Alternative Cosmology Group Newsletter - 2007 Year End Review

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Cosmology in 2007: A Year-End Survey

By Eric J. Lerner

In the past year, evidence again the conventional Big Bang model built up on several fronts. The evidence that the cosmic background radiation (CBR) is not randomly spread across the sky, as the inflationary Big Bang predicts, has become overwhelming. The contradictions between Big Bang predictions of the abundance of light elements and observations continue to get worse. In addition, new observations have contradicted the conventional concept of a universe that is homogenous and isotropic, demonstrating alignments of galaxies on extremely large scales.

Unfortunately, the accumulation of evidence hasn't yet sparked a general debate in cosmology over whether the Big Bang model is a valid one. But there are a few small signs that there is beginning to be a greater openness to questioning at least some aspects of the "convergence cosmology" and its ever-growing grab-bag of hypothetical constructs, like inflation, dark matter, dark energy, and quintessence. As conventional cosmologists leap ever higher into the realms of fantasy, even the popular press is starting, ever-so tentatively, to wonder if the Emperor really is naked.

1. Problems mount with the Big Bang

A. Patterns in the CBR become indisputable

The hypothetical process of "inflation" is a crucial part of the current Big Bang model. Without this early period of super-fast expansion, the theory predicts that different parts of the sky should have widely differing intensities of the CBR, in contradiction to observations. While inflation is a purely ad-hoc hypothetical process, based on no known laws of physics, it does make one firm prediction. This is that the small anisotropies or fluctuations in the CBR should be distributed entirely randomly—in a Gaussian distribution.

Yet almost since the first results of the WMAP satellite were released four years ago, it has been clear that the small anisotropies in the CBR are not random, there are patterns. Especially at large angular sale in the sky, there are regions where the CBR is smoother and where it is lumpier. In addition there are too many "hot" and "cold" spots in the sky for a Gaussian distribution.

There have been a number of efforts to try to attribute this non-randomness to a limited section of the sky which is "anomalous" and in particular to the "WMAP cold spot" a region of the sky with the least intense CBR. Lawrence Rudnick et al published a widely noted paper in which they tried to attribute the cold spot to a huge void, 280 Mpc in diameter that has been observed in the distribution of radio galaxies. The idea was that the gravitational effects of such a void could slightly redshift CBR photons from that direction.

However, Pavel Naselsky et al, among others demonstrated statistically that the non-Gaussian patterns on the sky are not just limited to the Cold Spot. Aleksandar Rakic, and Dominik J. Schwarz showed convincingly that the patterns are incompatible with the hypothesis of Guassianity, and Amit Yadav and Benajmin Wandelt, using a different method of analysis, ruled out the inflationary prediction at the 99.5% confidence level. The hot and cold spots themselves are not circular and show alignments on the sky as P. Vielva et al demonstrate.

Despite all this contradictory evidence, in only one paper, that of Y. Wiaux et al, is the validity of the inflationary hypothesis explicitly questioned. By contrast, Yadav and Wandelt conclude, not that the inflationary theory is wrong, but only that it is too simple and that more "exotic theories" with "multiple scalar fields, features in inflation potential, non-adiabatic fluctuations, non-canonical kinetic terms, deviations from the Bunch-Davies vacuum" will be needed.

To complicate the picture further, Gerrit L Verschuur finds that much of the anisotropy correlates with plasma clouds within the Milky Way, although the statistical significance of these correlations is still in some dispute.

Extragalactic Radio Sources and the WMAP Cold Spot
Authors: Lawrence Rudnick, Shea Brown, Liliya R. Williams
http://arxiv.org/abs/0704.0908v1

The mystery of the WMAP cold spot
Authors: Pave D. Naselsky (1), Per Rex Christensen (1), Peter Coles (2), Oleg Verkhodanov (3), Dmitry Novikov (4,5), Jaiseung Kim (1) ((1) Niels Bohr Institute, Copenhagen, Denmark; (2) School of Physics and Astronomy, Cardiff University, Wales, United Kingdom; (3) Special astrophysical observatory, Nizhnij Arkhyz, Russia; (4) Imperial College, London, United Kingdom; (5) AstroSpace Center of Lebedev Physical Institute, Moscow, Russia)
http://arxiv.org/abs/0712.1118v1

Correlating anomalies of the microwave sky: The Good, the Evil and the Axis
Authors: Aleksandar Rakic, and Dominik J. Schwarz
http://arxiv.org/abs/astro-ph/0703266v2

P. Vielva, Y. Wiaux, E. Martinez, P. Vandergheynst: Alignment and signed-intensity anomalies in WMAP data (MNRAS 000, 1 - 12, 2007)
http://arxiv.org/abs/0704.3736v2

