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The cosmic big-bang: how could mankind escape from it?

Abstract

When modern people these days ask, how did the universe come up at all and how did it evolve, then the answer given to them by cosmologists is: By the Big-Bang! - That gigantic, big initial explosion of cosmic matter - an explosive event at which cosmic matter was created at an incredibly high density and temperature driving with the inherent incredibly high pressure this matter apart of eachother till the present times, when one finds the universe with all its contents in a big Hubble expansion dynamics. This answer, however, provokes the question, how later then organized, organic matter, like especially also mankind, could escape from this inferno? All the more, since relativistic material pressure also does effectively gravitate and thus just impede an explosion. This question as we shall show here has an astonishing answer: This only could happen by a pressure of an unusual type that is not connected with matter, but with a pressurized, cosmic vacuum.

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A brief look into the standard cosmology

The standard cosmologic paradigm about the origin of the universe is its Big-Bang genesis , i.e. the understanding that there once happened an initial explosive event from which all cosmic structures and all their cosmic dynamics emerged. But this standard answer is not satisfying in itself, because it provokes the question how then could mankind escape from this material inferno into an anthropophilic region of our cosmos? The so-called Big-Bang must have indeed initiated the prime condition for the cosmic matter to fly apart of eachother and thereby start the cosmic Hubble expansion. But how should this exactly have happened as consequence of the active cosmic forces in such a begin? Matter, when it is highly condensed at this BB-begin. evidently organizes a strong gravitational field which effectively opposes the fly-off of cosmic matter. One evidently would need an “antigravitational”, explosive force, similar to that manifested at a granate explosion. As such a force physicists immediately will mention pressure forces. The BB-matter not only is infinitely dense and hot, it also, being such hot, evidently is highly pressurized. And hence it seems evident that it unavoidably tends to explode! - This, however, unfortunately and astonishingly enough, is simply not true, because the pressure connected with the relativistic Big-Bang matter also gravitates because of countable equivalent masses, as it is descibed by the theory of general relativity. This is simply so, because energy in all its mass-equivalent forms in general is the source for gravity. And the relativistic thermal energy of the Big-Bang matter can not at all be neglected relative to its rest mass energy. If, however, the mass energy $\varepsilon M = \varrho M \cdot c^2$, seen from its order of magnitude, competes with the energy equivalent of the material pressure p_M , then immedeately its pressure effects are showing up in the energy-momentum tensor Y_{ik} of the GR-field equations, here at first given without vacuum energy Λ , in the form:[1]

$$\Psi_{ik} - \frac{\Psi \cdot g_{ik}}{2} = 8\pi G \cdot \frac{Y_{ik}}{c^4}$$

Where Ψ_{ik} denotes the Riemannian curvature tensor, Ψ is the curvature scalar, and g_{ik} is the metric tensor, Y_{ik} is the energy-momentum tensor, and G is Newton‘s constant of gravitation.

The action of the material pressure p_M becomes more evident, when one procedes from the above tensor equations to the Friedmann-Lemaitre differential equations[2,3] in the form:

$$(\dot{R}/R)^2 = \frac{8\pi G}{3}\varrho_M(t) - \frac{kc^2}{3}$$

and:

$$\frac{\ddot{R}}{R} = -\frac{4\pi G}{3}\left(\varrho_M(t) + \frac{3p_M(t)}{c^2}\right)$$

where $R = R(t)$ is the time-dependent spatial scale of the homogeneous Robertson-Walker universe,[4] ϱ_M and p_M denote mass density and pressure of the cosmic matter, and k is the curvature parameter. In the second of these above differential equations one immedeately recognizes that the material pressure, as also the material density, both do contribute in the same sense to the acting gravitational field decelerating the scale expansion, and with $\ddot{R} < 0$ determine a collapsing!,- rather than an explosively expanding universe, if no other cosmic forces in addition had to be mentioned.

How then under such cosmic conditions the early universe can at all have exploded? This according to present-day views is only possible, if in addition to the upper material pressure $p_M(t)$ an additional cosmic pressure $\tilde{p}(t)$ becomes active which is not of thermodynamic nature and thus is not coupled to matter, but is of an unusual, different and immaterial form so that it does not gravitate. Such a pressure $\tilde{p}(t)$ could perhaps be connected with cosmic vacuum energy which nowadays is heavily discussed in cosmology. The first who introduced a pressure-less vacuum energy into cosmology was Einstein[5] with his cosmologic constant Λ which helped at least for the value $\Lambda = -8\pi G\varrho / c^2$ to enable a static Euclidean (uncurved $k = 0$) universe. Friedman[2,3] first introduced the cosmologic constant Λ into the field equations, obtained under the use of the so-called Robertson-Walker geometry,[4,6] and got the following set of equations:

$$(\dot{R}/R)^2 + c^2k/R^2 - c^2\Lambda/3 = 8\pi G\varrho/3$$

$$2\ddot{R}/R + (\dot{R}/R)^2 + c^2k/R^2 - c^2\Lambda = -\left(8\pi G/c^2\right)\cdot\left(p + \tilde{p}\right)$$

These equations then had been solved by Friedman[3] under the assumption that $p; \tilde{p} = 0$, i.e. both cosmic pressures, the thermodynamic one p , as also the one connected with cosmic vacuum energy, $\tilde{p}$, are assumed to vanish. What concerns the cosmic vacuum part $\tilde{p}$, it thus has been assumed by Friedman that the cosmic vacuum with an energy density Λ is a “pressure-less” vacuum.

