STAR FORMATION RATE CALIBRATIONS FOR WISE LUMINOSITIES

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ABSTRACT

Starting from an infrared selected GALEX-SDSS-2MASS-AKARI sample of local star forming galaxies, we built mock samples from redshift 0 to 2.5 to investigate star formation rate (SFR) calibrations using WISE luminosities. We find W3 and W4 band fluxes can indicate SFRs with small scatters when the rest-frame wavelengths are longer than ~ 6 μm. When the wavelength becomes shorter, the observed luminosities are more tightly connected to the emission of old stellar populations than dust, therefore lose the reliability to trace the SFR. The current SFR calibrations are consistent with previous studies.

Key words: galaxies: evolution; infrared: galaxies

1. INTRODUCTION

Star formation rate (SFR) is one of the fundamental properties of galaxies. The Wide-field Infrared Survey Explorer (WISE) provides all sky mid-infrared data at ∼3.4, 4.6, 12, 22 μm with extremely high sensitivity and resolution (Wright et al., 2010), and thus an unprecedented opportunity to study the star formation and galaxy evolution in the Universe. Therefore, SFR calibrations using WISE filters are important to interpret WISE data, and have important applications when investigating the evolution of galaxies.

In this work, we use multiwavelength data and spectral energy distribution (SED) fitting methods to construct spectrum templates and obtain calibrations of SFR for WISE bands from the local to the high-redshift universe. We then compare the template predictions with observational data to examine the reliability and efficiency of our method.

2. DATA

We use two samples of galaxies: a local sample and a high-redshift sample. The local sample with GALEX-SDSS-2MASS-AKARI FIS/IRC data is taken from Yuan et al. (2011). AKARI IRC and FIS fluxes are updated to the latest published values. FIS fluxes of extended sources are corrected using the AKARI diffuse maps. The high redshift sample is taken from Kartaltepe et al. (2010). It contains 1,503 galaxies in the COSMOS field, of which 602 have spectroscopic redshifts. We choose subsamples at certain redshifts: ∼ 0.5, 1.0, 1.5, 2.0, 2.5, for comparison with the local templates extrapolated to high redshifts (see Section 3).

3. METHOD

First, the spectral energy distributions (SEDs) of galaxies in the local sample are fitted using CIGALE (Code Investigating GALaxy Emission[1]). A bayesian procedure is used to obtain the best models with the smallest χ^2. Then the best models are used to generate mock galaxies at redshifts 0.5 to 2.5 with steps of 0.5. The highest redshift is chosen as 2.5 because the redshift limit of WISE for ULIRGs is ∼3 (Wright et al., 2010). From these mock galaxies, the WISE luminosity-SFR and -mass relations are then derived.

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[1] http://www.oamp.fr/cigale.

SEDs of galaxies in the high redshift sample are also fitted by CIGALE. From these galaxies, we can obtain the SFR and mass calibrations as well. These calibrations are then compared with those derived from local templates to examine the difference between models and observational data.

4.   RESULT

We find that W3 (12 μm) and W4 (22 μm) band luminosities are tightly correlated with SFRs. Figure 1 shows the correlation between the W4 luminosities and SFRs from redshift 0 to 2.5. Dots represent the results derived from local templates. Squares and triangles are those derived from the COSMOS data with spectroscopic redshifts and photometric redshifts, respectively. The results derived from local templates show little discrepancy with those derived from the COSMOS data at redshifts < 1. The discrepancy becomes larger at redshift higher than 1, where most of the galaxies have only photometric redshifts. Further examination is necessary to check whether it is due to the insufficient accuracy of the redshifts. We also compare our SFR calibrations derived from templates with previous studies (Figure 1). Our calibrations are consistent with these results. Future work will focus on applying these calibrations to observational data from WISE.

Fig. 1. The correlation between SFR and W4 band luminosity. Dots are from SED fitting of local galaxies, squares are from COSMOS data with spectroscopic redshifts, and triangles are from COSMOS data with photometric redshifts. Previous works by Elbaz et al. (2002), Takeuchi et al. (2005), Reddy et al. (2010) and Wu et al. (2005) are given as comparison.

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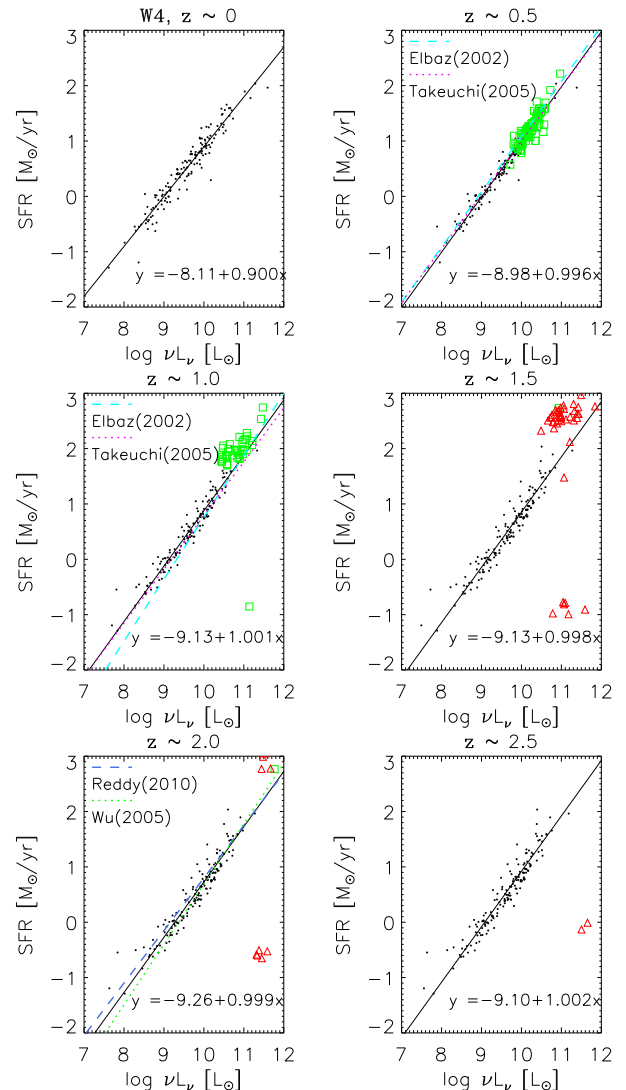
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