

$GM = tc^3$ Space/Time Explanation of Supernova Data

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Abstract. EVIDENCE from supernovae and the CMB may confirm a Relativistic Space/Time. Theory provides a simple and unified explanation for problems of current cosmology. Applications extend from the large-scale Universe of Relativity to the microscopic world of quantum phenomena. The principles of Space/Time may appear challenging, but explain our observations with unique precision.

1. General Introduction

RELATIVITY predicts a "Big Bang". The evidence, from redshift and the CMB, contains puzzles that are unexplained by the Standard Big Bang Model. The CMB is too uniform for a Universe expanding at the present value of c . Recent data from supernovae indicates that the distance/redshift relation breaks down at high Z . The observed "critical" density of mass is not explained by current paradigms. Fortunately there are simple, precise explanations for CMB radiation, density and redshifts.

Points in Space/Time have timelike separation $R = ct$ from the "Big Bang" singularity. The spherical Von Riemann Universe (Volume $V = 2\pi^2 R^3$) obeys the cosmological principle: It is closed, unbounded, homogeneous and isotropic. Scale $R = ct$ also expands as t increases, its expansion slowed by gravitation. Gravitation further requires that c and t be related by:

$$GM = tc^3 \quad (1)$$

Where G is Newton's constant, M and t are Mass and age of the Universe.

A simple equation can lead to many solutions. We solve for $c(t)$ and $R(t)$:

$$c(t) = (GM)^{1/3}t^{-1/3} \quad (2)$$

$$R(t) = ct = (GM)^{1/3}t^{2/3} \quad (3)$$

Latter is the metric of Einstein-de Sitter expansion, the favoured model of both authors. The Universe expands and slows to infinity, never stopping or reversing its expansion.

Any cosmology should satisfy the Einstein-Friedmann equations. They may be derived from General Relativity or Newtonian mechanics:

$$\left(\frac{\dot{R}}{R}\right)^2 = \frac{8\pi G\rho}{3} \quad (4)$$

$$\left(\frac{\ddot{R}}{R}\right) = -\frac{4\pi G\rho}{3} \quad (5)$$

When $k = 0$, $R = ct$ and $GM = tc^3$ form an exact solution of $\rho = (6\pi Gt^2)^{-1}$. This "critical" density $\Omega = 1$ of Einstein-de Sitter expansion is actually the stable density. Below that density, pair production of matter may be predicted.

At low values of t , baryonic matter will not have formed. For initial mass M , density ρ_i is then:

$$\rho_i = \frac{M}{V} = \frac{tc^3/G}{2\pi^2(ct)^3} = (2\pi^2Gt^2)^{-1} \quad (6)$$

Difference between ρ_i before matter formation and stable density $\rho = (6\pi Gt^2)^{-1}$ is 4.507%. This prediction is supported by the WMAP estimate of $4.4 \pm 0.3\%$. WMAP also indicates overall density $\Omega = 1$ as predicted. As with the Standard Big Bang Model, observed proportions of light elements may be calculated. Uniquely and without hypothetical fields, Theory predicts both overall density $\Omega = 1$ and the amount of baryonic matter.

Uniformity in the CMB shows that the Universe has expanded faster than the present value of c . From $GM = tc^3$ we may calculate the horizon distance:

$$\int_0^{t_0} c(t)dt = \frac{3}{2}(GM)^{1/3}t_0^{2/3} = \frac{3}{2}c_0t_0 \quad (7)$$

Where c_0 and t_0 are their present values, $(GM)^{1/3} = c_0t_0^{1/3}$. The horizon distance is proportional to scale factor $R = ct$. That should be a requirement of cosmology, otherwise new structures would continually appear in the CMB. Lack of the large-scale fluctuation spectrum predicted by inflation is easily explained. Theory uniquely satisfies the "horizon problem" without inflated parameters.

Another exciting prospect is the formation of large-scale singularities. Primordial Black Holes are an acknowledged consequence of density fluctuations, their size limited only by the horizon distance. There is growing consensus that large Black Holes accompanied early evolution of quasars and galaxies. Theory provides an origin to these structures. The horizon allowed density fluctuations to form singularities with a large range of masses. These massive Black Holes would have seeded the formation of clusters, galaxies, and possibly objects within galaxies.