Non-Guassianity analysis on local morphological measures of WMAP data
Authors: Y. Wiaux, P. Vielva, R. B. Barreiro, E. Martinez-Gonzalez, P. Vandergheynst
http://arxiv.org/abs/0706.2346v1

Detection of primordial non-Gaussianity (fNL) in the WMAP 3-year data at above 99.5% confidence
Authors: Amit P. S. Yadav, Benjamin D. Wandelt
http://arxiv.org/abs/0712.1148v2

High Galactic Latitude Interstellar Neutral Hydrogen Structure and Associated (WMAP) High Frequency Continuum Emission
Author: Gerrit L. Verschuur
http://arxiv.org/abs/0704.1125v2

B. SZ anomaly raises questions of the nature of the CBR

In the conventional cosmology, the CBR is assumed to come from vast distances corresponding to the early years after the Big Bang. As a result it is expected that dense clouds of plasma in clusters of galaxies will cast slight shadows by the CBR radiation coming from beyond them. This shadowing effect is called the Sunyaev-Zeldovich effect. In 2006 Richard Lieu et al pointed out that the shadowing effect was much less than was expected, implying that the CBR originated between us and the clusters, not beyond them. In 2007, Bailey and Shanks extended this analysis to many more clusters than the 31 studied by Lieu. They found that not only was the SZ effect less than expected, it tended to disappear as the redshift of the clusters studied went from 0.1 to 0.3, implying that most of the CBR come from redshifts less than 0.3. The authors did not draw that conclusion. But they did show that there was no available conventional explanation of the results.

Anomalous SZ Contribution to 3 Year WMAP Data
Authors: R.M. Bielby, T. Shanks
http://arxiv.org/abs/astro-ph/0703470v1

C. Light elements prediction in further conflict with observation

A second key prediction of the Big Bang model is the abundance of certain light isotopes deuterium He-3, He4- and Li-7. In particular, the Big Bang is supposed to have produce almost exactly 25% He as compared with hydrogen.

However, in an important paper that has received almost no notice although it was posted on the ArXiv in March, 2007 and published in MNRAS in December, Luca Casagrande et al show that old main sequence stars have much less helium than Big Bang nucleosynthesis predicts. Since He-4 is produced by stars, they should have more helium, not less, than the Big Bang predictions. The ones with the least helium are the ones that have the least heavier elements, which all astronomers agree are formed in stars and then distributed into interstellar space, going on to be incorporated in other stars. If helium abundance rises with heavy element abundance from values well below the primordial one, it implies that the helium, as well as the heavier elements, is formed in ordinary stars early in the process of forming a galaxy. This is exactly what a number of researchers, including myself, have hypothesized as the origin of the so-called primordial helium.

Casagrande et al found that for stars that had a metal (heavy element content) of less than 1.3%, the average helium abundance was 18+2%, three standard deviations below the Big Bang predictions. For individual stars the situation was even worse. The star in the sample with the fourth lowest metallicity, 0.14% (8% of the solar value), thus presumably the fourth oldest, had a helium abundance of 13+2% or six sigma below the predicted value. Two other individual stars had helium content more than four sigma below the predicted value, including one with a helium abundance of only 9.5+3.2%, less than half the predicted value.

However, Casagrande et al do not draw the conclusion that this data tends to refute the Big Bang theory. While they carefully rule out any explanation due to problems in stellar theory or their measurements, they conclude that there must be an unknown problem in the data. One caution about this data is that the helium is measured indirectly using stellar theory. However, the theory is a well-confirmed one.

For many years it has been know that the BBN lithium prediction was too high by a factor of at least three as compared with measurements of lithium in the atmosphere of old stars. The discovery of Li6 as well in these stars has made the problem worse. On the one hand, Li6 is very easily burned in stars, so if some of the Li7 was destroyed by stellar nuclear reactions, all of the Li6 would have been, so the existence of the Li6 implies that there has been very little destruction. But in addition the Big Bang does not predict the production of any Li6. Prodanovic and Fields assume that the Li6 is produced by cosmic rays, and find that these must produce some Li7 as well. This makes the contradiction between the predicted amount of Li7 and observation even worse.

The Helium abundance and Delta Y / Delta Z in Lower Main Sequence stars
Authors: Luca Casagrande (1,2), Chris Flynn (1,2), Laura Portinari (1,2), Leo Girardi (3), Raul Jimenez (4) ((1) Tuorla Observatory, (2) University of Turku, (3) INAF Padova Observatory, (4) UPenn)
http://arxiv.org/abs/astro-ph/0703766v1

Monthly Notices of the Royal Astronomical Society, Volume 382, Issue 4, Page 1516-1540, Dec 2007

Cosmological Cosmic Rays: Sharpening the Primordial Lithium Problem
Authors: Tijana Prodanovic, Brian D. Fields
http://arxiv.org/abs/0709.3300

D. More anisotropy

Conventional cosmology hypothesizes that the universe, on a large scale, is isotropic. Yet this year, evidence has shown large-scale anisotropies in measurements other than that of the CBR. Michael J. Longo showed that spiral galaxies tend to spiral more in one direction than another, possibly implying a large scale magnetic field in region some 350 Mpc across. The alignment of the spins seems to point in direction close to that defined by anisotropies in the CBR.

