Optical IFU observations of GOALS sample with KOOLS-IFU on Seimei Telescope: Initial results of nine U/LIRGs at z < 0.04

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Introduction

- Star formation and AGN activity in galaxies are often caused by galaxy mergers.
- AGN-driven outflows may affect the growth of galaxies and their supermassive black holes (SMBHs).
- Recent observations reported that IR luminous AGN often shows strong ionized gas outflows.

➢ **Follow-up observation of GOALS sample with KOOLS-IFU Okayama 3.8 m Seimei Telescope.**
Identifying how galaxy mergers affect the strength of ionized gas outflows.

Data

- 9 objects were selected from the GOALS sample.
- Merger classification provided by Stierwalt et al. 2013 (A-D).
- KOOLS-IFU (VPH 495 and VPH 683 grisms)
  VPH 495: $4300 - 5900$ Å, $R{\sim}1500$
  VPH 683: $5800 - 8000$ Å, $R{\sim}2000$

(before 2020/Sep.)

Number of fibers	127
FoV of a fiber	0.93 ± 0.04 arcsec diameter (design: 0.91 arcsec)
Fiber pitch	1.16 ± 0.05 arcsec (design: 1.14 arcsec)
Total FoV	15.1 ± 0.7 arcsec diameter (design: 14.8 arcsec)
Fiber core filling factor	58%

http://www.o.kwasan.kyoto-u.ac.jp/inst/p-kools/performance/index.html

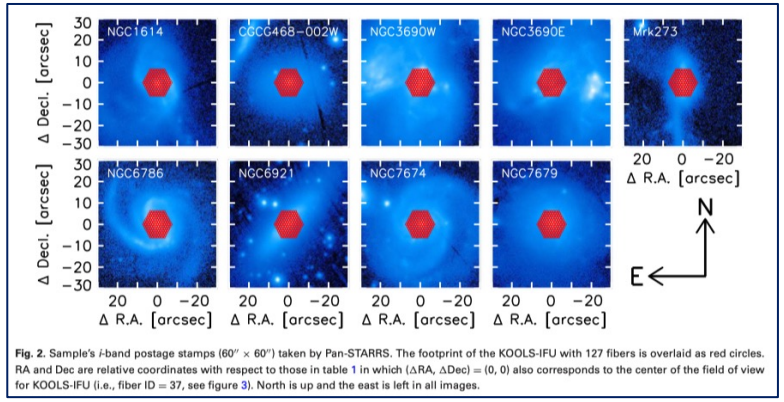

Fig. 2. Sample's *i*-band postage stamps (60″ × 60″) taken by Pan-STARRS. The footprint of the KOOLS-IFU with 127 fibers is overlaid as red circles. RA and Dec are relative coordinates with respect to those in table 1 in which (ΔRA, ΔDec) = (0, 0) also corresponds to the center of the field of view for KOOLS-IFU (i.e., fiber ID = 37, see figure 3). North is up and the east is left in all images.

Result

- Emission lines (Hβ, [O III] λλ4959,5007, Hα, [N II] λλ6549,6583 and [S II] λλ6716,6731) were detected in about 72% of the fibers.
- BPT diagram (Fig 6)
  NGC 1614, CGCG 468-002W, Mrk 273, and NGC 7674 are AGN-dominated with 50%–70% of fibers being classified as Sy2/Composite.

Outflow power: $\sigma_0 = \sqrt{v^2_{[\mathrm{O\,III}]} + \sigma^2_{[\mathrm{O\,III}]}}$,

- There is a negative correlation between distance from the galaxy center and σ_0 regardless of the merger stage (Fig 7).
  → This result supports an AGN-driven outflow
- Ionized gas outflow is more powerful as a sequence of merger stages.

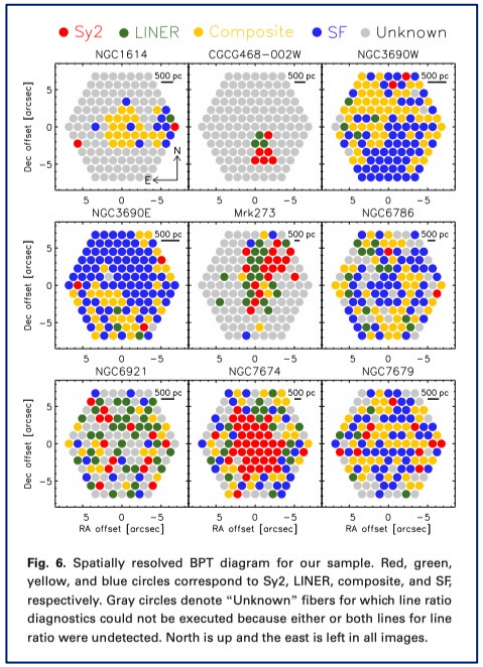

Fig. 6. Spatially resolved BPT diagram for our sample. Red, green, yellow, and blue circles correspond to Sy2, LINER, composite, and SF, respectively. Gray circles denote "Unknown" fibers for which line ratio diagnostics could not be executed because either or both lines for line ratio were undetected. North is up and the east is left in all images.

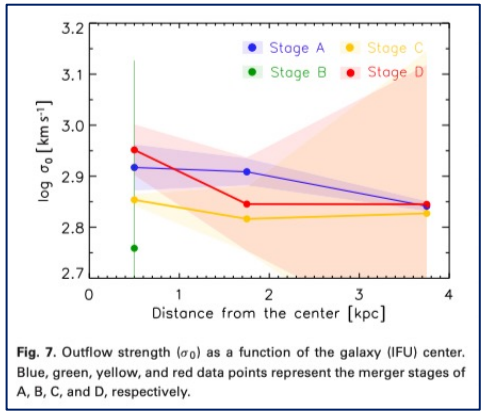

Fig. 7. Outflow strength (σ_0) as a function of the galaxy (IFU) center. Blue, green, yellow, and red data points represent the merger stages of A, B, C, and D, respectively.

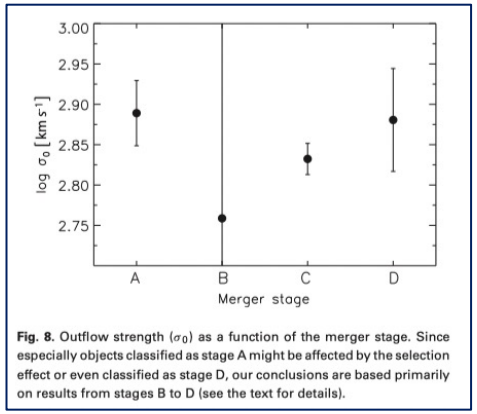

Fig. 8. Outflow strength (σ_0) as a function of the merger stage. Since especially objects classified as stage A might be affected by the selection effect or even classified as stage D, our conclusions are based primarily on results from stages B to D (see the text for details).

Summary

- Emission lines such as Hβ, [O III] λλ4959,5007, Hα, [N II] λλ6549,6583 and [S II] λλ6716,6731 were detected in over 70% of fibers.
- The [O III] outflows expected to be driven by AGN tended to be stronger (i) towards the Galactic center and (ii) along the merger stage.