TRINITY RELATIONS IN THE UNIVERSE

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On large scales where linear perturbation theory is valid, the mean square values of the mass excess $(\frac{\delta M}{M})^2$, the peculiar velocity v and the microwave background anisotropy $(\frac{\delta T}{T})^2_{sw}$ due to the Sachs-Wolfe effect, are simply expressed in terms of the present-day power spectrum of the density irregularity $P(k)$:

$$(\frac{\delta M}{M})^2(r_M) = \frac{1}{2\pi^2}\int_0^\infty k^2 P(k)\exp(-k^2 r_M^2)dk, \tag{1}$$

$$v^2(r_v) = \frac{\Omega^{1.2}H^2}{2\pi^2}\int_0^\infty P(k)\exp(-k^2 r_v^2)dk, \tag{2}$$

$$(\frac{\delta T}{T})^2_{sw}(r_T) = \frac{\Omega^{0.6}H^4}{8\pi^2}\int_0^\infty k^{-2} P(k)\exp(-k^2 r_T^2)dk. \tag{3}$$

For simplicity, we have used a Gaussian window function. If we consider the length scales satisfying that $r_M > r_v > r_T$, one can prove the inequalities among eqs.(1) to (3), *independently* of the specific form of $P(k)$; in the limit of $r_M \gg r_v \gg r_T$, they are reduced to:

$$(\frac{v}{1300\mathrm{km/sec}}) \gtrsim \Omega^{0.6}(\frac{r_M}{8h^{-1}\mathrm{Mpc}})(\frac{\delta M}{M}), \tag{4}$$

$$(\frac{\delta T/T}{5\times10^{-6}}) \gtrsim \Omega^{0.3}(\frac{r_M}{8h^{-1}\mathrm{Mpc}})^2(\frac{\delta M}{M}), \tag{5}$$

$$(\frac{\delta T/T}{6\times10^{-5}}) \gtrsim \Omega^{-0.3}(\frac{r_v}{60h^{-1}\mathrm{Mpc}})(\frac{v}{1000\mathrm{km/sec}}). \tag{6}$$

Interestingly, the ranges of the predicted values for $(\frac{\delta M}{M}), v$ and $(\frac{\delta T}{T})$ are very close to the observed ones. With the observational data on $(\frac{\delta M}{M}), v$ and $(\frac{\delta T}{T})$, the above *trinity* relations can be used to address the basic question; " Does the gravitational instability picture account for the formation of large scale structures in the universe ? " The detailed work is now in progress (Suto *et al.* 1987).

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