THE INFRARED BACKGROUND DUE TO GALAXIES

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ABSTRACT. We have investigated the galactic infrared background (GIRB) light that comes from the integrated emission of individual galaxies at different redshifts. By using (1) the galaxy M 82 infrared (IR) spectrum as a template spectrum of IR active galaxies and (2) the constraint given by the nucleosynthesis of the heavy elements in galaxies, we have derived the IR spectrum of the diffuse light that comes from the galaxies at different redshifts following the method by Stecker, Puget, and Fazio (1977). The observations by Matsumoto et al. (1988) impose severe constraints on the possible scenarios for the birth and evolution of the galaxies. Observations by the *COBE* satellite are expected to settle some important issues of this problem.

1. A BACKGROUND THAT WILL BE OBSERVED

Among the various backgrounds besides the 3K background that are predicted by cosmological scenarios, the GIRB is one that is bound to be observed due to the formation and evolution of galaxies. Indeed, if we (1) adopt the most standard Big Bang scenario, (2) use direct evidence from observations of IR galaxies, and (3) account for the nucleosynthesis of heavy elements in galaxies, then the relic released energy is most likely to appear in the IR spectrum. Upper limits on the visible extragalactic background forbid the appearance of the energy in the visible. In the following section we try the simplest approach for calculating the spectrum of the expected GIRB which is similar to that of Stecker, Puget, and Fazio (1977).

2. A TENTATIVE SPECTRUM OF THE GIRB

Figure 1 shows the GIRB spectrum that results from choosing the following set of parameters: $H_0 = 75$ km/s/Mpc, $\Omega_b = 0.02$, $L_0 = 0.3\, L_\odot\, \mathrm{kpc}^{-3}$ (Yang et al. 1984 and Soifer et al. 1986) and an exponential decay evolution with a starting redshift of $z_m = \omega_m - 1 = 12.3$ corresponding to a decay time of $H_0\tau = 0.29$. These parameters are similar to those inferred from faint galaxy counts by Guiderdoni and Rocca-Volmerange (1989, this volume). Various foregrounds and backgrounds crowding the whole IR window must be sufficiently understood before we can observe the GIRB spectrum. These are, by increasing wavelength: (1) faint stars that cannot be resolved (Puget 1976); (2) Zodiacal light scattering and emission (Hauser 1984); (3) interstellar dust emission, the so-called cirrus clouds (Boulanger and Pérault 1988) that are likely to show near IR features (attributed to polycyclic aromatic hydrocarbons, or PAHs) (see Giard et al. 1989, this volume for the 3.3 μm feature) modeled by a scaled version of the reflection nebula NGC 2023 (Sellgren 1985); the submm measurements of cirrus are from Lange et al. 1989, Fabbri et al. 1986, and Pajot et al. 1986; (4) the cosmic microwave background at ~2.74 K; and (5) the submm excess observed by Matsumoto et al. (1988) over the cosmic background (the point at 262 μm is an estimated upper limit). The best opportunity to detect the GIRB is between 200 and 700 μm.

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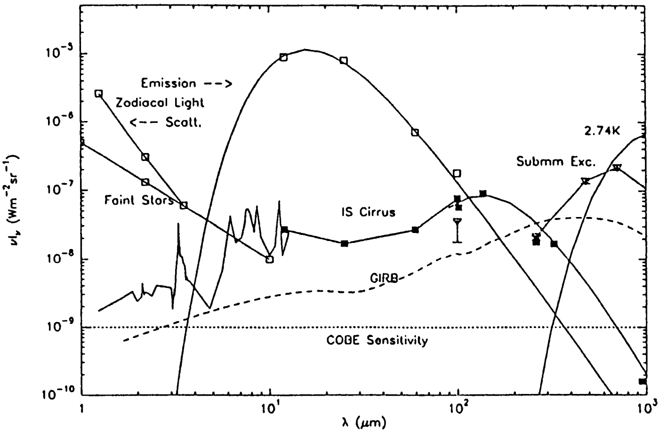

Figure 1. The IR background due to galaxies (GIRB, dashed line) among the various foregrounds and backgrounds (see text).

With the simplest hypotheses, we have computed a galaxian IR background that is within reach of rocket experiments and the *COBE* satellite. The background has a rather flat spectrum from 200 to 1000 μm with some bumps between 50 and 100 μm due to the redshifted near-IR features of galaxies. These bumps, if detected, could help the dating of the birth of galaxies. The hypothesis of 1/2 MeV per nucleon for the average nucleosynthesis energy release must be considered as an upper limit. This model cannot account for the observed submm excess for the two following reasons: (1) the observed submm brightness is larger than the (optimistic) predictions by at least a factor of five, and (2) the observed spectrum of the submm excess is very narrow in wavelength range compared with our predicted broad spectrum. A possible modification of the present model could include the fact that early starburst galaxies have such a high ultraviolet energy density that very small grains and PAHs are destroyed, leading to a negligible near-mid IR initial spectrum.

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