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Friedmann universe expands up to some maximal radius, contracts and again transforms into de Sitter universe in the confinement phase.

We have suggested therefore a possible realization of the Markov nonsingular oscillating inflationary universe scenario. Since the duration of de Sitter stage fluctuates from cycle to cycle, there will be large fluctuations in the duration of each cycle, but the average duration will be time-independent. This is one of the most important differences between the scenario discussed above and the standard oscillating universe model, in which a duration of each cycle grows infinitely with the number of the cycle due to the growth of the total entropy of the universe in each cycle (see e.g. Zeldovich & Novikov 1975). In our case all the entropy and all inhomogeneities of the contracting universe disappear in the purgatory of de Sitter stage, and then are generated anew in each new cycle.

Our discussion of the gravitational confinement hypothesis and of its cosmological consequences is, of course, far from being rigorous. The only purpose of this discussion was to reveal a rather unexpected possibility to realize the nonsingular oscillating inflationary universe scenario with the help of quantum gravity effects. For a discussion of quantum gravity and the singularity problem see also the paper by Hartle in this volume.

Appendix B. INFLATIONARY UNIVERSE SCENARIO AND THE ANTHROPIC PRINCIPLE

As we have mentioned in the Introduction, there exists a possible solution of the flatness, homogeneity, isotropy and baryon asymmetry problems based on the Anthropic Principle: It can be argued that in a curved, inhomogeneous and anisotropic universe without any baryon asymmetry no life would exist, and therefore nobody would ask any questions about homogeneity, isotropy, etc. This argument is very witty but is not quite convincing, since it cannot explain why the spectrum of inhomogeneities is almost scale-independent, why the universe is almost exactly isotropic and why the numerical value of $(n_B-n_{\bar{B}})/n_\gamma$ is $O(10^{-8})$.

In some cases, however, the results obtained by the use of the Anthropic Principle may be very informative. For example, one can obtain an "explanation" why our space is four-dimensional. Indeed, in the theories of electromagnetic and gravitational interactions in d-dimensional space-time at $d > 4$ any bounded systems such as atoms or planetary systems would be impossible, whereas at $d < 4$ free particles cannot exist. This indicates that the best conditions for the existence of life (or, at least, of our kind of life, based essentially on electromagnetic and gravitational interactions) can be realized just as in the four-dimensional space-time (Ehrenfest 1917). Similar considerations based on the study of conditions necessary for the existence of atoms, stars, galaxies, etc. lead to stringent constraints on the value of $\alpha = \frac{e^2}{4\pi}$, on the value of the gravitational constant G and on the masses of elementary particles (Carr & Rees 1979; Rosental 1980). The Anthropic Principle may help us to understand why the cosmological constant at present is zero (Hawking 1982a), why the elementary particle theory has the unbroken symmetry $SU(3) \times U(1)$ etc.

It could be argued, however, that our universe is unique, and it is meaningless to ask whether life can exist in space with $d \neq 4$ and with $\alpha \neq \frac{1}{137}$. One possible answer to this objection is that there may exist many disconnected universes (see Appendix A), and we live in just one of them, which is sufficiently suitable for the existence of intelligent life. Another possibility is related to the oscillating universe scenario discussed in Appendix A, since in this scenario the universe is created anew in each new cycle. However the simplest way to justify the Anthropic Principle (at least partially) can be found in the context of the new inflationary universe scenario.

Indeed, the phase transition in the new inflationary universe scenario occurs independently in each bubble, and after the phase transition the distance between the centres of the bubbles exceeds the size of the horizon $\sim ct$, where t is the age of the universe. Therefore the physical processes inside a bubble remain unaffected by the physical processes inside any other bubble even after the phase transition. In this sense any bubble behaves as a mini-universe almost completely isolated from all other mini-universes. Let us assume e.g. that the universe is open. After the phase transition this universe is divided into an infinite number of mini-universes, in each of which the phase transition occurs independently. This means that there will be infinitely many mini-universes with all possible symmetry breaking patterns. In particular, in the $SU(5)$ Coleman-Weinberg theory the phase transition may proceed with a comparable probability either to the phase $SU(3) \times SU(2) \times U(1)$ or to the phase $SU(4) \times U(1)$. Therefore after the phase transition the universe becomes divided into infinitely many mini-universes in the phase $SU(3) \times SU(2) \times U(1)$

and infinitely many mini-universes in the phase SU(4) × U(1) . This considerably simplifies the answer to the question why we are now in the phase SU(3) × U(1) but not in some other stable or metastable phase, corresponding to a local minimum of the effective potential. Indeed, the phase SU(3) × SU(2) × U(1) eventually evolves into the phase SU(3) × U(1) . Therefore this phase (if it is sufficiently stable) should exist inside infinitely many mini-universes, and all other "desert islands" (in which other kinds of life may exist) are of no importance for us.

There is some interest now in the theories in which our space originally has more than four dimensions, but extra dimensions are spontaneously compactified (see e.g. Cremmer & Sherk 1976; Witten 1981a). However it is not very simple to explain why just four dimensions remained uncompactified (Schwarz 1982). The new inflationary universe scenario makes it more easy to answer this question. In the context of this scenario it would be sufficient that the compactification to the space $d = 4$ is possible, but there is no need for the four-dimensional space to be the only possible space after the compactification. Indeed, if the compactification to the space $d = 4$ is possible, there will be infinitely many mini-universes with $d = 4$, in which intelligent life can exist.

Thus we see that the new inflationary universe scenario may serve as a basis for a kind of a Weak Anthropic Principle: All possible phases which may appear after the phase transition and which are sufficiently stable should exist in some of the mini-universes, and then (hopefully) we are free to choose the best mini-universe to live in. As was claimed by Guth (1982), the inflationary universe is the only example of a free lunch (all matter in this scenario is created from the unstable vacuum). Now we can add that the inflationary universe is the only lunch at which all possible dishes are available.

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