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DEIMOS and MOSFIRE spectroscopy of star-forming galaxies in the AKARI NEP-Deep field

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Abstract. Observing high resolution optical to infrared spectra is crucial to understanding how energy is generated in galaxies. We present follow-up optical Keck-II/DEIMOS and infrared Keck-I/MOSFIRE spectra of ∼200 galaxies in the AKARI/North Ecliptic Pole Deep survey region at intermediate redshift. From rest-frame optical emission lines, we classify most of our objects as star-forming (53%), with the MIR selection favoring relatively massive galaxies (median log $M/M_{\odot}\sim10.3$). In addition, we combine our spectroscopic redshifts with UV to FIR photometry as inputs in order to model SEDs with CIGALE, and we measure the PAH 7.7 μm luminosity as an SFR indicator.

Keywords. techniques: spectroscopic, galaxies: evolution, infrared: galaxies

1. Introduction

The AKARI North Ecliptic Pole (NEP) Deep Field is a unique region with continuous 2-24 μm coverage in ∼0.5 square degrees from the Infrared Camera (IRC), providing crucial mid-infrared data of the dust-obscured universe out to $z\sim1$ (Murata *et al.* 2013, Oi *et al.* 2014). We present optical to NIR spectroscopic results of ∼200 galaxies in the NEP-Deep field, combining Keck-I/MOSFIRE J- and Y-band and Keck-II/DEIMOS observations. DEIMOS targets prioritized intermediate redshift ($z\sim1$) sources with AKARI/IRC photometry and Chandra X-ray sources to include possible (obscured) AGN. MOSFIRE targets prioritized strong emission line galaxies with previous optical spectroscopy and AKARI sources in the range $0.7<z<1.1$ in order to measure Hα/[NII]. In addition, we used the Y-band to target Hα/[NII] sources at $0.5<z<0.8$.

2. Source Classification

Most of our DEIMOS galaxies on the BPT classification diagram (Fig. 1, left) lie along the star-forming sequence (53%) with 30% composite, 4% Seyfert, and 13% LINERs. In comparison, the sample of AKARI NEP-Wide galaxies (Shim *et al.* 2013, median $z\sim0.24$

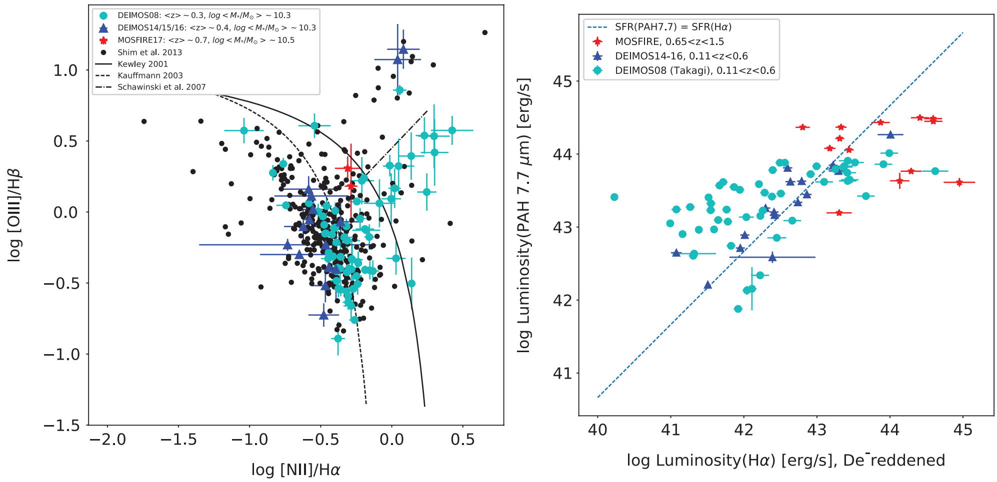

Figure 1. Left: BPT-NII source classification diagram. Right: PAH 7.7 μm luminosity vs. the dust-corrected Hα luminosity for combined DEIMOS and (higher z) MOSFIRE sample.

on BPT) contains a smaller fraction of AGN. Our IR-selected sample contains relatively massive galaxies. Although not shown here, the BPT diagram was consistent with the Mass-Excitation Diagram ([OIII]/Hβ vs. stellar mass).

3. Spectral Energy Distributions and PAH Luminosity Estimates

We combined our spectroscopic redshifts with UV to FIR photometry in order to model SEDs with CIGALE. We assumed a delayed star formation history with exponential burst, Salpeter IMF, and solar metallicity for the stellar model. Key parameters that were allowed to vary included color excess E(B-V) of the young stellar population (0–1.6), mass fraction of PAH dust (0.47–4.58), and AGN fraction (0–0.4).

In order to investigate the PAH 7.7 μm feature as a SF indicator, we compare the PAH 7.7 luminosity from CIGALE best fits to the de-reddened Hα luminosity (Fig. 1, right) assuming the Calzetti *et al.* (2000) extinction law and E(B-V) from CIGALE for our combined DEIMOS S11 (z~0.5) and MOSFIRE L15 (z~1) sample. The dashed line represents the luminosity relation such that SFR(PAH7.7)=SFR(Hα), where SFR(PAH7.7) [$M_\odot$/yr] = 4.56×10^{-9} L(PAH7.7) [$L_\odot$] (Hernán-Caballero *et al.* 2009) and SFR(Hα) [$M_\odot$/yr] = 5.49×10^{-42} L(Hα) [erg/s] (Kennicutt *et al.* 2009). Our limited MOSFIRE points at z~1 (red stars) cannot determine how the SFR(PAH7.7)/SFR(Hα) correlation evolves from low z to z>1, highlighting the need for further data.

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