Star formation and dust extinction properties of local galaxies seen from AKARI

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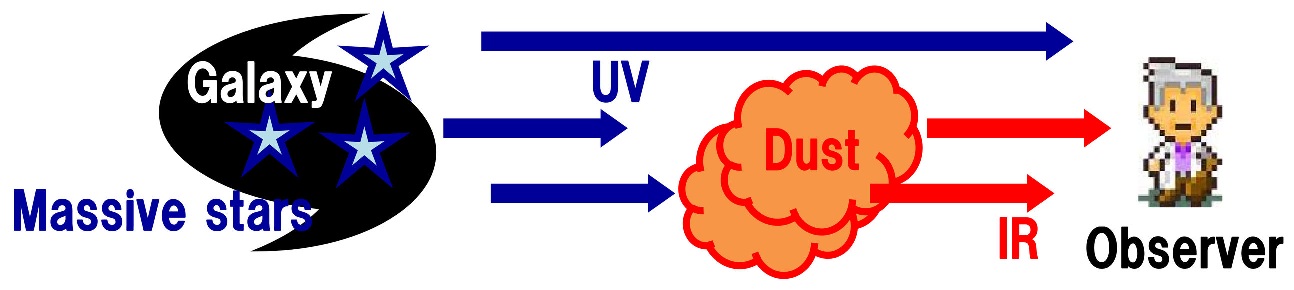
Abstract

Accurate estimation of the star formation (SF)-related properties of galaxies is crucial for understanding the evolution of galaxies. In galaxies, ultraviolet (UV) light emitted by formed massive stars is attenuated by the dust which is also produced by the SF activity, and is reemitted at mid- and far-infrared wavelengths (IR). In this study, we investigated the star formation rate (SFR) and dust extinction using data at UV and IR. We selected 4086 local galaxies which are detected at AKARI FIS 90 μm band. We measured flux densities at FUV (1530Å) and NUV (2310Å) from the GALEX images. We examined the SF and extinction by using 4 wave bands given by AKARI.

Then, we calculated FUV and total IR luminosities, and obtained the so called SF luminosity (L_{SF}: the total luminosity related to star formation activity) and the SFR. We found that in most of galaxies, L_{SF} is dominated by L_{dust}. We also found that galaxies with higher SF activity have a higher fraction of SF hidden by dust. Especially, SF of galaxies which have SFRs > 20 M_{sun} yr^{-1} is almost completely hidden by dust.

Although these results were claimed by previous studies, confirming them precisely using a much larger samples from AKARI and GALEX all sky surveys has a great impact on our understanding of the SF in Local galaxies. I will also show some physical interpretations.

Introduction



Star formation activity

1. Directly visible star formation

Observationally, the SFR of galaxies is measured by the ultraviolet (UV) luminosity of massive stars because of their short lifetime ($\sim 10^{6-8}$ yr) compared with the age of galaxies or the universe.

2. Hidden star formation

The UV photons are easily scattered and absorbed by dust grains. The absorbed energy is re-emitted at mid-far infrared (FIR) wavelength.

In this study, we investigated star formation using UV and IR data.

Observational Data

We used the UV and IR data of the imaging sky survey.

GALEX
GALEX performed an all sky survey at FUV (1530Å) and NUV (2310Å) with detection limits of 19.9 mag and 20.8 mag

IRAS
IRAS has four FIR wavebands centered on 12, 25, 60, 100 μm.
The PSCz is a redshift survey of selected at the IRAS 60μm with a flux density limit of S60 > 0.6 [Jy].

AKARI
AKARI FIS has four FIR wavebands centered on 65μm (N60), 90μm (WIDE-S), 140μm (WIDE-L) and 165μm (N160).

We constructed a multiband catalog based on the AKARI all sky survey 90μm selected sources associated with IRAS PSCz galaxies. And we measured the NUV, FUV flux densities photometry of the parent AKARI galaxies. After some procedure, the number of galaxies is 4086.

