Pre-Big Bang, vacuum and noncyclic cosmologies - Description of HEP 2011 poster 707

Luis Gonzalez-Mestres[a]

[a]LAPP, Université de Savoie, CNRS/IN2P3, B.P. 110, 74941 Annecy-le-Vieux Cedex, France

WMAP and Planck open the way to unprecedented Big Bang phenomenology, not only for the standard Big Bang model but also for less conventional approaches including pre-Big Bang patterns. An example is provided by the recent claim (Gurzadyan et al.) that the cosmological sky is a weakly random one with mostly regular signal. If confirmed, this situation would have significant implications not only for cyclic cosmologies following the analyses recently proposed by Gurzadyan and Penrose, but also for noncyclic cosmologies incorporating a new fundamental scale beyond Planck scale and, possibly, new ultimate constituents of matter with unconventional basic properties as compared to conventional particles. More generally and in all cases, new alternatives to standard physics can be considered from a cosmological point of view concerning vacuum structure, the nature of space-time, the origin of our Universe, the validity of quantum field theory, solutions to the cosmological constant problem, inflationary scenarios, dark matter and dark energy, a new approach to string-like theories... Lorentz-like symmetries (standard or superbradyonic) can then be naturally stable space-time configurations produced in general cosmological scenarios including the formation and evolution of the present vacuum. We discuss basic ideas and phenomenological issues for non-cyclic pre-Big Bang cosmologies in the present context.

1. Georges Lemaître, Bing Bang, constant and law

The poster evokes the 80th anniversary of the Big Bang hypothesis, with a photograph of Georges Lemaître and the first page of his 1931 paper [1] followed by pages 55 and 56 from his article [2] that introduced the law relating velocities, distances and redshifts and the constant associated to this law.

2. Cosmology and superbradyons

The introduction :

1931-2011
- 80 years after the Big Bang hypothesis
- Are the standard quanta ultimate constituents ?
- What beyond Big Bang ?

(end of quote)

is followed by the explanation :

Possible hypotheses

- Pre-Universe made of the actual ultimate constituents of standard matter (superbradyons ?)
- String scenario (Gasperini, Veneziano). But are strings " elementary " ?
-Initial singularity generating the " primeval quanta " of the Big Bang
-Cyclic cosmology (Penrose, Gurzadyan)
-(...)

Superbradyons would be particles with positive mass and energy, and a critical speed in vacuum $c_s \gg c$ (speed of light) similar to $c \gg c_{ph}$ (sound speed). Their existence naturally breaks Lorentz symmetry and requires a privileged (vacuum) local rest frame in our Universe.

(end of quote)

As references associated to this text, the poster includes :

- Page 1 of the paper *Cosmological Implications of a Possible Class of Particles Able to Travel Faster than Light*, TAUP 1995 [3], with the mention *Superbradyon cosmology, alternative to standard Big Bang and inflation.*

- Page 1 of the paper *Properties of a Possible Class of Particles Able to Travel Faster than Light*, Moriond January 1995 [4], with the mention *First paper on the superbradyon hypothesis*.

3. Superbradyons, strings, Lorentz symmetry

The poster states :

Superbradyons and strings

Since the 1970's STRINGS ARE KNOWN TO BE REMINISCENT OF AN UNDERLYING COMPOSITE STRUCTURE (gluon "fishnet" leading to hadronic dual resonance models). Current string models can reflect the existence of ultimate constituents of matter beyond the "conventional" particles of the standard model.

Superbradyons may be ultimate constituents of matter, not just building blocks like the standard preons but the elements of a more fundamental matter where the vacuum of our Universe would be a phase generated at some fundamental scale, and the standard particles, excitations of this phase.

Then, gravitation and usual gauge interactions would be composite phenomena and not really exact theories. Like special relativity itself, and possibly quantum mechanics, they would be a low-energy limit of conventional physics in our Universe. Some remnant superbradyons may exist as free particles in our Universe, interacting very weakly with conventional matter at low energy.

Lorentz symmetry

Superbradyon patterns generate a fundamental violation of standard Lorentz symmtry, which ceases to be a fundamental law. The effective space-time properties depend on the structure of matter.

However, superbradyons possibly obey themselves a Lorentz symmetry of the Lorentz type with a critical speed, c_s, much larger than c.

The Minkowskian metric can be a naturally stable metric when other metrics (e.g. Euclidean) are unstable and lead to transitions in the effective space-time structure.

Superbradyons are just an ansatz. But, together with deformed Lorentz symmetry for standard particles, they may constitute the embryo of a new theory of matter.

LSV = Lorentz symmetry violation.