There is also an asymmetry in the Hubble expansion, or in the velocities of galaxies within an even large volume, some 600 Mpc or more across. First Megan L. McClure and C. C. Dyer, and then Dominik J. Schwarz and Bastian Weinhorst used supernova data to find that the Hubble constant is about 10% lower in some directions than in others, implying either an asymmetry in the process that creates the Hubble redshift, or velocities for galaxies of up to 3,000 km/sec.

Is the Cosmic "Axis of Evil" due to a Large-Scale Magnetic Field?
Authors: Michael J. Longo
http://arxiv.org/abs/astro-ph/0703694v2

Does the Universe Have a Handedness?
Authors: Michael J. Longo

http://arxiv.org/abs/astro-ph/0703325v2

Anisotropy in the Hubble constant as observed in the HST Extragalactic Distance Scale Key Project results
Authors: M. L. McClure, C. C. Dyer
http://arxiv.org/abs/astro-ph/0703556v1

(An)isotropy of the Hubble diagram: comparing hemispheres
Authors: Dominik J. Schwarz, Bastian Weinhorst
http://arxiv.org/abs/0706.0165v1

E. Too high surface brightness galaxies

If the universe is expanding, the surface brightness (apparent luminosity divided by apparent surface area) of distant galaxies will be much less than that of nearby ones. But if it is not expanding, the surface brightness will be the same. It turns out that the surface brightness is, in fact, the same. The conventional, Big Bang, explanation of this observation is that the distant galaxies have extremely high intrinsic surface brightness but with cosmological dimming, by coincidence, they appear to have the same surface brightness as nearby ones. One of the big problems with this explanation is that the implied intrinsic surface brightness is much larger than that observed for any nearby galaxies and may be physically impossible.

In 2007, Akiyama et al studying size and surface brightness of galaxies in the optical V band find that at z=3, the highest surface brightnesses, assuming cosmological dimming, are 16 times brighter than any in the nearby universe. Trujillo et al looked at massive galaxies and find that at z=1.85 the most massive, >10^11 stellar mass, galaxies are five times smaller than nearby galaxies, taking into account the assumed cosmological formula for converting angular dimensions to linear dimensions. (The expanding universe formula makes objects (1+z) ^1.5 times smaller than they would be if the universe is not expanding.) This implies that they are 125 times denser than massive galaxies today and such dense galaxies are not found in the nearby universe. Trujillo et al hypothesize that mergers could reduce their density, but such mergers would make them into extremely massive galaxies, which are very rare.

Are there really such super bright galaxies in the nearby universe? An earlier paper by Hoopes et al had claimed to have discovered such super-high-surface- brightness galaxies in the nearby universe. But Riccardo Scarpa, Renato Falamo and myself point out the errors in their analysis, indicating that no such super-galaxies have been found locally. Overzier et al replied with Hubble Space Telescope observations that, they claim, shows that extremely small bright galaxies do exist today, so could have existed at high z. The catch is that only one of the galaxies observed with HST was observed in the far UV wavelengths that the high-z galaxies are observed at. This one galaxy had a surface brightness intermediate between that claimed by Hoopes and that claimed for the same galaxy by Scarpa based on ground telescope observations. There will be much more to come on this debate in 2008.

Strong size evolution of the most massive galaxies since z~2
Authors: Ignacio Trujillo, Christopher J. Conselice, Kevin Bundy, M. C. Cooper, P. Eisenhardt, Richard S. Ellis
http://arxiv.org/abs/0709.0621v1

Adaptive Optics Rest-Frame V-band Imaging of Lyman Break Galaxies at z~3: High-surface Density Disk-like Galaxies ?
Authors: M.Akiyama, Y.Minowa, N.Kobayashi, K.Ohta, M.Ando, I.Iwata
http://arxiv.org/abs/0709.2714v1

Title: Do local analogs of Lyman Break Galaxies exist?
Authors: Riccardo Scarpa, Renato Falomo, Eric Lerner
http://arxiv.org/abs/0706.2948

HST morphologies of local Lyman break galaxy analogs I: Evidence for starbursts triggered by merging
Authors: Roderik A. Overzier, Timothy M. Heckman, Guinevere Kauffmann, Mark Seibert, R. Michael Rich, Antara Basu-Zych, Jennifer Lotz, Alessandra Aloisi, Stephane Charlot, Charles Hoopes, D. Christopher Martin, David Schiminovich
http://arxiv.org/abs/0709.3304v2

2. Growth of the debate about cosmological models

In what is perhaps a sign that popular science journals are becoming more open to talking about the problems of conventional cosmology, American Scientist has published in its September-October issue a critique of the Big Bang by Dr. Michael Disney . American Scientist is the publication of Sigma Chi, the US scientific research society, and is aimed at a general audience. The article, forthrightly titled ”Modern Cosmology, Science or Folk-tale” demonstrates that at all points in its history the Big Bang model has had more independent adjustable parameters than observable data points, giving it almost no powers of prediction, the key characteristic of scientific theories. Dr. Disney participated in the first Crisis in Cosmology Conference.

