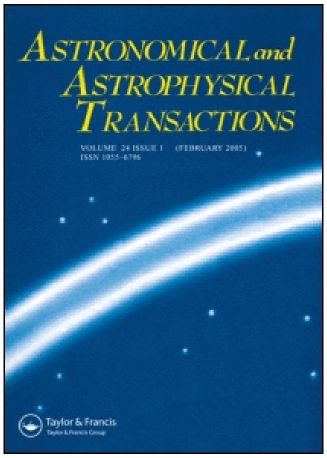

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Fundamental constants, cosmological nucleosynthesis and the mirror universe

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FUNDAMENTAL CONSTANTS, COSMOLOGICAL NUCLEOSYNTHESIS AND TME MIRROR UNIVERSE

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It is shown that Big Bang nucleosynthesis constraints on the mirror Universe are not an absolutely rigorous test.

KEY WORDS Nucleosynthesis, weak-interaction, constants.

In this paper we shall touch upon the restrictions imposed by the abundance of ^{4}He onto the rate of weak interaction reactions in the early epoch, in connection with a test of the existence of the mirror Universe suggested by Carlson and Glashow (1987 [1]). The idea about the existence of the mirror Universe dates back to 1956 in connection with the discovery of the parity non-conservation in weak interactions. Later Kobsarev, Okun and Pomeranchuk (1966 [2]) suggested a model of the CP-mirror world in which neutrinos and gravitons are the same as in the observed world. In 1988, Holdom [3] substantiated the possibility of a mixed form of matter connected with both the conventional and mirror forces. In such a model the electromagnetic connection of the two universes occurs by mixing photons with a coupling constant $\sim 10^{-6}$. The mixing of photons may reveal itself, in particular, due to $e^+e^- \to \gamma \to e^{+\prime}e^{-\prime}$ (the prime refers to the mirror particles), i.e., the single-quantum annihilation of the ortopositronium may serve as a test of the existence of the mirror Universe (Glashow, 1986 [4]).

Another test for the existence of the mirror world is connected with the yield of ^{4}He in the primary cosmological nucleosynthesis.

The expansion rate of the early Universe is described by the dependence $t = 2.42 g_{\rm eff}^{-1/2} T^{-2}$, where t is the time elapsed from the beginning of expansion (in seconds), T is the temperature (in Mev), and $g_{\rm eff}$ is the constant determining the number of degrees of freedom. The duration of weak-interaction reactions is determined by a stronger dependence on temperature: $t = f(g_w^2)T^{-5}$[5].

The analysis [1] is based on an implicit assumption of the invariability of g_w; in this case the existence of the mirror Universe will cause an increase of the yield of primary helium over the observed limit $g_{\rm eff} \leqslant 13$, due to a greater number of particle species in the hot plasma ($g'_{\rm eff} = 21.5$). However, a greater value of the weak interaction constant in the past may compensate the increase of ^{4}He yield connected with the contribution of the mirror Universe. In this case the decrease of the duration of weak-interaction reactions in the epoch of primary nucleosynthesis in comparison with the present value by K times, where $K \leq (13/21.5)^{1/2} = 0.8$, corresponds to an increase of g_w by 10%. Thus, it is enough to shift the "freezing" time of weak interaction reactions to a later epoch approximately by 20% to compensate for the increase of the helium yield due to the increase of the number of the particle species, and the mirror world becomes admissible. Note that such a shift may be caused not only by a greater value of g_w, but also by a choice of other non-standard models of cosmological nucleosynthesis, for example, by accounting for an inhomogeneity of the neutron-proton density. The example of the time variation of the weak-interaction constant presented by the authors, of course, resembles balancing on a razor blade, when the extravaganse of one hypothesis revives another eccentric hypothesis. But actually we want to note only the fact that primary nucleosynthesis is not an absolutely rigorous test of the mirror Universe. Its existence in equilibrium with our world in the primary nucleosynthesis epoch may prove admissible owing to one more chance of the category of those lucky chances that caused the emergence of the present Universe.

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