INTENSITY FLUCTUATIONS OF THE COSMIC BACKGROUND RADIATION DUE TO POLARIZATION EFFECTS

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The Nagoya-Berkeley experiment has revealed a substantial excess over the blackbody radiation in the submillimetre part of wavelengths. Its origin is unknown. The concept of high-redshift cosmological dust (e.g., Hayakawa et al., 1987), though not without problems, remains one of the simplest explanations. It is clear that other types of observations will be necessary to identify the source of the excess. Needless to say, searches for cosmic background radiation (CBR) intensity fluctuations on fine angular scales in the submillimetre region are especially desired.

In the context of the cosmological dust model, Rudak and Panek (1989) considered possible processes of the CBR polarization. They assumed that nonspherical grains of "astronomical silicate" (Draine and Lee, 1984) are embedded in the primeval magnetic field of intensity $B \approx 10^{-9}(1+z)^2\,Gs$ and are organised in "domains." The resulting alignment of grains can be substantial and leads to partial linear polarization of the CBR in the submillimetre region.

The CBR, observed in different directions, crossing N_D randomly oriented domains, each of the characteristic angular size θ, will show intensity fluctuations on scales corresponding to θ. Figure 1 shows expected wavelength dependence of $\Delta I/I$ for $N_D = 10$ and for different values of alignment parameter Q_A. The only $\Delta I/I$ measurements on small angular scales, for λ falling into the range of interest, come from Caderni et al. (1977) ($\theta = 25'$, $\lambda = 1.2$ mm). They obtained a negative result with an upper limit of 5.3×10^{-4} (shown in Figure 1). Assuming that intensity fluctuations in the Wien part of the spectrum are entirely due to polarization effects, this limit translates to a polarization degree as low as 0.5% at $\lambda = 400$ μm.

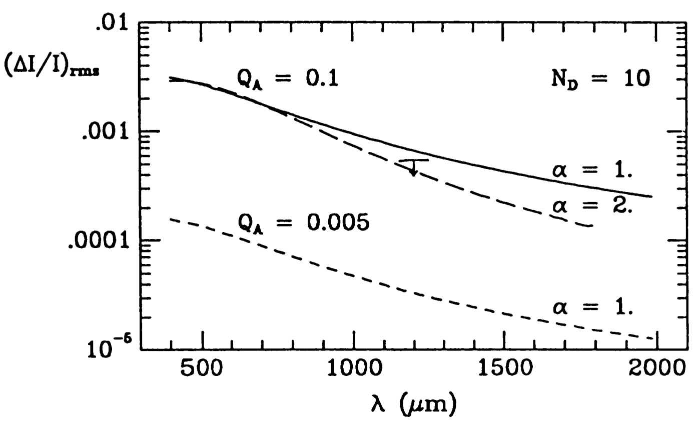

Figure 1. The relative intensity fluctuations vs. wavelength λ for oblate grains. Curves are labelled with the alignment parameter Q_A and the α power index in the dust optical depth: $\tau = 0.2\,(700\ \mu m/\lambda)^{\alpha}$. The arrow indicates the limit found by Caderni et al. (1977).

S. Bowyer and C. Leinert (eds.), The Galactic and Extragalactic Background Radiation, 402–403.

Let us identify the domains with regions of density perturbations corresponding in mass to primordial galaxies rather than clusters or superclusters. Then the angular scale of 25′ is too large, and the results of Caderni et al. lead to only approximate constraints on the polarization degree or alignment parameter Q_A within such domains. The behaviour of $\Delta I/I$ vs. number of domains (and implicitly, vs. angular scale) is shown in Figure 2.

The character of dependence $\Delta I/I$ vs. λ due to polarization is very similar to that which results from dust density fluctuations (Panek and Rudak, 1988). Therefore, to distinguish between these two mechanisms, direct measurements of the polarization should be carried out.

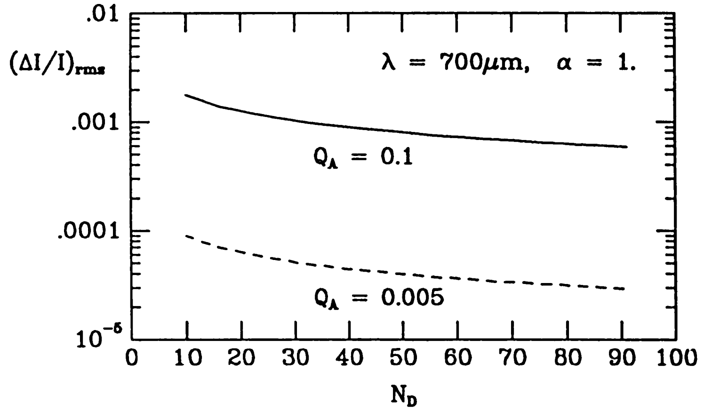

Figure 2. The relative intensity fluctuations vs. number of domains for oblate grains λ = 700 μm (channel 2 in the Nagoya-Berkeley experiment).

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