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This assumption, however, needs not at all to be fulfilled, but other solutions are physically much more convincing and thus merit to be discussed, as we show below.

The unusual form of pressure $\tilde{p}$ still furtheron is assumed to be connected with the vacuum energy which nowadays anyway is strongly instrumentalized for cosmological purposes, but its physical nature and relations to other physical quantities still is heavily under discussion. Nevertheless as has been shown by Fahr,[7] vacuum energy only is a conserved quantity of cosmic spacetime as introduced by Einstein with $\Lambda = const$, - only if the proper energy of the comoving space time volume is conserved. This invariance , however, only then can be expected when this vacuum proper energy or its energy density does not perform work at the expansion or the dynamics of cosmic space time. If to the contrary, such a work is in fact performed by the vacuum energy, then as an unavoidable thermodynamical consequence it can not be constant! This is because in that case the thermodynamic relations between the cosmic vacuum energy density ϵ_{vac} and the associated vacuum pressure p_{vac} do require:

$$\frac{d}{dR}\left(\epsilon_{vac} R^3\right) = -p_{vac} \frac{d}{dR} R^3$$

which mathematically can only be fulfilled when the following relation between these two quantities is valid:

$$p_{vac} = -\frac{3-\xi}{3}\epsilon_{vac}$$

where ξ is the polytropic vacuum index, i.e. a pure number which only for the case $\xi = 3$ describes the case of a pressure-less vacuum which Friedman[3] did consider. In all other cases $p_{vac} \lesseqgtr 3$ vacuum energy is associated with a pressurized vacuum and evidently so does perform work at the expansion of space. Under such latter conditions, however, vacuum energy density ϵ_{vac} as shown by the upper equation, can not be constant, as was conceived by Einstein[5] with $\Lambda = const$.

Coming back to the earlier problem that the pressure p_M of relativistic matter can not help to make the Big-Bang matter explode, we thus would need a vacuum with positive pressure p_{vac} with $\xi > 3$, but then this pressure performs thermodynamic work at the expansion of the universe (i.e. with growing R), however, with the unavoidable consequence that ϵ_{vac} can not be constant! All together this would not be a bad solution for a Big-Bang universe, were it not contrary to what was thought by many cosmologists of these days, especially by Perlmutter et al.,[8] Schmidt et al.,[9] or Riess et al.[10] that this actual universe, in view of its observed redshift-luminosity relations, can well and best! be explained by a constant vacuum energy density with $\Lambda = 8\pi G \varrho_{vac} / c^2 = const$ according to the recommendation by Einstein.[5]

It thus seems, as if there are only two options to understand the universe: Either one accepts a variable vacuum energy density decreasing at ongoing expansion scale $R(t)$, i.e. with increasing scale $R(t)$. This would imply that cosmic vacuum energy density becomes less and less important in the cosmic future. Or alternatively one assumes, that cosmic vacuum energy density is a constant quantity, however, with a permanently vanishing pressure, - but then one can not explain the explosive Big-Bang event and the ongoing Hubble expansion of the universe due to an evident lack of cosmic pressure! The reader may make his own final choice himself!

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Conflicts sof interest

None.

References

1. Goenner H. Einführung in die spezielle und allgemeine Relativitätstheorie, Spektrum Akademischer Verlag, Heidelberg, 1996.
2. Friedman A. Über die Krümmung des Raumes. *Zeitschrift f Physik.* 1922;10:377–386.
3. Friedman A. Über die Möglichkeit einer Welt mit konstanter negative Krümmung. *Zeitschrit f Physik.* 1924;21:326–332.
4. Robertson HP. Relativistic cosmology. *Rev Mod Phys.* 1933;5:62–90.
5. Einstein A. Kosmologische Betrachtungen zur Allgemeinen Relativitätstheorie, Sitzungsberichte der K.P.Akademie der Wissenschaften. *Phys Math Klasse.* 1917;142–152.
6. Robertson HP. On the foundations of relativistic cosmology. *Proc Nat Acad Sci (USA).* 1929;15:822–829.
7. Fahr Hans J. Cosmic vacuum energy with thermodynamic and gravodynamic action power. *Phys Astron Int J.* 2022;6(2):62–66.
8. Perlmutter S, Aldering G, Goldhabe G, et al. The supernova cosmology project: Measurement of Omega and Lambda from 42 high–redshift supernovae. *Astrophys J.* 1999;517:565–586.
9. Schmidt BP, Suntzeff NB, Philipps MM, et al. The high-Z- supernova search; measuring cosmic deceleration and global curvature of the universe using type Ia supernovae. *The Astrophysical Journal.* 1998;507(1):46.
10. Riess AG, Filippenko AV, Challis P, et al. Observational evidence from supernovae for an accelerating universe and a cosmological constant. *Astronomical Journal.* 1998;116(3):1009.

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