Discovery of an Excess of Hα Emitters around 4C+23.56 at z = 2.49

TANAKA, Ichi, KODAMA, Tadayuki (NAOJ)
BREUCK, Carlos De, VENEMANS, Bram, VERNET, Joël (European Southern Observatory)
KURK, Jaron D. (Max-Planck-Institut für extraterrestrische Physik)
TANIGUCHI, Yoshiaki (Ehime University)
KAJISAWA, Masaru (Tohoku University / Ehime University)
ICHIKAWA, Takashi (Tohoku University)
MATSUDA, Yuichi (University of Durham)
PACKHAM, Chris (University of Florida)
ZIRM, Andrew (University of Copenhagen)
SEYMOUR, Nick (UCL)
STERN, Daniel (Jet Propulsion Laboratory)
STOCKTON, Alan (University of Hawaii)

1 Aim and Method

Most of massive galaxies in clusters generally show no structure with homogeneously red color. It has been shown from the studies of stellar populations that they are formed through the intense star-formation that happened at $z > 2$, then evolved passively until today. Therefore, we may be able to observe the site of major star-formation on the progenitors of such massive cluster galaxies directly if we go and find protoclusters lying at the redshifts of 2 to 4.

However, the number of known protoclusters are still small. Especially, the number of those lying at $2 < z < 2.7$ where we can observe their Hα emission from the ground is only a few. Availability of Hα emission is important because it is the best tracer of the star-formation activity. Hα emission is one of the most familiar lines for astronomy and so it is well-calibrated through a large number of histric studies. It is much less affected by dust extinction compared to the UV continuum or Lyα emission which we use to explore the very distant universe.

In order to find the formation site of cluster galaxies in the act, we embarked a survey of massive star-forming galaxies in the putative protocluster lying around the radio galaxy 4C+23.56 at z = 2.5, one of the most distant object which we can observe the redshifted Hα from the ground. We choose the field because 4C+23.56 was once suggested to have a possible protocluster[2,3]. To enable detecting the redshifted Hα emission at z = 2.48, we employed a custom-made narrowband filter and installed it into MOIRCS instrument on Subaru Telescope. The observation was carried out making use of the observatory time. The field had a deep *Spitzer* MIPS mid-infrated data in the archive. We used the MIPS 24 μm photometry data for supplementary purpose, because it is the independent probe of the star-formation and works even under extreme dust extinction.

2 Results

We have found 11 candidate Hα emission-line galaxies (hereafter HAEs) to a flux limit of $\sim 7.5 \times 10^{-17}$ erg s^{-1} cm^{-2}[1]. This is about 5 times more than expected from the field counts. The distribution of HAEs on the sky is tightly confined to a 1.2-Mpc-radius area at z = 2.49. Contrary to the usual assumption, 4C+23.56 is situated at the western edge of the emitter distribution and not at the center. Analysis of the MIPS 24 μm imaging also shows that there is about 2.5 times more faint sources. All but two of the 11 HAEs are also found in the MIPS data. The inferred star-formation activity in the proto-cluster from those dataset is very high, with the median SFR a few 100 $M_{\odot}$ yr^{-1}. What is more, most of those extreme star-forming galaxies are quite massive ($> 10^{11} M_{\odot}$). It is quite rare that we observe such intense star-formation on a number of massive galaxies in cluster core region at $z <$ 1.5. This suggests that we may be witnessing the very end stage of massive cluster galaxy formation. The area will serve the ideal targets for science with ALMA.

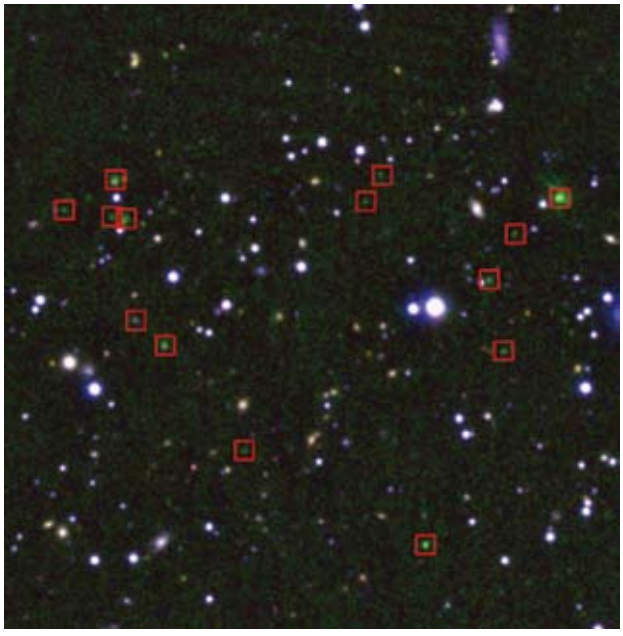

Figure 1: The Hα emitters discovered around 4C+23.56 (green objects with red open boxes). A part of the MOIRCS FOV is shown. Reproduced from our press release at http://subarutelescope.org (Feb 1, 2011).

References

[1] Tanaka, I., et al.: 2011, *PASJ*, **63S**, 415.
[2] Knopp, P., Chambers, C.: 1997, *ApJS*, **109**, 367.
[3] Kajisawa, M., et al.: 2006, *MNRAS*, **371**, 577.