Active supermassive blackholes deeply buried in luminous infrared galaxies, unveiled with AKARI infrared satellite

IMANISHI, Masatoshi (NAOJ)

NAKAGAWA, Takao, SHIRAHATA, Mai (ISAS/JAXA)

OHYAMA, Yoichi (ASIAA/TAIWAN)

ONAKA, Takashi (University of Tokyo)

Luminous infrared galaxies (LIRGs) emit the bulk of their large luminosities (>10^{11} $L_\odot$) in the infrared, and thus must possess luminous energy sources hidden behind dust. Most LIRGs are gas-rich mergers, and the dust obscured energy sources can be merger-induced starburst activity (energy generation by nuclear fusion reaction inside stars) or AGN activity (the release of gravitational energy generated by a mass-accreting supermassive blackhole, and conversion to radiative energy) or the combination of the two. Since LIRGs are the dominant galaxy population in the distant universe at $z > 1$, in terms of the cosmic infrared radiation density, understanding the hidden energy sources of the LIRG population is important to uncover the history of galaxy formation and supermassive blackhole growth in the early universe. Distant LIRGs are generally too faint to investigate in detail with existing observing facilities, so that comprehensive understanding of nearby LIRGs continues to play an important role.

For this purpose, infrared spectroscopy at $\lambda > 2.5\,\mu$m is effective, because effects of dust extinction are small. Furthermore, Polycyclic Aromatic Hydrocarbons (PAH) emission features, found in this infrared wavelength range, can be used to distinguish between a starburst and an AGN, because the features are seen only in a starburst, but not in an AGN (due to PAH destruction by AGN's strong X-ray radiation). Finally, the optical depths of dust absorption features in this infrared wavelength range can be used to discriminate a starburst, where stellar energy sources and dust are spatially well-mixed, or a buried AGN, where the energy source (= a compact mass-accreting supermassive blackhole) is more centrally-concentrated than dust.

In nearby ultraluminous infrared galaxies with $L_{IR} > 10^{12}\,L_\odot$, since the compact nuclear regions (< several 100 pc) dominate the total luminosities, narrow slit spectroscopy using infrared spectrographs attached to ground-based large telescopes and Spitzer infrared satellite has been widely applied to understand the physical nature. However, for LIRGs with $L_{IR} < 10^{12}\,L_\odot$, spatially-extended emission is important, so that spectroscopy with large apertures is indispensable to quantitatively estimate the relative energetic importance of starbursts and buried AGNs.

We have performed infrared 2.5–5 μm slitless spectroscopy of >100 nearby LIRGs, using the IRC infrared instrument onboard the AKARI infrared satellite, and separated starburst-dominated LIRGs and buried AGN important sources, based on infrared spectral shapes (Figure 1). We found the trend that the energetic importance of buried AGNs increases with increasing galaxy infrared luminosity (Figure 2)[1,2].

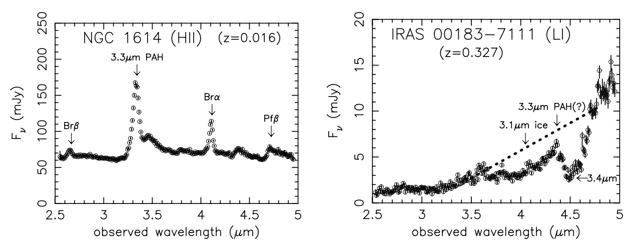

Figure 1: (Left): Infrared 2.5–5 μm spectrum of a starburst-dominated luminous infrared galaxy. PAH emission and hydrogen recombination lines (Brβ, Brα, Pfβ) are strong, and the continuum slope is flat. (Right): Spectrum of a buried AGN dominated galaxy. PAH emission is very weak, and strong dust absorption features are detected. The continuum is red, and steeply rising with increasing wavelength.

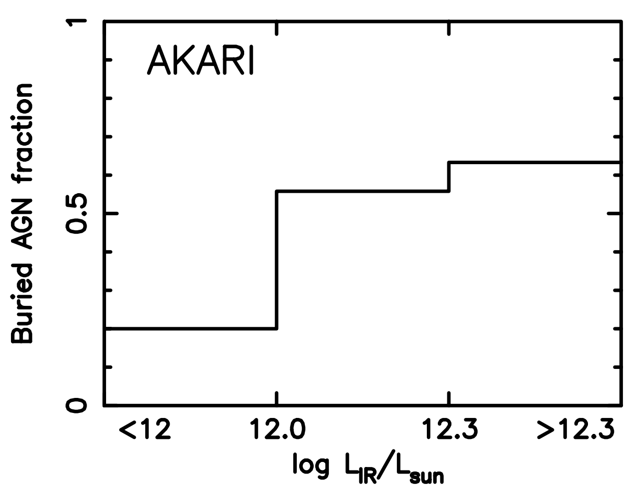

Figure 2: The abscissa and ordinate mean galaxy infrared luminosity and the detection rate of a luminous buried AGN, respectively. Buried AGNs become important with increasing galaxy infrared luminosity.

References

[1] Imanishi, M., et al.: 2008, *PASJ*, **60**, S489.

[2] Imanishi, M., et al.: 2010, *ApJ*, **721**, 1233.