Near-infrared spectroscopy of massive star-forming galaxies at $z \simeq 2$

ONODERA, Masato (ETH Zürich)
ARIMOTO, Nobuo (NAOJ/GUAS)
DADDI, Emanuele (CEA-Saclay)
RENZINI, Alvio (INAF-Padova)
KONG, Xu (USTC, China)
CIMATTI, Andrea (Università di Bologna)
BROADHURST, Tom (University of Basque Country)
ALEXANDER, Dave M. (Durham University)

We have obtained near-infrared (near-IR) spectra of a sample of *BzK*-selected, massive star-forming galaxies (*sBzK*s; [1]) at $1.5 < z < 2.3$ that were obtained with OHS/CISCO at the Subaru telescope and with SINFONI at the VLT[2]. Among the 28 *sBzK*s observed, Hα emission was detected in 14 objects, and for 11 of them the [N II] λ6583 flux was also measured. Multiwavelength photometry[3] was also used to derive stellar masses and extinction parameters, whereas Hα and [N II] emissions have allowed us to estimate star-formation rates (SFR), metallicities, ionization mechanisms, and dynamical masses.

In order to enforce agreement between SFRs from Hα with those derived from rest-frame UV and mid-infrared, additional obscuration for the emission lines (that originate in H II regions) was required compared to the extinction derived from the slope of the UV continuum.

We have also investigated the stellar mass-metallicity relation (Figure 1), as well as the relation between stellar mass and specific SFR (SSFR), and compared them to the results in other studies. At a given stellar mass, the *sBzK*s appear to have been already enriched to metallicities close to those of local star-forming galaxies of similar mass. At the similar redshift range, the *sBzK*s presented here tend to have higher metallicities compared to those of UV-selected galaxies, indicating that near-infrared selected galaxies tend to be a chemically more evolved population.

The *sBzK*s show SSFRs that are systematically higher, by up to ~ 2 orders of magnitude, compared to those of local galaxies of the same mass. The relation between SSFR and stellar mass of Hα detected sample is consistent with that for so-called main-sequence star-forming galaxies at $z \simeq 2$ derived through multiwavelength SED modeling[4] and radio stacking analysis[5] with a couple of outliers reaching very high SSFRs similar to those of submillimeter selected galaxies which are thought to be in violent star-forming phases driven by stochastic events like major merger.

The empirical correlations between stellar mass and metallicity, and stellar mass and SSFR are then compared with those of evolutionary population synthesis models[6] constructed either with the simple closed-box assumption, or within an infall scenario. Within the assumptions that are built-in such models, it appears that a short timescale for the star-formation ($\simeq$100 Myr) and large initial gas mass appear to be required if one wants to reproduce both relations simultaneously.

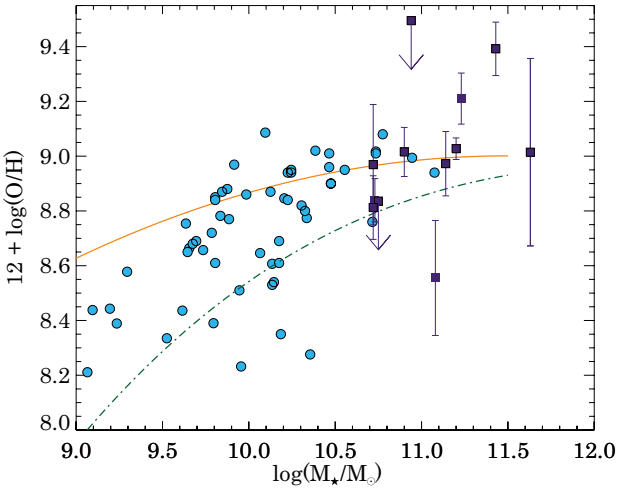

Figure 1: Mass-metallicity relation for sBzK galaxies in this study (filled square) compared with UV-selected $z \simeq 2$ galaxies (green dot-dashed line; [7]), $z \simeq 0.7$ galaxies (cyan circles; [8]), and local galaxies from SDSS (orange solid line; [9]).

References

[1] Daddi, E., et al.: 2004, *ApJ*, **617**, 746.
[2] Onodera, M., et al.: 2010, *ApJ*, **715**, 385.
[3] Kong, X., et al.: 2006, *ApJ*, **638**, 72.
[4] Daddi, E., et al.: 2007, *ApJ*, **670**, 156.
[5] Pannella, M., et al.: 2009, *ApJ*, **698**, L116.
[6] Fioc, M., Rocca-Volmerange, B.: 1997, *A&A*, **326**, 950.
[7] Erb, D. K., et al.: 2006, *ApJ*, **644**, 813.
[8] Savaglio, S., et al.: 2005, *ApJ*, **635**, 260.
[9] Tremonti, C. A., et al.: 2004, *ApJ*, **613**, 898.