Cosmology, Gravity, and the WMAP ratio 0.73 : 0.23 : 0.04

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[Note - shortly after arXiv removed this paper, in response to some comments mde by others, I added the material set off by [ ] .]

Abstract

WMAP results indicate that our universe is now made up of 73% dark energy (DE), 23% dark matter (DM), and 4% ordinary matter (OM), the DE possibly being in the form of a cosmological constant (itself a misnomer, as a "cosmological constant" can be variable). A model of gravity based on the conformal group Spin(2,4) = SU(2,2), motivated by work of I. E. Segal, can be used to estimate the present-day DE : DM : OM ratio. If DM obeys the ordinary matter equation of state, then the model gives the ratio 0.753 : 0.202 : 0.045, which is quite close to the WMAP observation of 0.73 : 0.23 : 0.04.

WMAP results indicate that our universe is now made up of 73% dark energy (DE), 23% dark matter (DM), and 4% ordinary matter (OM), the DE possibly being in the form of a cosmological constant (itself a misnomer, as a "cosmological constant" can be variable).

In the D4-D5-E6-E7-E8 VoDou Physics model, Gravity and the Cosmological Constant come from the MacDowell-Mansouri Mechanism and the 15-dimensional Spin(2,4) = SU(2,2) Conformal Group, which is the group used by Irving Ezra Segal in his work on gravity and cosmology.

The 15 generators of the Conformal Group SU(2,2) = Spin(2,4) correspond to:

- 3 Rotations;
- 3 Boosts;
- 4 Translations;
- 4 Special Conformal transformations; and
- 1 Dilatation.

The main purpose of this paper is to use the structure of the Conformal group to estimate the present-day ratio

DE : DM : OM

which, according to WMAP results, is

.73 : .23 : .04

The basis of the estimation is the following correspondence:

- DE (dark energy, cosmological constant) - the 10 Rotations, Boosts, and Special Conformal generators
- DM (dark matter) - the 4 Translations
- OM (ordinary matter) - the 1 Dilatation

[Here is some motivation for the above correspondence:

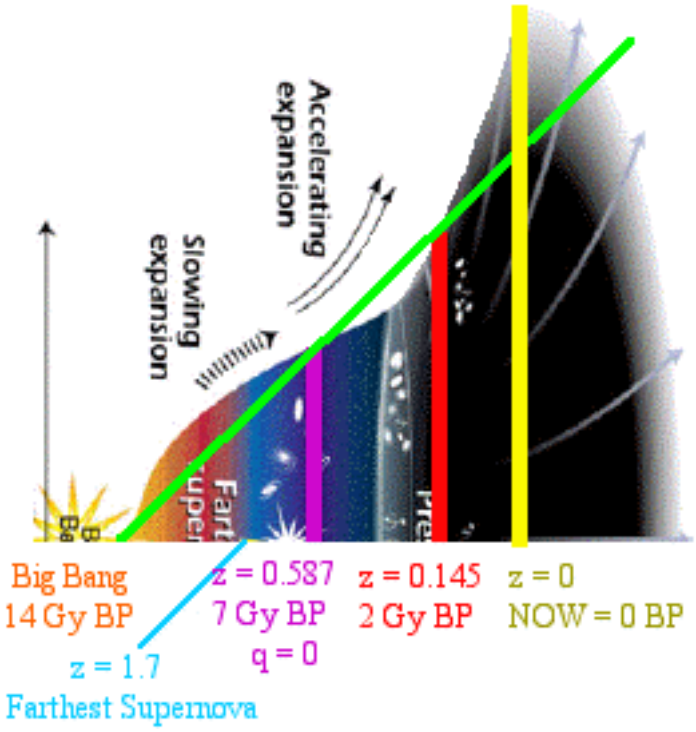
- DE is the NORMAL state of stuff in our universe (it is now, according to WMAP, about 73% of it). It looks more like deSitter spacetime than Minkowski spacetime. In Segal's model and as Aldrovandi and Peireira show in some mathematical detail in their paper at gr-qc/9809061 the DE spacetime structure comes from "... the group Q, formed by a semi-direct product between Lorentz and special conformal transformation groups ...". Those are the 10 Rotations, Boosts and Special Conformal generators that correspond to DE.
- DM is a lesser part (it is now, according to WMAP, about 23% of it) of our universe, and differs from the dominant DE by being based on the 4 Translations that are the basis for Einstein's description of spacetime curvature, which in turn describes effective mass (such as the mass of such DM candidates as primordial black holes). Those 4 Translations therefore correspond to DM.
- OM (the stuff of which we and Earth are made) is sort of weird and exceptional (it is now, according to WMAP, only about 4% of it). For us to call it ordinary is quite provincial, because it is only ordinary in the context of our physical bodies and the planet on which we live. What characterizes all OM is that its mass comes from the Higgs mechanism. The Dilatation gives the spin 0 Higgs field, and therefore all the mass of OM, so the 1 Dilatation therefore corresponds to OM.

