Dependence to physical quantities of dust extinction and galaxy

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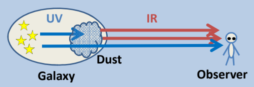
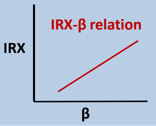
INTRODUCTION





Dust extinguishes UV and optical light and re-emits infrared (IR) radiation. Though originally star forming galaxies should be bright in UV because of the radiation from massive stars, star formation of the galaxies is hidden by dust produced their own. So we cannot estimate the true SFR only through UV observations. A complementary IR observation is the most direct to overcome this problem, it is often difficult. Instead, a correlation between ratio of FUV to FIR luminosity and UV color, called IRX-beta relation, is often used in order to estimate amount of extinction especially for distant galaxies whose IR observation is usually difficult. However, in fact this correlation has a large dispersion, so this approach needs to be reconsidered. In this study, we examined dependence on various physical quantities of galaxies of this correlation in local galaxies using data of AKARI (FIR), GALEX (UV), 2MASS (NIR), SDSS (optical), and IRAS PSCz (redshift).

OBSERVATION

Physical quantities (Takeuchi ,T.T.et.al 2010 A&A)

- ☐ Stellar mass M^* (Yang et al.(2007))
- ☐ Total IR luminosity L_{TIR}

$$L_{AKARI} = 1.47\times10^{12} L_\nu(90\mu m) + 0.831\times10^{12} L_\nu(140\mu m)$$

$$\Rightarrow \log L_{TIR} = 0.964 \log L_{AKARI} + 0.814$$

- ☐ FUV luminosity L_{FUV}
- ☐ Star formation rate SFR

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

$$\log SFR_{TIR} = \log L_{TIR} - 9.75 + \log(1-\eta) \qquad \eta = 0.3$$

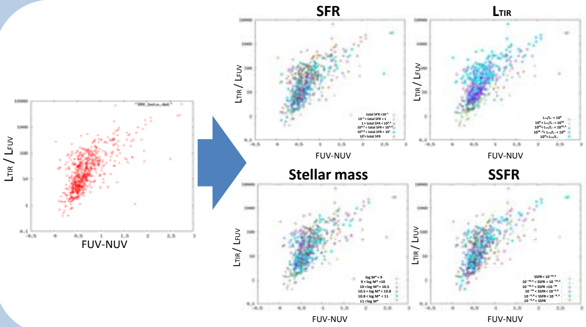
$$\Rightarrow SFR = SFR_{FUV} + SFR_{dust}$$

- ☐ Specific star formation rate SSFR

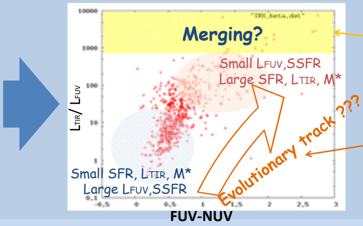
SSFR=SFR/M^*= [SFR(T) in Current] / [Average SFR(T) in the past]

⇒ Large SSFR・・・The galaxy is growing up actively in current.
Small SSFR・・・The galaxy is almost finished growing.

Conclusion -607 galaxies-



I grouped in value width of each quantities and plotted in different colors for each group.

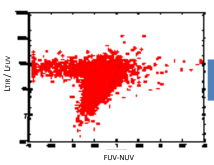


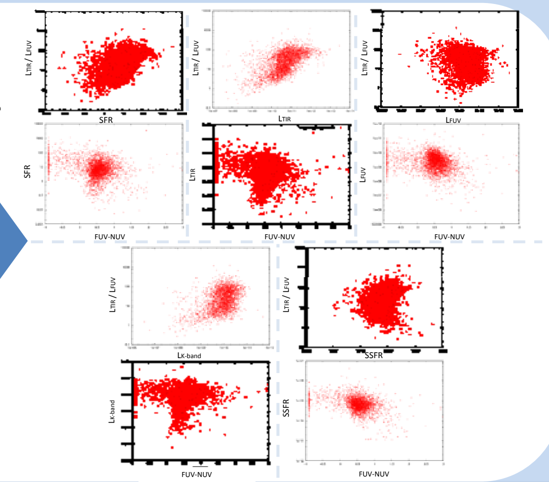
All the quantities are large.
These galaxies may be in some intense situations such as merging.

