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Electromagnetic modulation of monochromatic neutrino beams

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The use of radioactive ions leads to possibility of producing «clean» neutrino beams (with neutrinos of single flavour) with well-known spectra. Such beams may be useful for a wide range of neutrino researches. We discuss a possibility to produce a modulated, monochromatic and clean neutrino beam. Monochromatic neutrinos can be obtained in electron capture by nuclei of atoms or ions, in particular, by nuclei of hydrogen-like ions [1,2]. It is shown that monochromatic neutrino beam from such hydrogen-like ions with nuclei of non-zero spin can be modulated because of different probabilities of electron capture from hyperfine states. Modulation arises by means of inducing of electromagnetic transitions between the hyperfine states.

The nuclei of hydrogen-like ions have to satisfy several requirements. The electron-capturing nuclei should decay through Gamow-Teller transition. Thus, the spins of the initial and the final nuclear states have to differ by 1, and their parities have to be the same. To provide high monochromaticity of the neutrino beam, β^+ decay must be highly suppressed and the nuclear transition through electron capture must go predominantly to only one final state (we accepted the branching larger than 98 % of total decay probability). In order to produce a beam of significant intensity, the nuclei have to be short-living (we set the upper limit on the half-lives $T_{1/2} < 10^6$ s).

We have found all the nuclei, satisfying the stated requirements. It turns out that the list of appropriate nuclei is rather short. It consists of ^{71}Ge, ^{107}Cd, ^{118m}Sb, ^{131}Cs, ^{135}La, ^{163}Er, ^{165}Er nuclei [3]. However, the H-like ions with these nuclei noticeably differ from each other both by the lifetime with respect to the electron capture as well as by the hyperfine structure of the ground states. The latter is important for the modulation method.

References

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