In an as-yet unpublished paper, Richard Lieu surveys the “evidence” for the convergence cosmology and finds it wanting, although he does not go so far as to question the reality of the Big Bang itself.

In a survey of cosmology aimed at philosophers, Timothy Eastman concludes that the dominant cosmology can not be taken as fully established and that other approaches have to be considered. In his view, no current cosmology accounts for all the observations.

Modern Cosmology, Science or Folk-tale
Author: Michael Disney
http://www.americanscientist.org/template/AssetDetail/assetid/55839

LambdaCDM cosmology: how much suppression of credible evidence, and does the model really lead its competitors, using all evidence?
Authors: Richard Lieu
http://arxiv.org/abs/0705.2462

Cosmic Agnosticism
Author: Timothy Eastman
"Process Studies" (Vol. 36.2, Fall-Winter 2007, pp. 181-197) *(not yet online)*

3. Work on alternative theories

A. MOND work grows

Last year, there was a continued growth in the number of papers dealing with Modified Newtonian Dynamics or MOND. MOND is an alternative theory to dark matter as an explanation of the velocity curves of galaxies. It hypothesizes that gravity is stronger than in the Newtonian theory at low accelerations.

Sky and Telescope, the leading US amateur astronomy magazine, featured an article on MOND, the first coverage in years in the magazine of alternative cosmology.

A number of papers described ways to develop the theory behind MOND and make predictions with it. Other papers looked at the so-called Bullet Cluster, a pair of colliding clusters of galaxies that was used in 2006 to “prove” the existence of dark matter. These papers demonstrated that MOND could describe the cluster observation better than dark matter. In addition, Scarpa et al showed that MOND could also describe velocities of stars in a globular cluster, which is not supposed to contain any dark matter.

The modified Newtonian dynamics-MOND-and its implications for new physics
Authors: Jacob D. Buckstein
http://www.arxiv.org/abs/astro-ph/0701848

Fundamental parameter-free solutions in Modified Gravity
Authors: J. W. Moffat, V. T. Tooth
http://arxiv.org/abs/0712.1796v2

The collision velocity of the bullet cluster in conventional and modified dynamics
Authors: Garry W. Angus (St. Andrews), Stacy S. McGaugh (Maryland)
http://arxiv.org/abs/0704.0381v1

The Bullet Cluster 1E0657-558 evidence shows Modified Gravity in the absence of Dark Matter
Authors: J. R. Brownstein, J. W. Moffat
http://lanl.arxiv.org/abs/astro-ph/0702146

Using Globular Clusters to Test Gravity in the Weak Acceleration Regime
Authors: Riccardo Scarpa, Gianni Marconi, Roberto Gilmozzi, Giovanni Carraro
http://www.eso.org/sci/publications/messenger/

4. Evidence and theories about intrinsic redshifts in quasars

As in previous years, evidence continues to accumulate that quasar (QSO) redshifts are at least in part intrinsic, and that many QSOs are no where near as distant as the redshifts imply. Ryabinkov showed that there are periodicities in the absorption line spectra in QSOs, a pattern that would not be expected if the absorption lines were from intervening galaxies. Bell and McDiarmid showed that the angular motions in quasar jets are more easily understood if the QSOs are not at extreme distance.

There may be a plasma-based explanation of what could generate the redshifts within the atmosphere of the quasar. Sisir Roy et al have devoted such a theory and have compared it to quasar observations.

The redshift distribution of absorption-line systems in QSO spectra
Authors: A.I. Ryabinkov, A.D. Kaminker, D.A. Varshalovich
http://www.arxiv.org/abs/astro-ph/0703277v1

An Abrupt Upper Envelope Cut-off in the Distribution of Angular Motions in Quasar Jets is Compatible in all Respects with a Simple Non-Relativistic Ejection Model
Authors: M.B. Bell, D.R McDiarmid
http://arxiv.org/abs/astro-ph/0701093

Dynamic Multiple Scattering, Frequency Shift and Possible Effects on Quasar Astronomy
Authors: Sisir Roy, Malabika Roy, Joydip Ghosh, Menas Kafatos.
http://lanl.arxiv.org/abs/astro-ph/0701071