INFLATIONARY UNIVERSE MODELS AND CLUSTERING OF QUASAR RED SHIFTS

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ABSTRACT.   Recently it has been shown that many of the puzzling features
of conventional cosmological models (such as the horizon and flatness
problems) could be explained by invoking inflationary models of the ear-
ly universe with an exponential expansion phase at very early epochs.
These models have the added advantage that they are able to make a defi-
nite prediction about the present matter density in the universe, i.e.
they require that the density be exactly equal to the closure density
which in turn can be easily estimated from the Hubble constant now known
to within a factor of two. Now if one goes back to an earlier idea that
explored the possibility of unusual clustering of quasar redshifts aro-
und z = 2 or 3, we get an example of another cosmological model with a
definite prediction for the present overall matter density. This is a
modified version of the Eddington-Lemaitre type of model which naturally
accommodates such features as a clustering of quasars at certain epochs.
From these models one can get a prediction for the present matter densi-
ty which would be an involved function of the Hubble constant and the
redshifts at which such clustering occurs. It can be shown that if such
clustering had occurred at any z, the present matter density predicted
would be substantially smaller than the corresponding closure density.
The conclusion is that any clustering of quasar redshifts is incompati-
able with inflationary universe models, indirectly providing observat-
ional support for these new theories.

The overall matter density of the universe is usually specified by
the dimensionless parameter expressed as a ratio $\Omega = \rho/\rho_c$. Here ρ
is the actual density and ρ_c is the so called critical density requir-
ed to just close the universe. ρ_c can be related to the measurable qua-
ntity called the Hubble constant H_0 as : $\rho_c = 3H_0^2/8\pi G$ where $H_0 = (\dot{R}/R)_0$
is the present value of the expansion rate of the universe, R being the
scale factor and $\dot{R}$ its time derivative, (o denoting present values) G is
the gravitational constant.

Now big bang nucleosynthesis of the elements deuterium (D), Helium
-4 (He-4), He-3, etc. as well as the dynamics of galaxies and clusters
of galaxies are all consistent with $\Omega \simeq 0.1$ to 0.2. However the con-
ventional big bang model despite its success in naturally accounting for
both the microwave background and the abundance of the light elements

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faces several serious problems when extrapolated to early epochs such as the horizon, flatness and monopole problems. Inflation models involving an early exponential expansion phase appear to resolve most of these problems. But these models require as a prediction that $\Omega = 1$. One other model which makes a definite prediction for the present density ρ_0 of the universe is a variation of the Eddington-Lemaitre model which can also account for any clustering of quasar red shifts at any z if indeed such clustering does occur. Such models involve a 'cosmological constant or Λ-term' which effectively increases the age of the universe thus :

$$t_H = H_0^{-1} \int_0^\infty \frac{dz}{(1+z)[(1+z)^2(1+\Omega z) - (\Lambda c^2/8\pi G\rho_c)z(2+z)]^{1/2}}$$

If clustering of quasars had occurred at some z (say z = 2.2) when the scale factor of expansion was R_z : then we obtain the following equations for the <u>present</u> scale factor, R_0, H_0 and density ρ_0 (all <u>present</u> values)

$$R_0 = R_z(1+z) ; \quad R_z \sim \Lambda^{-1/2}$$

$$H_0 = (\dot{R}/R)_0 = \left(\frac{1}{3}\Lambda c^2 - \frac{c^2}{R_0^2} + \frac{2c^2}{3\Lambda^{1/2} R_0^3 G} \right)^{1/2}$$

$$\rho_0 = (4\pi G R_0^3 \Lambda^{1/2} / c^2)^{-1}$$

For a given z (where redshifts are thought to cluster), we can solve these equations to obtain both H_0 and ρ_0. Thus for z = 2, we have $H_0 = (20/81\Lambda)^{1/2}$ C, and from the observed $H_0 = 50$ km/s/Mpc we have the (predicted) $\rho_0 \leq 5 \times 10^{-31}$ g/cc $\ll \rho_c$. For z = 3, $H_0 = (27/96\Lambda)^{1/2}$ C again $\rho_0 \ll \rho_0$. For all z between 2 and 3 where observations have now and then reported clustering we have $\Omega < 0.1$ as a prediction. As inflation requires $\Omega = 1$, this is not in agreement with the presence of vast amounts of dark matter in the universe.