Formation of structures is highly complex, but may be modelled as waves fluctuating about an average density. Smaller fluctuations will occur randomly, but normal Gaussian distribution predicts that 68% of mass will lie in regions of overdensity. Such regions will have collapsed into singularities, appearing as great voids between sheets of galaxies. The missing 68% of the Universe ascribed to Dark Energy may be hidden within those voids.

Statistics also predict that many smaller singularities will have formed. Such medium-sized Black Holes will be attracted by larger masses and form haloes around the galaxies. Black Holes may form the majority of the "Dark Matter". Continued observing for this "Dark" component is therefore encouraged. Applications of Theory may explain the both the formation of large-scale structures and "Dark Matter".

The "most profound mystery" of supernova redshifts may be predicted from Theory. As anticipated, the applications are far-reaching. Most observations indicate that the energy relationship $hc = E\lambda$ is constant, as are the fine-structure value $\frac{e^2}{hc}$ and the gravitational coupling value $\frac{\hbar c}{Gm_p^2}$. This is not an obstacle, but a possible path into the microscopic world. The common factor (hc) is considered constant, linking Relativity to quantum theory. Scalar field $h(t)$ allows calculation of conditions in the very early Universe. The effect of $c(t)$ upon redshift is striking evidence.

Our observations of distant supernovae allow magnitude to be compared with redshift, providing a test of Theory. Redshift increases linearly at low Z , indicating $\Omega = 1$ and Einstein-de Sitter expansion as predicted. At high redshifts $\frac{v}{c}$ has been observed to increase non-linearly, suggesting acceleration. Alternately the data shows that c has decreased at precisely the rate predicted.

Once again we have $c(t) = (GM)^{1/3}t^{-1/3}$ and $R(t) = (GM)^{1/3}t^{1/3}$:

$$\left(\frac{R_0}{R_i}\right) = \left(\frac{t_0}{t_i}\right)^{2/3} = 1 + Z \quad (8)$$

$$\left(\frac{c_i}{c_0}\right) = \left(\frac{t_0}{t_i}\right)^{1/3} = \sqrt{1 + Z} \quad (9)$$

When light of redshift Z was emitted, c was greater by factor $\sqrt{1 + Z}$. Apparent redshift is therefore decreased. This effect is only apparent at high Z . For supernovae of Absolute $Z = 0.5$, apparent $z = .38$. For Absolute $Z = 1.0$, apparent $z = .57$. Supernova energy output $E = mc^2$ is also affected up to factor $\left(\frac{c_i}{c_0}\right)^2 = 1 + Z$. For $Z = 0.5$, $\frac{E_i}{E_0} = 1.5$ for a maximum magnitude change of $-.44$. For $Z = 1.0$, maximum magnitude change is $-.75$. Compared with the curve of supernova redshifts, Theory produces an unprecedented fit with data.

Using data from both supernova groups and WMAP, one may reach these conclusions: (1)The Universe is of stable density $\Omega = 1$, as predicted. (2)The Universe expands and slows as predicted. (3)The value c is given by $GM = tc^3$. First two conclusions are shown by the general slope of supernova redshifts and the first acoustic peak in the CMB. The last conclusion is strongly indicated by the curve of supernova redshifts. Observations allow cosmological Theory to be precisely verified.

Future observations will aid in providing more precise tests. The Planck spacecraft and a Supernova Astronomy Probe will be especially helpful. Present Theory uniquely predicts the scale, expansion, overall density and amount of baryonic matter in the Universe. Horizon and supernova data may also be explained without hypothetical fields or energies. Observations of "Dark Matter" and "Dark Energy" may lead to profound solutions. Since Space/Time precisely predicts observations and not epicycles, Theory should be considered as an alternative to more cumbersome ideas.

Acknowledgements to High-Z Supernova Search and Supernova Cosmology Project. Travel for research is being funded by SFSU College of Science and Engineering. Thanks are due to Tod Lauer, Kathy English and NOAO for organising a successful conference. Questions and comments are welcome at Sailorstarfightr@yahoo.com