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Environmental dependence of galaxy formation explored by near-infrared spectroscopy of two protoclusters at z>2

Rhythm Shimakawa[1,2], Tadayuki Kodama[2,3], Ken-ichi Tadaki[3], Masao Hayashi[3], Yusei Koyama[4] and Ichi Tanaka[1]

email: rhythm@naoj.org
[1]Subaru telescope, National Astronomical Observatory of Japan
650 North A′ohoku Place, Hilo, HI 96720, USA
[2]Department of Astronomy, School of Science, Graduate University for Advanced Studies
Mitaka, Tokyo 181-8588, Japan
[3]Optical and Infrared Astronomy Division, National Astronomical Observatory
Mitaka, Tokyo 181-8588, Japan
[4]Institute of Space Astronomical Science, Japan Aerospace Exploration Agency
Sagamihara, Kanagawa, 252-5210, Japan

Abstract. Protoclusters at high redshifts are the ideal laboratories to study how the environmental dependences of galaxy properties seen in local Universe were initially set up when the progenitors of present-day early-type galaxies were in their early formation phases. We have conducted a deep near-infrared spectroscopy of Hα emitters (HAEs) associated with two protoclusters (PKS 1138–262 at $z=2.16$ and USS 1558–003 at $z=2.53$) with the Multi-Object Infrared Camera and Spectrograph (MOIRCS) on the Subaru telescope.

As a result, the cluster membership of 27 and 36 HAEs are newly confirmed in these two protoclusters, respectively. The inferred dynamical masses of the protocluster cores are consistent with being the typical progenitors of present-day most massive clusters (Shimakawa *et al.* 2014a). Also, those HAEs in the protoclusters show much higher [OIII]/Hβ ratios than local star forming galaxies. It is probably caused by the combination of their much higher specific star formation rates, lower gaseous metallicities and redshift evolution of inter-stellar medium.

We also find that the mass-metallicity relation in the protocluster galaxies is offset to higher metallicity compared to those of field galaxies at a given stellar mass at $M_\star < 10^{11} M_\odot$ (Shimakawa *et al.* 2014b). This trend is compatible with the recent work (Kulas *et al.* 2013). The mass-metallicity relation is regulated not only by star formation history hence metal production history, but also by inflow and outflow processes that are known to be very active at $z>2$ (Steidel *et al.* 2010). It suggests that the higher gaseous metallicities of protocluster galaxies may be caused by those gas transfer processes that are dependent on surrounding environments.

Keywords. galaxies: clusters: general — galaxies: evolution — galaxies: formation

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