ANISOTROPIES IN LUMINOSITY DISTANCE

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Anisotropies in luminosity distance-redshift relation ($d_L - z$ relation) caused by the large-scale structure (LSS) of the universe are studied. We solve the Raychaudhuri equation on FRW models taking account of LSS by the linear perturbation method. Numerical calculations to evaluate the amplitude of the anisotropies are done on flat models with cosmological constant and open models, employing Cold Dark Matter models and COBE-normalization for the power spectrum of the density perturbations.

We found that there are three effects: peculiar velocity, gravitational lensing and Sachs-Wolfe effect. The dominant contribution is the velocity effect for low z and the gravitational lensing for high z.

These anisotropies in d_L cause uncertainties in determining the deceleration parameter $q_0$via magnitude-redshift (equivalent to $d_L - z$) relation: $|\delta q_0| = \frac{2}{z}|\Delta d_L/d_L|$. The fluctuations of d_L are amplified by the factor of $2z^{-1}$, leading to large uncertainties of q_0 for low z. Our calculations give $\Delta d_L/d_L \sim 10^{-1}$ for $z = 0.01$, 10^{-2} for $z = 0.1$, leading to $\delta q_0 \sim 1$ and 0.1, respectively. This indicates that it is *impossible in principle* to constrain the parameter with practical presicion by observing such low z samples. On the other hand, for $z = 0.5$ the uncertainties of q_0 is ~ 0.01. Then the effect of Δd_L is negligible for sources at such high redshifts.

K. Sato (ed.), Cosmological Parameters and the Evolution of the Universe, 269.