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Letter to the Editor

Star-forming galaxies with hot dust emission in the Sloan Digital Sky Survey discovered by the Wide-field Infrared Survey Explorer (WISE)

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ABSTRACT

We present the results of a search for Sloan Digital Sky Survey (SDSS) emission-line galaxies with very red 3.4 μm–4.6 μm ($W1-W2$) colours in the Wide-field Infrared Survey Explorer (WISE) Preliminary Release Source Catalogue (PRSC) aiming to find objects with hot dust emission. For this purpose we considered a sample of ~16 000 galaxies with strong emission lines selected out of a total of ~900 000 SDSS spectra and identified them with the PRSC sources. We find that ~5000 sources out of the ~16 000 SDSS galaxies are present in the PRSC, including ~1000 galaxies with sufficiently strong [O III] λ4363 emission lines to permit reliable determinations of the oxygen abundance. No correlation of $W1-W2$ with metallicity is found. On the other hand, there is clear evidence for a redder $W1-W2$ index in galaxies with higher Hβ luminosity and higher Hβ equivalent width, implying that strong UV radiation from young starbursts efficiently heats interstellar dust to high temperatures. However, galaxies with very red colours $W1-W2>2$ mag, similar to that in the local extreme star-forming galaxy SBS 0335–052E, are very rare. In addition to three previously known sources, which are not present in our sample, we found only four such galaxies.

Key words. galaxies: fundamental parameters – galaxies: starburst – galaxies: ISM – galaxies: abundances

1. Introduction

Nearby star-forming emission-line galaxies play an important role for our understanding of star-formation processes in low-metallicity environments, and they can be considered as local counterparts or "analogs" of high-redshift star-forming Lyman-break galaxies (LBGs). Recently, Heckman et al. (2005) identified nearby ($z<0.3$) ultraviolet-luminous galaxies (UVLGs) selected from the Galaxy Evolution Explorer (GALEX). Eventually, compact UVLGs were called Lyman-break analogs (LBAs). They resemble LBGs in several respects. In particular, their metallicities are subsolar, and their star-formation rates (SFRs) of ~4–25 $M_\odot$ yr^{-1} are overlapping with those for LBGs. Recently, Cardamone et al. (2009) selected a sample of 251 compact strongly star-forming galaxies at $z\sim0.112$–0.36 on the basis of their intense green colour on the Sloan Digital Sky Survey (SDSS) images ("green pea" galaxies), which again are similar to LBGs owing to their low metallicity and high SFRs. Izotov et al. (2011) extracted a sample of 803 star-forming luminous compact galaxies (LCGs) with hydrogen Hβ luminosities $L(\mathrm{H}\beta)\geq3\times10^{40}$ erg s^{-1} and Hβ equivalent widths EW(Hβ) $\geq$ 50 Å from SDSS spectroscopic data. These galaxies have properties similar to "green pea" galaxies but are distributed over a wider range of redshifts $z\sim0.02$–0.63. The SFRs of LCGs are high ~0.7–60 $M_\odot$ yr^{-1} and overlap with those of LBGs. Izotov et al. (2011, see also Guseva et al. 2009) showed that LBGs, LCGs, luminous metal-poor star-forming galaxies (Hoyos et al. 2005), extremely metal-poor emission-line galaxies at $z<1$ (Kakazu et al. 2007), and low-redshift blue compact dwarf (BCD) galaxies with strong star-formation activity obey a common luminosity-metallicity relation. Therefore, it is important to study nearby star-forming galaxies over a wide range of luminosities and metallicities to shed light on physical conditions and star-formation history in high-redshift galaxies even though most metal-deficient and low-luminosity high-redshift galaxies are still awaiting their detection.

The Infrared Space Observatory (ISO), *Spitzer*, and most recently the Wide-field Infrared Survey Explorer (WISE, Wright et al. 2010) open up the opportunity to probe properties of star-forming galaxies in the mid-infrared range (MIR) ~ 3.5–24 μm, the range of warm and hot dust. The WISE mission has an advantage because it is directed to produce an all-sky photometric survey at wavelengths 3.4 μm ($W1$), 4.6 μm ($W2$), 12 μm ($W3$) and 22 μm ($W4$) with a sensitivity at ~12–24 μm that is ~1000 times higher than that of the InfraRed Astronomical Satellite (IRAS) and has an angular resolution of ~6″ at 3.4 μm.

Thuan et al. (1999) first showed (from *ISO* spectroscopy) that one of the most metal-deficient BCDs, SBS 0335–052E (e.g. Izotov et al. 1990), is extraordinarily bright in the MIR range, implying a large amount of warm (~100–300 K) dust. Later, Houck et al. (2004) based on *Spitzer* spectra have confirmed the presence of warm dust in SBS 0335–052E and found that the dust emission peaks at a wavelength of ~28 μm, much shorter than that for the bulk of star-forming galaxies. Ground-based infrared spectroscopy of SBS 0335–052E by Hunt et al. (2001)