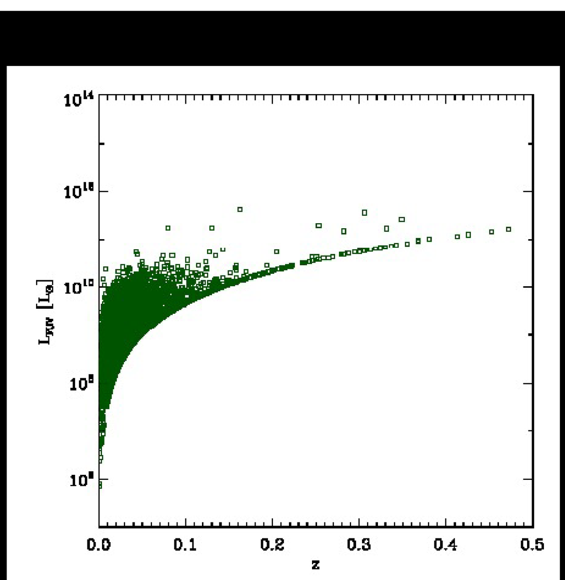


Fig.1 L_{FUV}-z relation

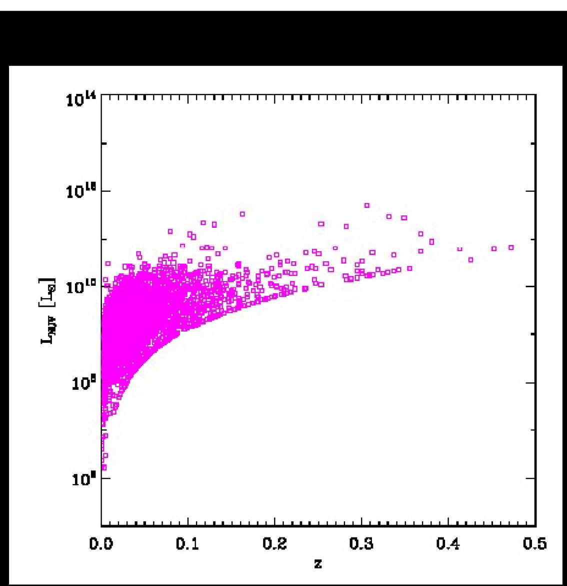


Fig.2 L_{NUV}-z relation

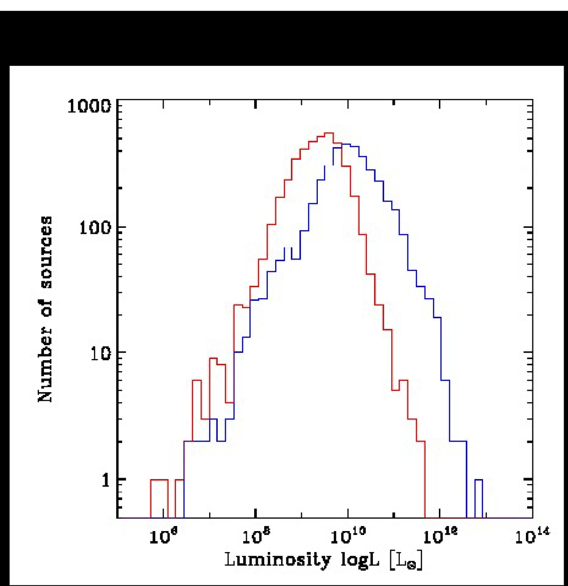


Fig.3 Luminosity distribution
Red: IR luminosity
Blue: FUV luminosity

Fig.1 and Fig.2 show the relation between the each UV luminosity and redshift z. Most of galaxies are locates at low redshift.

