Predicting Dust Extinction Properties of Galaxies from Hα/UV Ratio

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Star formation rate (SFR) is one of the most fundamental parameters which characterize the nature of galaxies. The Hα line (6563Å) is widely used as a good indicator of SFRs and is well calibrated in the local universe. With recent advents of sensitive near-infrared facilities, it is becoming easier to observe Hα line of high-z galaxies. However, to reliably measure SFRs, it is important to derive their extinction levels. Ideally, we want to use Hα/Hβ (4861Å) ratio (i.e. Balmer decrement) to measure the dust extinction, but it is usually impossible to detect faint Hβ line from individual high-z galaxies.

In this work, we use SDSS (DR7) spectroscopic catalog, in combination with GALEX FUV all-sky survey data, to establish empirical calibration to predict Hα extinction ($A_{\mathrm{H}\alpha}$) from the observed Hα/UV luminosity ratio [1]. As shown in Fig. 1, we find that there is a positive correlation between $L_{\mathrm{H}\alpha}/L_{\mathrm{UV}}$ ratio and $A_{\mathrm{H}\alpha}$, but at the same time there is a large scatter around the correlation. We find that this scatter is related to various galaxy properties——e.g. stellar mass. We find that more massive galaxies tend to have higher $A_{\mathrm{H}\alpha}$ at a fixed $L_{\mathrm{H}\alpha}/L_{\mathrm{UV}}$ ratio (the color coding of Fig. 1 indicates average stellar mass of galaxies measured at each pixel). By quantifying this trend, we demonstrate that we are able to predict dust extinction levels of individual galaxies by combining Hα, UV, and stellar mass information.

Furthermore, by combining the AKARI FIR all-sky survey data, we compare the $A_{\mathrm{H}\alpha}$ and $L_{\mathrm{IR}}/L_{\mathrm{UV}}$ ratio (Fig. 2). $L_{\mathrm{IR}}/L_{\mathrm{UV}}$ represents the dust extinction for *stellar continuum light*, whilst $A_{\mathrm{H}\alpha}$ indicates extinction toward *nebular lines*. As demonstrated in Fig. 2, we show that more massive galaxies tend to show higher extinction levels toward nebular regions at fixed $L_{\mathrm{IR}}/L_{\mathrm{UV}}$ ratio. The difference between the extinction toward nebular and stellar continuum lights is often interpreted as a consequence of different star/dust geometry within the galaxies. Our results therefore suggest that internal dust geometry of galaxies could depend on stellar mass of galaxies, and this can be (at least a part of) the physical explanations of the trend that we reported in Fig. 1.

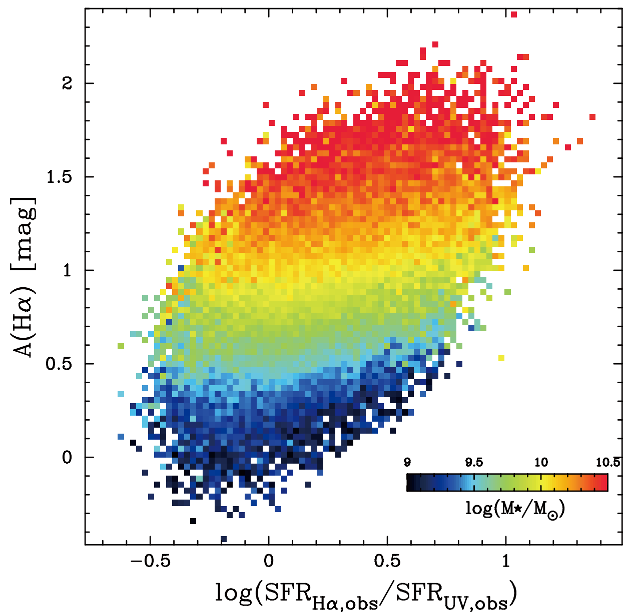

Figure 1: Hα dust extinction derived from Hα/Hβ as a function of Hα/UV ratio. The color coding indicates the average stellar mass of galaxies in each pixel. More massive galaxies tend to be more heavily obscured by dust at fixed Hα/UV.

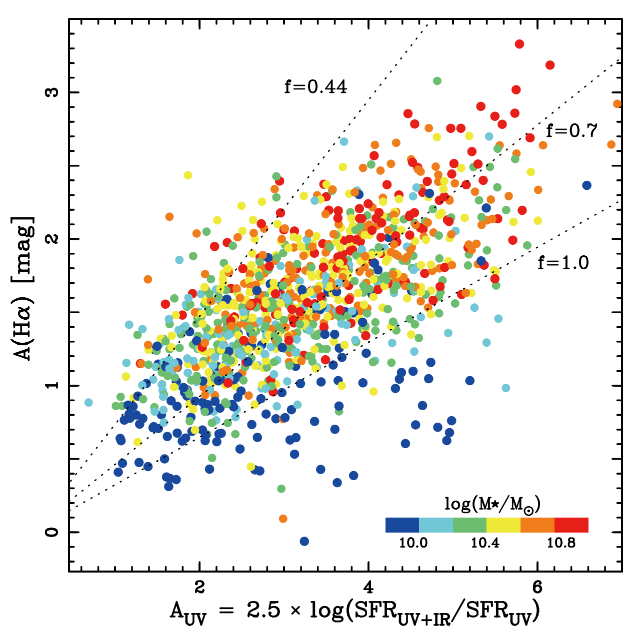

Figure 2: Hα extinction as a function of IR/UV ratio. The color of the data points indicate their stellar mass. $A_{\mathrm{H}\alpha}$ shows extinction for *nebular emission lines*, whilst IR/UV ratio reflects extinction for *stellar continuum light*. More massive galaxies tend to have higher extinction for nebular lines.

Reference

[1] Koyama, Y., et al.: 2015, *MNRAS*, **453**, 879.