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DUST AND HYDROGEN MOLECULES IN METAL-POOR GALAXIES

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In order to understand the chemical and thermodynamical state of the interstellar medium (ISM) in the early stage of galaxy evolution, dust formation needs to be considered. Even in metal poor galaxies, dust grains can drastically accelerate the formation rate of molecular hydrogen (H_2). Hydrogen molecules emit vibrational-rotational lines, thus cooling the gas. Consequently, the abundance of the molecules affects the spectrum and the cooling rate of a galaxy.

We have developed a model for the evolution of dust content in primordial galaxies. We cannot compare our model with observations of high-redshift (z) primordial galaxies, since as yet there is no clear evidence for such objects. Nevertheless, because of their low metallicity and active star formation, we have focused on the evolution of dust content in nearby star-forming dwarf galaxies. Here, we discuss SBS 0335−052, since this may be experiencing its first active star formation whose age may be $\lesssim 5$ Myr (Vanzi et al. 2000). The details of the model are found in Hirashita, Hunt, & Ferrara (2002). We assume a constant star formation rate of 1 $M_\odot$ yr^{-1} for the application to SBS 0335−052.

One of the direct ways to measure dust content is to observe far-infrared (FIR) emission. In Figure 1, we show the evolution of FIR luminosity for $r_{\rm SF} = 300$, 100, and 30 pc (solid, dotted, and dashed lines, respectively), where $r_{\rm SF}$ represents the radius of the star-forming region. If $r_{\rm SF} \lesssim 100$ pc, the observed FIR luminosity ($\sim 10^9$ $L_\odot$; Dale et al. 2001) for SBS 0335−052 is reached in a few Myr. The dust temperature is ~ 80 K.

The dust accumulation leads to an enhancement of the molecular fraction. This is because of [1] the shielding of UV photons by dust and [2] increased reaction rate. The self-shielding of H_2 which further enhances the molecular amount occurs within 10^7 yr from the beginning of the starburst.

Now we are applying our model to high z (> 5; Hirashita & Ferrara 2002). Our model demonstrates that dust drastically increases the molecular fraction by an order of magnitude on a timescale ($\sim$ 3–5 dynamical times). This leads to an enhancement of star formation. We have also found that about a half of the radiative energy from stars is reprocessed by dust grains and is finally radiated in FIR. For statistical properties, we have found that i) ALMA can detect the dust emission from a few times 10^3 galaxies per square degree, ii) *NGST* can detect the stellar emission from 10^6 galaxies per square degree, and iii) the spatial fluctuation in the surface brightness of sky in mm bands can be used to trace the metal amount at $z \sim 5$–7. These three observations will be a strict test for our scenario for high-redshift star formation history.

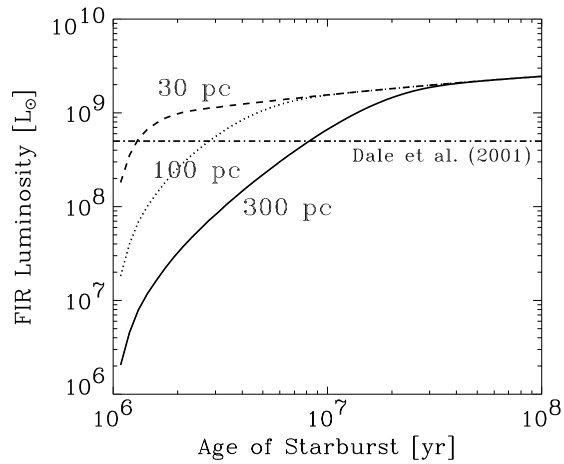

Fig. 1. Time evolution of the far-infrared (FIR) luminosity for the constant star formation rate of 1 $M_\odot$ yr^{-1}. The radius of the galaxy is assumed to be 300, 100, and 30 pc (*solid*, *dotted*, and *dashed* lines, respectively). The observed FIR luminosity is shown by the horizontal dot-dashed line ($\sim 5 \times 10^8$ $L_\odot$; Dale et al. 2001).

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