \sim 3$. Furthermore we find a rich cluster of X-ray luminous ALMA sources at the core of the protocluster, composed of seven objects with spec-z/photo-$z = 3.09$, in the "ALMA Deep Field in SSA22". Our results indicate that environment can be a key factor on the formation of dusty starbursts and the growth of SMBHs within them.

Reference

Umehata, H., Tamura, Y., Kohno, K., *et al.* 2014, *MNRAS*, 440, 3462