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LETTER TO THE EDITOR

PROPOSAL FOR THE SEARCH OF SMALL VIOLATION OF THE PAULI EXCLUSION PRINCIPLE IN NUCLEI

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The possibility of investigating a small violation of the Pauli Exclusion Principle is discussed. The technique involves searching for stable ^{5}Li nuclei using accelerator mass spectrometry.

Recently there has been renewed interest in the validity of the Pauli Exclusion Principle (PEP). Ignatiev and Kuzmin[1] constructed a model which allows a description of a small deviation from the PEP, the deviation being characterized by a small parameter $\beta \ll 1$. The generalization of their model to quantum field theory was attempted by Greenberg and Mohapatra[2] and by Okun[3]. Unfortunately all those attempts have failed and at present there is not a valid consistent field theory which describes the violation of PEP. The present status of this problem is discussed by Okun[4].

However, even in the absence of the theoretical model it is still of great interest to search for systems or processes which would signal the violation of PEP. Recently the consequences of PEP violation for the physics of the solar interior were investigated by Plaga[5] who concluded that the PEP violating parameter $\beta^2/2$ should be smaller than 1.6×10^{-15}.

In this letter we propose a method which could lower this limit by several orders of magnitude. The basic idea is to search for stable non-Paulian $^5\widetilde{\text{Li}}$ nuclei with 3 protons in the 1s shell; their masses are expected to be approximately 20 MeV lower than the masses of normal ^{5}Li nuclei. $^5\tilde{\mathrm{Li}}$ nuclei could be produced in nuclear reactions involved in stellar nucleosynthesis and in nucleosynthesis triggered by the primordial explosions. One possible reaction is $^3\mathrm{He} + {}^3\mathrm{He} \to {}^5\tilde{\mathrm{Li}} + \mathrm{p}$. The interaction of two ^{3}He nuclei proceeds also via $^3\mathrm{He} + {}^3\mathrm{He} \to {}^4\mathrm{He} + 2\mathrm{p}$ channel, and if only these two mechanisms are considered then the PEP violating parameter could be expressed as the ratio of $^5\tilde{\mathrm{Li}}$ and ^{4}He nuclei

$$\frac{\beta^2}{2} \approx \frac{N({}^5\tilde{\mathrm{Li}})}{N({}^4\mathrm{He})} \approx \frac{\eta^2\, N(\mathrm{Li})}{N(\mathrm{He})}. \qquad (1)$$

In Eq. (1) N(Li) and N(He) are the number of normal lithium and normal helium nuclei, respectively, and η^2 is the ratio of $^5\tilde{\mathrm{Li}}$ and normal lithium nuclei.

For detection of $^5\tilde{\mathrm{Li}}$ we propose the use of accelerator mass spectrometry. This is a particularly favourable situation as there are no known $A = 5$ nuclei which are stable against particle emission; a high lithium current is also easy to obtain. A sensitivity at the level $\eta^2 \approx 10^{-20}$ could be achieved. Second advantage is that the lithium abundace in the Universe is only 10^{-8} that of helium[6] and a large enhancement in the search for violation of the PEP is expected.

On the basis of simple mass considerations the decay $^5\tilde{\mathrm{Li}} + \mathrm{e}^- \to {}^5\tilde{\mathrm{He}} + \nu$ is possible, with a Q value of the order of several hundred keV. However, we expect that this reaction will also violate the PEP. From the existing estimates one can expect the half-life of the above process would be much longer than the age of the Universe and the decay can be neglected[7].

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PRIJEDLOG ZA TRAŽENJE NARUŠENJA PAULIJEVOG PRINCIPA U JEZGRAMA

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Razmatra se mogućnost mjerenja narušenja Paulijevog principa u jezgrama tražeći stabilni ^{5}Li pomoću akceleratorske masene spektrometrije.