

## Cosmic Star Formation Rate at $z \sim 3$ — Metallicity Effect

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**Abstract.** Infrared (IR) emission from Galactic dust is frequently used as an indicator of the star formation rate (SFR). Recently, A. K. Inoue, H. Hirashita, & H. Kamaya derived a formula for conversion from the IR luminosity to the SFR based on a physical model of H II regions (PASJ, 52, 539, 2000). They expressed this as  $\text{SFR}/(M_{\odot} \text{ yr}^{-1}) = \{1.1 \times 10^{-10}(1-\eta)/(0.4-0.22f+0.6\epsilon)\}(L_{\text{IR}}/L_{\odot})$ , where  $f$  is the fraction of ionizing photons absorbed by hydrogen,  $\epsilon$  is the efficiency of dust absorption for non-ionizing photons,  $\eta$  is the cirrus fraction of the observed dust luminosity, and  $L_{\text{IR}}$  is the observed luminosity of dust emission. Since  $f$  depends on the dust-to-gas ratio and the dust-to-gas ratio is related to metallicity, we present the dependence of the formula on metallicity.

Our metallicity-dependent conversion formula is applied to the cosmic star formation history. Based on a recent model of the cosmic star formation history and metal enrichment history, we find that the photons from OB stars are not efficiently reprocessed in the IR before  $z \sim 3$  because of a low dust-to-gas ratio. This indicates that the star formation rate estimated from the submillimeter luminosity using an empirical formula is significantly underestimated (by *at least* a factor of 3).

### Discussion

Daniele Pierini: You derive the star formation rate from the dust-to-gas ratio. How does the latter ratio relate to the UV-to-optical light ratio in galaxies at  $z = 0$ ?

Hiroiyuki Hirasita: We did not derive the SFR from the dust-to-gas ratio, but from the relation between the SFR and IR luminosity. Our result is consistent with the UV-to-optical ratio.

Floyd Stecker: How do your calculations affect the determination of the Madau plot of star formation rate versus redshift?

Hirasita: The correction of extinction is smaller at high redshift. But we predict an upward correction for the star formation rate at  $z \sim 3$ , as estimated from the submillimeter flux.