VRF = Vacuum rest frame.

(end of quote)

4. Cosmological issues

The poster states :

ARE THE HIGGS AND BOSON ZERO MODES STATICALLY CONDENSED IN VACUUM ?

If gauge forces are not fundamental but result from vibrations of the superbradyonic matter excited by the presence of conventional particles as excitations of our vacuum, then the Higgs boson and the zero modes of standard bosonic particles do not need to be permanently condensed in vacuum.

It may happen that the condensate be formed only in the presence of standard particles, and at the required frequencies => NO COSMOLOGICAL CONSTANT PROBLEM ?

Some possible noncyclic pre-Big Bang scenarios

i) The Universe expands as a nucleated phase, the nucleation corresponding to the transformation of the superbradyonic ground state into our vacuum.

ii) Our three-dimensional Universe is similar to a new kind of three-dimensional soliton in a space with four or more dimensions. The soliton has an internal structure, initially very hot and with a small size, and expands in superbadyonic matter.

iibis) At the beginning, the soliton is not necessarily three-dimensional. Some dimensions fold or unfold.

iii) Cosmic time is the modulus of a SL(2,C) spinor.

Primordial nucleation => Standard matter. Lorentz symmetry and Quantum Mechanics as low-energy limits ?

Superbradyons with $v > c$ can decay spontaneously in our Universe by emitting standard particles ("Cherenkov" in vacuum) => a cosmological sea of superbradyons with $v = c$ or with some lower speed (dark matter, dark energy ?). They are expected to couple very weakly to "ordinary" matter at low energy => preserve experimental bounds on LSV.

Superbradyons can obey different fundamental laws "conventional" particles that would become composite objects similar to phonons, solitons...

Spinorial space-time geometry can lead to a naturally expanding universe.

5. Possible tests

The poster concludes :

The hypotheses presented here can possibly be tested in two ways :
- High-energy cosmic-ray physics
- WMAP, PLANCK...

In the second case, the question of randomness and of unconventional signals raised by V.G. Gurzadyan, R. Penrose and other authors to discuss possible signatures of cyclic pre-Big Bang cosmologies deserves attention for noncyclic patterns.

Tracks and signals from pre-Big Bang superbradyonic matter and dynamics may in principle have survived to primordial nucleation of our present vacuum and of standard matter. Further signals may come from the primordial expansion of this vacuum as a condensed phase in superbradyonic matter.

(end of quote)

As references associated to this text, the poster includes :

- Page 1 of the paper *Lorentz symmetry violation, dark matter and dark energy*, Invisible Universe 2009, [5] (updated and enlarged version), with the mention *Addenda on cosmological issues and phenomenology.*

- Page 1 of the paper *Superbradyons and some possible dark matter candidates* [6] (updated and enlarged version), with the mention *Remnant superbradyons, signatures, cosmology...*

- Page 1 of the paper *Space, time and superluminal particles* [7], with the mention *Superbradyon apparent motion. Cosmic spinorial space-time.*

- Page 1 of the paper *Preons models, relativity, quantum mechanics and cosmology (I)* [8], with the mention *Superbradyons would not necessarily obey quantum mechanics.*

6. Post Scriptum

See also [9,10], as well as the arxiv.org discussion concerning the suggestions by V.G. Gurzadyan, R. Penrose [11,**?**] and other authors on possible signatures of cyclic pre-Big Bang cosmologies.

REFERENCES

1. Georges Lemaître, *Nature* **127**, 706 (9 May 1931).
2. G. Lemaître, Ann. Soc. Sci. Brux. **A 47**, 49 (1927), http://adsabs.harvard.edu/abs/1927ASSB...47...49L
3. L. Gonzalez-Mestres, http://arxiv.org/abs/astro-ph/9601090
4. L. Gonzalez-Mestres, http://arxiv.org/abs/astro-ph/9505117
5. L. Gonzalez-Mestres, http://arxiv.org/abs/0912.0725
6. L. Gonzalez-Mestres, http://arxiv.org/abs/0908.4070
7. L. Gonzalez-Mestres, http://arxiv.org/abs/physics/9702026
8. L. Gonzalez-Mestres, http://arxiv.org/abs/0908.4070
9. L. Gonzalez-Mestres, CRIS 2008, http://arxiv.org/abs/0902.0994 and references therein.
10. L. Gonzalez-Mestres, CRIS 2010, http://arxiv.org/abs/1011.4889 and references therein.
11. V.G. Gurzadyan and R. Penrose, http://arxiv.org/abs/1104.5675 and references therein.
12. P. Tod, http://arxiv.org/abs/1107.1421 and references therein.