Result and Discussion

Total IR luminosity from the AKARI FIS bands

$$L^{2band}_{AKARI} = \Delta\nu(WIDE\text{-}S)L_\nu(90\,\mu m) + \Delta\nu(WIDE\text{-}L)L_\nu(140\,\mu m)$$

$$\Delta\nu(WIDE\text{-}S) = 1.47 \times 10^{12}\,[Hz]$$

$$\Delta\nu(WIDE\text{-}L) = 0.831 \times 10^{12}\,[Hz]$$

$$\log L_{TIR} = 0.964 \log L^{2band}_{AKARI} + 0.814$$

Star formation luminosity

$$L_{SF} \equiv L_{FUV} + (1-\eta)L_{TIR}$$

Star formation late

$$\log SFR_{FUV} = \log L_{FUV} - 9.51$$

$$\log SFR_{dust} = \log L_{TIR} - 9.75 + \log(1-\eta)$$

$$SFR = SFR_{FUV} + SFR_{dust}$$

L_{SF} is the luminosity produced by newly forming stars. Fig.4 is comparison between L_{FUV} and L_{TIR}. It shows that the star L_{SF} is dominated by L_{TIR}. Parameter "η" is the fraction of the IR emission produced by dust heated by old stars which is not related to the current star formation. We adopt a value of 30% for this fraction.

Figures 5 and 6 are the contributions of L_{TIR} and L_{FUV} to the total star formation luminosity L_{SF}. The contribution of L_{FUV} has a large scatter.

The obtained SFR is shown as a function of the fraction of the contribution of the SFR_{FUV}/SFR in Fig.7. The scatter of the SFR_{FUV}/SFR is very large at SFR < 20 $M_\odot yr^{-1}$. However, there is a sudden drop at SFR > 20. $M_\odot yr^{-1}$.

The blue symbols in these figures are galaxies which have UV flux densities below the detection limit of GALEX. They have a distribution shifted from those with detections in all figures.

symbols
□detection
□upper limit

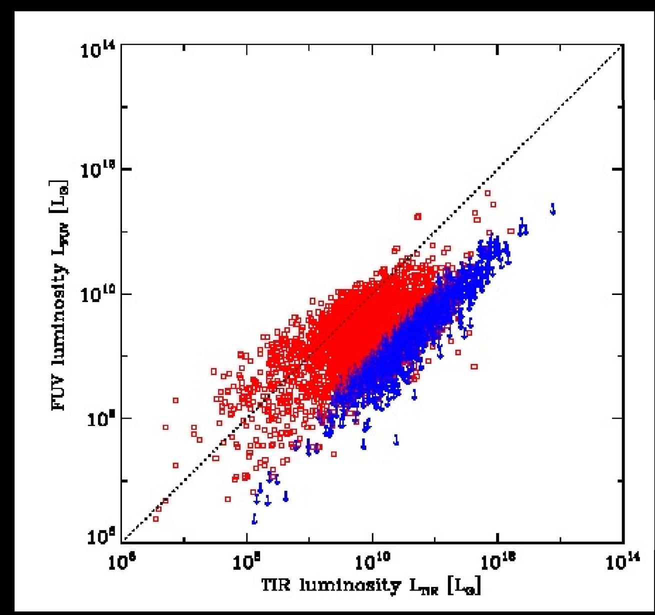


Fig.4. Comparison between TIR and FUV luminosities.

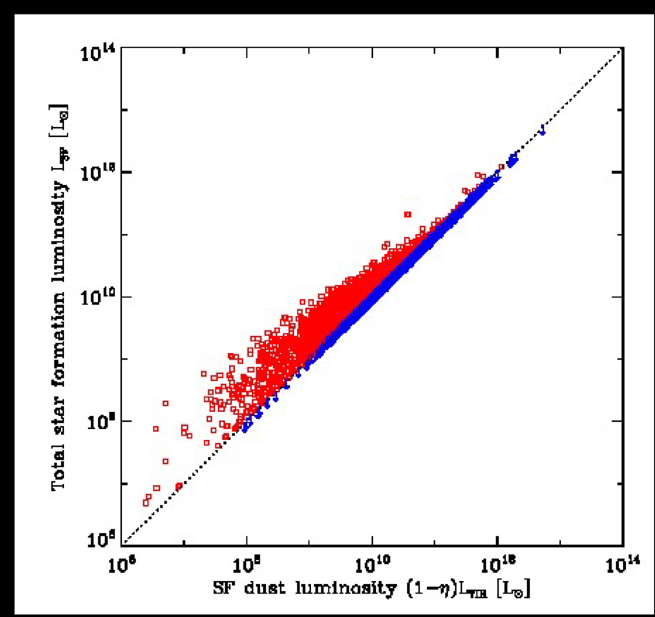


Fig.5. The contribution of L_{TIR} to L_{SF}..