Small galaxies are actively forming stars currently.
Old and large galaxies form only small amount of stars.
⇒We can regard this sequence as the evolutionary track of galaxy.

New conclusion -3882 galaxies-

To investigate further, we used new version of AKARI data with better precision and quality.





THEORETICAL SPECTRAL EVOLUTION OF A GALAXY

Model

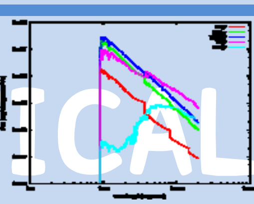
1.Radiation from stars

- ☐ IMF・・・Salpeter (Salpeter 1955)

$$\phi(m) \propto m^{-(1+x)} \qquad x = 1.35$$

- ☐ SFR・・・Exponential

$$SFR(t) \propto \exp\left(-\frac{t}{\tau_{SF}}\right)$$

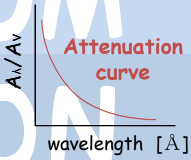


2.Dust extinction

- ☐ Dust extinction・・・Proportional to metallicity (Guiderdoni & Rocca-Volmerange 1987)

Optical depth τ_λ

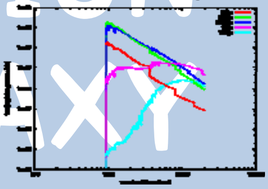
$$\tau_\lambda(t) = 0.44\times3.25\left(\frac{A_\lambda}{A_V}\right)\left(\frac{Z_g(t)}{Z_{solar}}\right)g(t) \qquad g(t) = M_g(t)/M_0$$



- ☐ Attenuation curve・・・(Calzetti et al. 2000)

$$\frac{A_\lambda}{A_V} = \frac{k(\lambda)}{4.05}$$

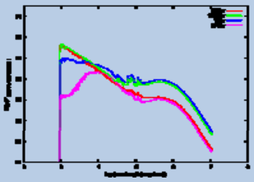
$$= \begin{cases} 0.657(-1.857+1.040/\lambda)+1 & 0.63\mu m \le \lambda \le 2.20\mu m \\ 0.657(-2.156+1.509/\lambda-0.198/\lambda^2+0.011/\lambda^3)+1 & 0.12\mu m \le \lambda < 0.63\mu m \end{cases}$$



3.Dust re-radiation

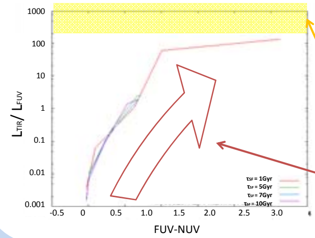
I assumed total energy extinguished by dust is re-emitted as dust emission.

- ☐ SED of dust emission・・・(Dale et al. 2001)



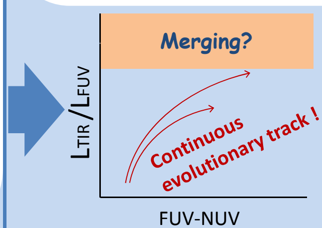
Conclusion

Using the above model, SED evolution (galactic age :10Myr, 100Myr, 1Gyr, 5Gyr,10Gyr) of galaxies with different SFR (timescale of star formation: 1Gyr, 5Gyr, 7Gyr, 10Gyr) on IRX-beta diagram are shown below.



IRX >100 galaxies do not exit.
⇒This result means large IRX galaxies are out of continuous evolution.

On IRX-beta diagram, continuous evolution of galaxy is shown as track from left bottom to right top.



Continuous evolution trajectory consistent with those expected from the results of observation.
In contrast, we suggest that galaxies with IRX>100 might be in a particular situation. According to the observations, these galaxies seem very active. Thus, they may be have merging. Further validation is required to confirm this.

SUMMARY

- ☐ We examined IRX- β relation in local galaxies using observational data from AKARI.
- ☐ Small galaxies having large SSFR and small M* are bluish and less extinguished, while large galaxies having small SSFR and large M* are reddish and extinguished considerably.
- ☐ We constructed a spectral evolution model of a galaxy consistent with chemical evolution.
- ☐ By comparing with the model, we found that though most galaxies follow the IRX-beta relation expected in continuous galactic evolution, galaxies with very large IRX suggest some intense situations such as collisions.
- ☐ In the future, we want to verify why galaxies with very large IRX have rather large beta.
- ☐ And, we need to extend the model in order to deal with star burst galaxies.