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H.R.GULKANYAN, V.S.POGOSOV, A.G.TAMANYAN

ON A POSSIBLE METHOD OF EXPERIMENTAL INVESTIGATION OF PROTON DECAY MODES

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Г.Р.ГУЛКАНЯН, В.С.ПОГОСОВ, А.Г.ТАМАНЯН

ОБ ОДНОМ ВОЗМОЖНОМ МЕТОДЕ ЭКСПЕРИМЕНТАЛЬНОГО ИССЛЕДОВАНИЯ МОД РАСПАДА ПРОТОНА

Для экспериментального исследования мод распада протона предлагается создание подземного детектора, представляющего собой многоплоскостную многопроволочную газовую камеру высокого давления, расположенную в подземной полости в слое каменной соли, аналогичной известным подземным искусственным хранилищам горючего газа. Это позволит идентифицировать распадные частицы и кинематику реакции при количествах рабочего газа в несколько десятков килотонн и выше, необходимой для регистрации распада протона при периоде полураспада $\tau > 10^{33}$ лет и изучения мод распада при $\tau \lesssim 10^{33}$ лет. Одновременно детектор позволит исследовать другие экзотические явления, например, поиск частиц с дробным зарядом, нейтринных осцилляций и т.д.

Ереванский физический институт

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An underground detector representing a multiwire high pressure gas chamber, located in an underground cavity in a rock salt layer, analogous to known underground artificial depositories of fuel gas is proposed for the experimental investigation of proton decay modes. It will allow to identify decay particles and reaction kinematics at the amount of working gas of several dozens of kilotons and more required for the proton decay detection at the half-lifetime $\tau > 10^{33}$ years and investigation of decay modes at $\tau \lesssim 10^{33}$ years. The detector will also permit to investigate other exotic events such as a search for fractional charge particles, neutrino oscillations etc.

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As is known, grand unification models lead in a number of cases to predictions of nucleon instability with half-lifetimes which, in principle, are experimentally measurable [1]. Hence, a large number of experiments [2] were proposed recently for the search of nucleon decay. Some of these experiments are now in progress, and it is believed that in the years to come the very fact of nucleon instability will be established provided its half-lifetime is $\tau \lesssim 10^{33}$ years. At half-lifetimes $\tau \gtrsim 3 \cdot 10^{33}$ years there arise basic difficulties in the identification of nucleon decay against the background due, in the main, to atmospheric neutrino, which at the accuracy of kinematic reconstruction of events accessible on the setups under construction will imitate the process in question with a frequency comparable or exceeding that of the appearance of nucleon decay events [1].

The low accuracy of the reconstruction of event kinematics owes in the main to [2-3]: the Fermi motion of nucleons which are predominantly or completely in a bound state in the nuclei of working material; the secondary interactions of decay mesons within the nucleus; the low accuracy of measuring the energy and angles of decay products; the limited identification of decay products. The above circumstances do not allow to identify the majority of nucleon decay modes (particularly the many-body ones) with sufficient accuracy, even at "moderate" values of $\tau \sim 10^{32} \div 10^{33}$ years that would have been extreemly desirable for the selection or exclusion of some variants of grand unification models.

It seems expedient from the abovesaid to consider the problem of the construction of setups of "the following generation" designed for the detection of proton decay (unbound in the nucleus) at the half-lifetime $\tau > 10^{33}$ years and measurement of particle widths for the most decay modes at $\tau \lesssim 10^{33}$ years.

This aim in view we propose a method consisting in the application of manylayer multiwire high pressure (~ 150 atm) protportional or ionization gas chamber where an underground cavity is used as the working volume (e.g. cavities with the volume $\gtrsim 10^5$ m^3 intended for the storage of natural gas under the pressure ~ 150 atm, located in salt layers at depths of ~ 1000 m), and hydrogen or some other gas with high hydrogen content (e.g. methane) as a working gas medium. One can concentrate in such volumes several dozens of kilotons of compressed methane containing about $5 \cdot 10^{33}$ protons in free state.

At an appropriate separation of signal electrodes one can, in principle, get better accuracies in the measurement of energy (to a few per cent) and decay angles (to several degrees) of decay particles as compared with [2-3] , and concurrently measure the energy losses along the particles trajectories.

This will allow to achieve a better discrimination of background events and to identify the decay particles (including the instable ones) and proton decay modes with a sufficient reliability. Besides, there is a possibility of measuring the polarization of "direct" decay mesons by measuring the angular asymmetry of $\mu^+ \to e^+$ decay, which, along with the measurement of partial widths of proton decay modes, will allow to essentially reduce the range of possible grand unification models[1-4].

Along with the investigation of proton instability such a setup will allow to solve a wide range of problems, for the investigation of which underground detectors are used. One can relate to these problems the investigation of penetrating component of cosmic radiation and its interaction both with the setup matter and the rock surrounding, the search for exotic particles (e.g. particles with a fractional charge), the search for neutrino oscillations, the neutrino astronomy (detection of neutrinos by recording the recoil electrons in the elastic $\nu \to e$ scattering) etc.

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