In terms of I. E. Segal's book Mathematical Cosmology and Extragalactic Astronomy (Academic Press 1976), you might say that DE and DM are respectively related to Unispace and Minkowski space, and that OM is something like a little frothy foam on/in the DE/DM system.]

As a first-order calculation, the correspondence gives the ratio

DE : DM : OM = 10/15 : 4/15 : 1/15 = **.67 : .27 : .06**

However, the various components of DE, DM, and OM vary differently with time (or, equivalently, with the radius of our expanding universe), so the ratio 0.67 : 0.27 : 0.06 is valid only for a particular time, or scale factor, of our Universe, so it is necessary to ask at what stage of the expansion of the universe should the first-order ratio 0.67 : 0.27 : 0.06 be valid. In order to answer that question, we should try to see **what are the Special Times in the History of our Universe ?**



There seem to be four Special Times in the history of our Universe:

- the **Big Bang Beginning of Inflation** (about 13.7 Gy BP);
- the **End of Inflation** = Beginning of Decelerating Expansion (beginning of green line also about 13.7 Gy BP);
- the **End of Deceleration** (q=0) = Inflection Point = Beginning of Accelerating Expansion (purple vertical line at about z = 0.587 and about 7 Gy BP). According to a hubble site web page credited to Ann Feild, the above diagram "... reveals changes in the rate of expansion since the universe's birth 15 billion years ago. ... **The curve changes noticeably about 7.5 billion years ago**, when objects in the universe began flying apart as a faster rate. ...". According to a CERN Courier web page: "... Saul Perlmutter, who is head of the Supernova Cosmology Project ... and his team have studied altogether some 80 high red-shift type Ia supernovae. Their results imply that **the universe was decelerating for the first half of its existence, and then began accelerating approximately 7 billion years ago**. ...". According to astro-ph/0106051 by Michael S. Turner and Adam G. Riess: "... **current supernova data ... favor deceleration at z > 0.5** ... **SN 1997ff at z = 1.7** provides direct evidence for an early phase of slowing expansion if the dark energy is a cosmological constant ...".
- the **Last Intersection** of the Accelerating Expansion of our Universe with Linear Expansion

(green line) from End of Inflation (first interesection) through Inflection Point (second intersection, at purple vertical line at about z = 0.587 and about 7 Gy BP) to the Third Intersection (at red vertical line at z = 0.145 and about 2 Gy BP), which is also around the times of the beginning of the Proterozoic Era and Eukaryotic Life, Fe2O3 Hematite ferric iron Red Bed formations, a Snowball Earth, and the start of the Oklo fission reactor.

After the Last Intersection at the end of the Early Part of the Accelerating Expansion of our Universe, expansion of our Universe continues to accelerate with the Late Part of its Accelerating Expansion.

Those four Special Times define four Special Epochs:

- The **Inflation Epoch**, beginning with the Big Bang and ending with the End of Inflation. The Inflation Epoch is described by Zizzi Quantum Inflation, ending with Self-Decoherence of our Universe.
- The **Decelerating Expansion Epoch**, beginning with the End of Inflation. During the Decelerating Expansion Epoch, the Radiation Era is succeeded by the Matter Era, and the Matter Components (Dark and Ordinary) remain more prominent than they would be under the "standard norm" conditions of Linear Expansion.
- The **Early Accelerating Expansion Epoch**, beginning with the End of Deceleration and ending with the Last Intersection of Accelerating Expansion with Linear Expansion. During Accelerating Expansion, the prominence of Matter Components (Dark and Ordinary) declines, reaching the "standard norm" condition of Linear Expansion at the end of the Early Accelerating Expansion Epoch at the Last Intersection with the Line of Linear Expansion.
- The **Late Accelerating Expansion Epoch**, beginning with the Last Intersection and continuing into the far future. During the Late Accelerating Expansion Epoch, DE dark energy is more prominent than it would be under the "standard norm" conditions of Linear Expansion.

In making my estimation of the ratio DE : DM : OM, **the time of the first approximation ratio 0.67 : 0.27 : 0.06** is taken to be the time of the Last Intersection, which **is about 2 billion years ago**.

To see how the ratio DE : DM : OM evolved during the 2 billion years from the Last Intersection to the present time, you must know the value of w in equation of state

density =proportional= 1 / R^3(1+w)

for DE, DM, and OM in our universe at a time when its scale factor is R.

- For DE (dark energy cosmological constant), w = -1
- For DM(dark matter) that obeys the ordinary matter equation of state, w = 0
- For OM, w = 0

About 2 billion years ago, the redshift z = 0.145 , or 1+z = 1.145, or (1+z)^3 = 1.5,

so that from then to now:

- DM density would decline by the1 / R^3 factor as Ordinary Matter, from .27 to .27 / 1.5 = .18.
- OM density would decline by the1 / R^3 factor as Ordinary Matter, from .06 to .06 / 1.5 = .04
- DE density would remain constant at .67.

Therefore, the ratio as of now would be

DE : DM : OM = .67 : .18 : .04 = .753 : 202 : 0.45

or

75.3% : 20.2% : 4.5%

which is quite close to the WMAP observation of

73% : 23% : 4%.