R10b **Anomalous Flux Ratio of Infrared Hydrogen Recombination Lines in Ultraluminous Infrared Galaxies**

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We observed infrared hydrogen recombination lines Br$\alpha$ (4.05 $\mu$m) and Br$\beta$ (2.63 $\mu$m) in 51 ultraluminous infrared galaxies (ULIRGs) with AKARI, which has unique capability to observe these lines simultaneously owing to its 2.5–5.0 $\mu$m wavelength coverage. We detected the Br$\alpha$ and Br$\beta$ lines in 30 ULIRGs, and in nine of them, we find an anomalous Br$\beta$/Br$\alpha$ line ratio ($\sim$ 1.0), which is much higher than the ratio (0.56) expected in case B. If dust extinction affects the line fluxes, the ratio becomes lower because the Br$\beta$ line has a shorter wavelength and is attenuated more than the Br$\alpha$ line. Thus ratios higher than 0.56 are opposite to the effect of dust extinction, and thus incompatible with the case B prediction.

We carefully examine possible biases such as a systematic spectral fringing caused by the instrument, contamination of the Br$\beta$ line by the molecular hydrogen line, and dust absorption or emission properties which may correlate with unknown dust features affecting the ratio. We find no clear evidence that the Br$\beta$/Br$\alpha$ line ratio is affected by these biases, and we conclude that this anomalous ratio is real and caused by extreme conditions in the ionized hydrogen gas. As one possible explanation, we find that the anomalous Br$\beta$/Br$\alpha$ line ratio is reproduced in very high density conditions ($n_{\rm H} \simeq 10^8$–$10^9$ cm$^{-3}$) with a CLOUDY simulation. This indicates that starbursts in such extreme conditions might occur in these very bright, dust-rich objects.