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OBSERVATIONAL STATUS OF THE TEXTURE LARGE-SCALE STRUCTURE FORMATION MODEL

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ABSTRACT

We reexamined CDM texture large-scale structure (LSS) formation model. We confirmed that texture model is consistent with 4-year COBE data both in an open and a critical matter density ($\Omega_0 = 1$) universes, and then obtained normalization for density perturbation power spectrum. We next compare the power spectrum with LSS observation data. Contrary to the previous literature, we found that texture model matches with these data in an open universe no better than in an $\Omega_0 = 1$ universe. We also found that the model is more likely to fit these data in a cosmological constant dominated (Λ-) universe.

Key Words : cosmology, cosmic defects, CMB, galaxy clustering

We first compare theoretical cosmic microwave background (CMB) fluctuation power spectra both in an $\Omega_0 = 1$ and open universe with 4-yr COBE data given by Górski (1996) in order to test spectrum shape as well as to constrain the amplitude parameter ϵ_4 (Fig.1). Here the ϵ_4 is related to the symmetry breaking scale of texture field, ϕ_0, by $\phi_0 = 1.35\epsilon_4^{1/2}10^{16}$ GeV, and is also proportional to the power spectrum amplitude of CMB ($C_l^{1/2}$) and of matter (Δ).

One notable difference between the $\Omega_0 = 1$ model and the open model is that the spectrum is roughly flat ($C_l l(l+1) \simeq const.$) for the former, while lower multipole components are suppressed for the latter model. This is because at larger scales, the defect dynamics slows down due to the rapid expansion of the universe, while at scales significantly below the curvature scale today, this suppression is small. Since the quadrupole of COBE data is small, the best chi-square fit is given by $\Omega_0 \simeq 0.2$ although this low Ω_0 preference is only marginally statistically significant. Our result is that all texture models for all values of Ω_0 in the range 0.2−1 match these data as well as $n = 1$ inflation model.

In Table 1, we summarize obtained amplitudes for $\Omega_0 = 1$ (upper curve of Pen *et al.*1994, Durrur and Zhou 1996; hereafter PST94, DZ96) and for open texture model (Pen and Spergel 1995; hereafter PS95), (Umeda and Freese 1996 for detail).

Having used COBE to normalize the texture power spectrum on large scales, we now compare to large scale structure data on small scales. Observation data adopted are Peacock and Dodds (1994) galaxy correlation data with bias b_I, the cluster abundance constraint σ_8 (Viana *et al.*1996), the high red-shift DLAS and quasar abundance constraints (Liddle *et al.*1996) and POTENT velocity observations (Dekel 1994; Liddle *et al.*1996). Our results in an $\Omega_0 = 1$ universe (e.g. the left panel of Fig.2) indicate that in order to fit the σ_8 point, amplitudes of the DZ96 and PST94 model have to be 1.5 times larger than the COBE normalization. Also when the model is normalized to COBE,

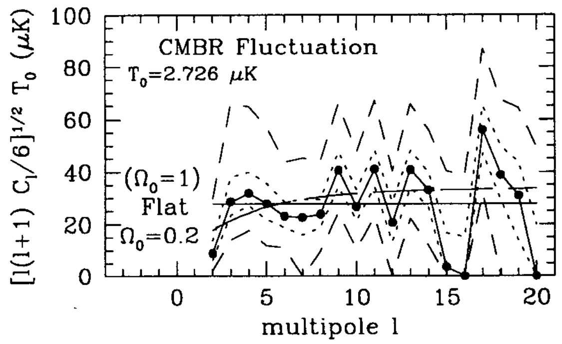

Fig. 1.— Comparison of COBE data and theoretical texture models. The solid and other jagged lines represent the most likely value, 68, and 99% c.l. errors of these data. These data include a full DMR noise model and the Gaussian cosmic variance. The solid and long-dashed curves give the best χ^2 fitting for the flat ($\Omega_0 = 1$) spectrum, and for the PS95 open universe model, respectively.

the bias parameter has to be 1.5 times larger than the value shown in the figure ($b_I = 2$), which is probably unacceptable.

Comparisons in an open and a Λ- universe are shown in the right panel of Fig.2. One advantage of these models is that the CDM power spectrum shape can fit better the galaxy correlation data for a low $\Omega_0 h(\sim 0.2)$ as known previously (e.g. PS95).

In these universe models, the power spectrum amplitude Δ is enhanced by a factor $g(\Omega_0)/\Omega_0\epsilon_4 \simeq \Omega_0^{-0.3}\epsilon_4$ in an open universe and $\simeq \Omega_0^{-0.8}\epsilon_4$ in a Λ- universe (PST94). This enhancement is, however, not necesssarily an advantage of these models, because LSS data also depend on Ω_0. For low Ω_0, this increase of Δ is smaller than the increase of these data in an open universe, while it is larger than data in a Λ- universe (Umeda 1996). From this reason, we conclude that the Λ- model can fit LSS data best among these mod-

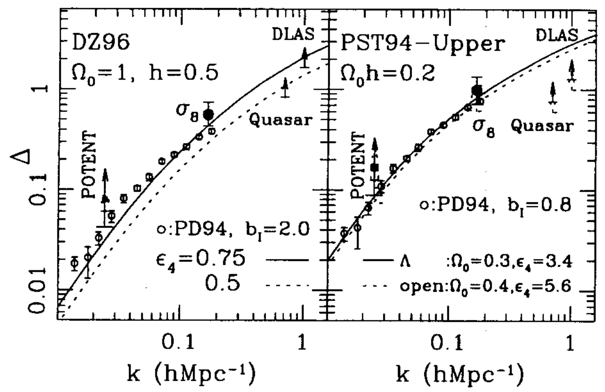

Fig. 2.— Comparison of LSS observation data with power spectra of the $\Omega_0 = 1$ CDM texture model by DZ96 (left panel); and of the PST94 upper curve in an open and a Λ-CDM universes (right panel).

Table 1. Texture theory nomalizations obtained by COBE data fitting. The result includes only a systematic error in determining the averaged power spectrum from simulation results. The PS95 simulation did not include tensor modes. With these modes included, the normalizations shown may be decreased by a factor 1.2 (PS95).

Model	ϵ_4	
	Central	99%c.l.
PST94 $\Omega_0 = 1$	1.1-1.4	0.9-1.7
DZ96 $\Omega_0 = 1$	0.35-0.43	0.3-0.5
PS95 $\Omega_0 = 0.4$	1.4-1.6	1.2-1.9
PS95 $\Omega_0 = 0.2$	2.1-2.5	1.8-2.8

els. Therefore, calculating precise normalization of the Λ- model, which has not been performed, will be interesting to test the texture model. We are grateful to K.Górski for providing us data before publication; D.Spergel, A.Stebbins, I.Szapuki, R.Durrer, and U.Pen for useful conversation. The result includes only a systematic error in determining the averaged power spectrum from simulation results. The PS95 simulation did not include tensor modes. With these modes included, the normalizations shown may be decreased by a factor 1.2 (PS95).

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