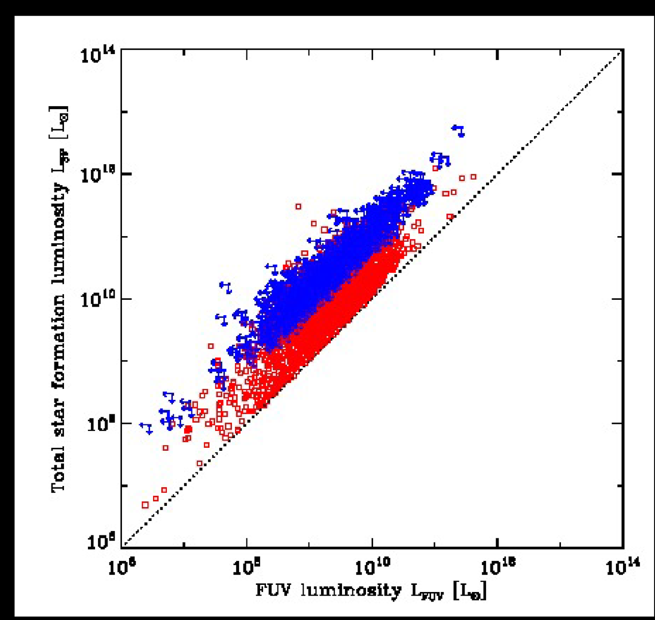


Fig.6. The contribution of L_{FUV} to L_{SF}..

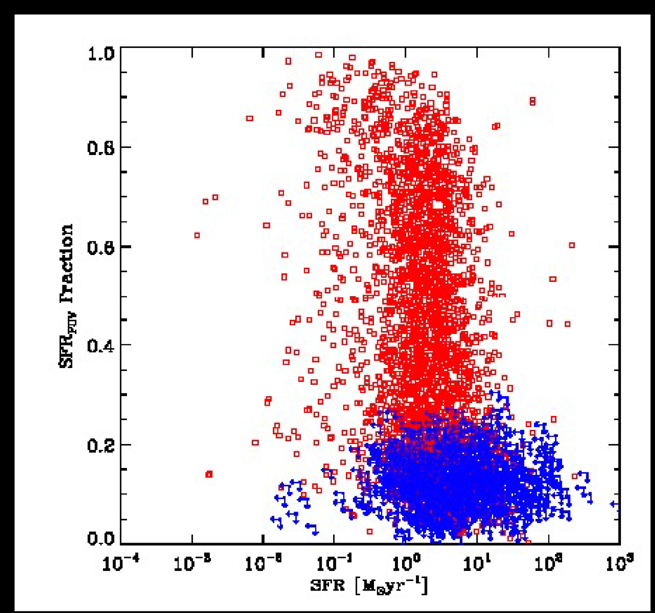


Fig.7. The contribution of the SFR_{FUV} to the total SFR.

References

•Takeuchi, T. T., Buat, V., Heinis, S., et al. 2010, A&A, 514, A4
•Iglesias-Paramo, J., et al. 2006, ApJS, 164, 38

Summary

We analyzed star formation-related properties of local galaxies by using AKARI and GALEX data.
•The L_{SF} is dominated by L_{TIR}.
•The contribution of L_{FUV} to L_{SF} has a larger scatter than that of the contribution of L_{TIR} .
•It is difficult that estimation only from the relation between L_{SF} and L_{FUV}.
•Galaxies with higher SF activity (SFR > 20$M_\odot yr^{-1}$) have a higher fraction of SF hidden by dust.
•Scatters in all figures are smaller than the previous study because of the better S/N of the new data.