Infrared 18μm High-Spatial-Resolution Imaging of nearby Luminous Infrared Galaxies Using Subaru and Gemini South Telescopes

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Luminous infrared galaxies (LIRGs) radiate very large infrared luminosities with $L_{IR} > 10^{11} L_{\odot}$, and so must possess luminous energy sources hidden behind dust, which absorbs the bulk of the primary energetic radiation, is heated, and produces strong thermal infrared radiation. The dust-obscured hidden energy sources can be either starburst (energy release by nuclear fusion reaction inside stars) and/or AGN activity (release of gravitational energy by a mass accreting active supermassive black-hole). We have previously performed systematic infrared 2.5–40 μm low-resolution spectroscopy of LIRGs, to investigate the relative energetic roles of starburst and AGN activity [1,2]. Based on the strengths of polycyclic aromatic hydrocarbon emission and dust absorption features detected in infrared spectra, AGNs with hard primary energetic radiation and more centrally-concentrated energy source geometry than dust, can be differentiated from normal starbursts which emit soft energetic radiation and have mixed energy sources and dust geometry. Although AGNs and normal starbursts are distinguishable, an **extreme** starburst, consisting of HII-regions only and showing an exceptionally centrally-concentrated energy source geometry, can produce similar infrared spectral shapes to AGNs, and so cannot be ruled out based on infrared spectroscopy alone.

It is shown, both theoretically and observationally, that there is an upper limit for the emission surface brightness of starburst activity with ~$10^{13} L_{\odot}$ kpc^{-2} [3,4], because the radiative energy generation efficiency of nuclear fusion inside stars is modest (0.7 % of Mc^2). It is very difficult even for an extreme starburst to exceed this threshold by a large factor, as long as the extreme starburst is powered by nuclear fusion. On the other hand, an AGN can produce much higher emission surface brightness, because the efficiency of a mass accreting supermassive blackhole can be 6–42 % of Mc^2. Thus, a very high emission surface brightness energy source, if detected, must be an AGN, rather than an extreme starburst.

We performed infrared 18 μm high-spatial-resolution imaging of nearby luminous infrared galaxies using Subaru 8.2 m and Gemini South 8.1 m telescopes (Figure 1). Infrared 18 μm observations can probe the dominant dust emission components of luminous infrared galaxies, and the point spread function (PSF) is stable at 18 μm, due to the reduction of Earth's atmospheric turbulence, making reliable discussion of intrinsic emission's spatial extent possible. Since we can constrain the emission size more strongly, and obtain a more stringent lower limit of emission surface brightness using ground-based large 8–10 m telescopes than space-based satellites with small apertures, our ground-based data play a crucial role. We found that many LIRGs with AGN signatures in previously-taken infrared spectra show emission surface brightnesses much higher than the maximum value set by a starburst phenomenon, supporting the AGN scenario for these galaxies, rather than the extreme starburst picture [5].

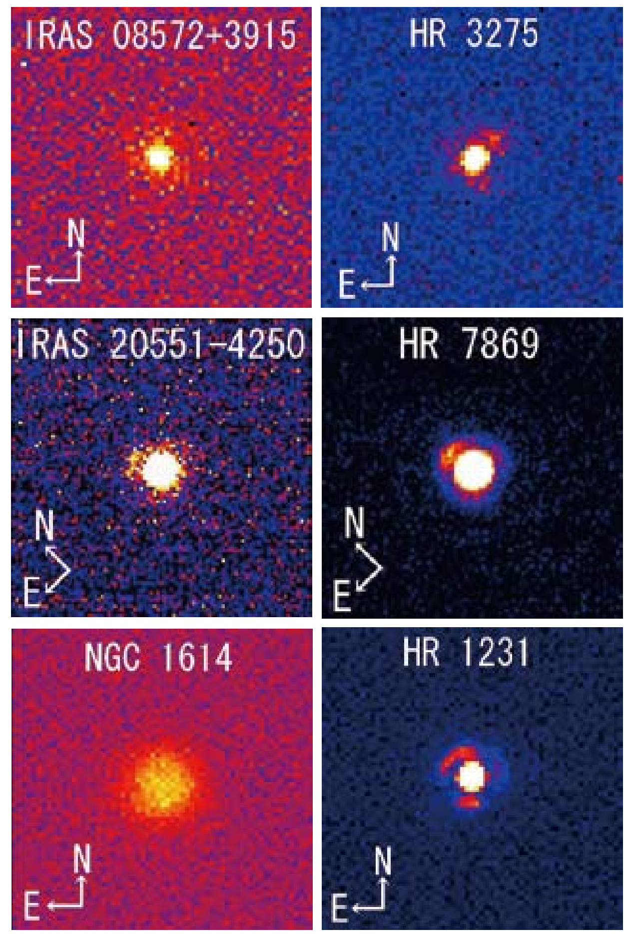

Figure 1: Infrared 18 μm images taken with Subaru (Top and bottom; 5″×5″) and Gemini South telescope (Middle; 8″×8″). (Left) : galaxies. (Right) : corresponding PSF reference stars. North and East directions are indicated. (Top and middle): Infrared emission from galaxies is compact and its spatial extent is indistinguishable from PSF stars. The observed very high emission surface brightnesses suggest AGNs. (Bottom): Galaxy infrared emission is spatially extended, and can be explained by a normal starburst.

References

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