structure similar to that of InSb. We could state then that intense ionization by hot carriers, capable of raising the quantum efficiency, takes place in semiconducting crystals already at photon energies close to $2E_g$.

In light of the foregoing, it seems to us also that calculations of energy scattering by hot carriers, carried out by the Monte Carlo methods, apparently agree with the actual facts.

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CONCERNING ONE EXPERIMENTAL POSSIBILITY IN NEUTRINO ASTRONOMY

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In spite of the fact that the potential feasibility of obtaining information concerning the sun by means of neutrino astronomy has become evident a long time ago [1], there exists so far only one setup capable, in principle, of registering solar neutrinos [2]. We have in mind the $Cl^{37} \to A^{37}$ radiochemical method [3]. This setup has already yielded significant information concerning the sun, although it has not yet been possible to record solar neutrinos with its aid [2].

Other radiochemical methods [4] proposed to date can yield, in principle, important additional information, but they are much more difficult to realize.

Various electronic methods [5] proposed for the registrations of neutrinos from the sun have not yet been realized and do not satisfy many important requirements.

What are the desirable properties of a solar-neutrino detector based on electronic registration methods?

1. The apparatus should register electrons from the ν-e scattering process or electrons from the inverse β process, with energy on the order of several MeV (and possibly lower).

2. The sensitive part of the detector should amount to not less than 10 t.

3. The apparatus should yield information on the direction of arrival of the registered neutrinos.

4. The apparatus should yield some information concerning the energy spectrum of the electrons produced by the neutrinos.

5. It is desirable that the apparatus distinguish quite strongly between electrons having a "neutrino nature" and background electrons.

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6. It is desirable to develop an "ever ready" filmless instrument. Indeed, owing to the rarity of the sought events, an uncontrolled tracking instrument is utterly useless in neutrino astronomy, and a controllable instrument is difficult to realize in view of the character of the detected events (single electrons with energy of several MeV).

It seems to us that these requirements can be satisfied to a considerable degree by a new type of detector, now under development in a number of laboratories mainly for high energies and cosmic rays. We refer here to a liquid ionization instrument, preferably with internal multiplication. Although liquid ionization chambers were realized long ago, they were used until recently only in the dc regime. A recent preliminary communication reports development of a pulsed instrument using liquid argon [6 - 8]. Particularly promising are the results of B.A. Dologshein and co-workers, who were able to obtain, by a clever method, a highly effective regime similar to that of a Geiger counter [6].

For the purpose of neutrino astronomy, we can imagine something similar to a multifilament gas-proportional chamber [9], with a volume of several cubic meters, but filled with liquid argon or another liquid that preserves free electrons. Searches for such liquids that contain nuclei of elements suitable for the observation of the inverse β process (for example ^{2}H, ^{19}F, etc.) would be of great interest.

Obviously, such a setup would satisfy requirements 1 - 4 and 6 more than any of those heretofore discussed. It will be shown below that requirement 5 will also be satisfied. This is important, because in any non-radiochemical method it is extremely difficult to overcome the background due to processes connected directly or indirectly with the naturally radioactive elements (αn, nγ; n, γ; γ from U fission [10]). The recoil electrons from such γ quanta (with continuous albeit steeply falling energy spectrum up to energies exceeding 10 MeV) constitute the main source of the background. Calculations show that the flux of γ quanta and neutrons from ordinary mineral rocks should produce in the detector an electron background exceeding by many orders of magnitude the number of electrons due to neutrinos. Consequently, besides screening the apparatus with "specially pure" materials, it is necessary to distinguish electrons of neutrino origin from background electrons. Unlike the procedure in which large scintillators are used, where the total energy of the γ quantum is usually registered, the proposed setup makes it possible to separate single electrons due to ν-e scattering from the background of the Compton electrons, which are not produced singly. This makes it possible, for a specified effect due to the ν-e scattering, to operate at a radioactivity-emission background exceeding that which can be tolerated if large scintillators are used. A similar situation arises also in observation of the neutrino-induced inverse β process when the nucleus is produced directly at the ground level. Transition to an excited level produces γ quanta that hinder the indicated possibility of reducing the background.

To realize our suggestion, it is necessary to overcome many difficulties of fundamental and technical character. However, the predicted progress toward the solution of the corresponding problems, particularly of the complicated problem of extracting the information, gives grounds for hoping that the development of apparatus of this type for neutrino astronomy, especially solar astronomy, is quite promising.

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PRODUCTION OF MUON PAIRS IN INTERACTIONS OF HADRONS OF HIGH ENERGY

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In recent experiments of the CERN group [1] they measured the cross section for the production of muon pairs following absorption of protons in uranium. It is customarily assumed that this process follows the scheme of Fig. 1 [2]. However, an important competitor is the purely electromagnetic process of the type shown in Fig. 2. With increasing effective mass of the produced muons, this process becomes the principal one. Let us compare the cross sections of both processes, substituting for simplicity a proton for the uranium. The cross section of the process of Fig. 1 is estimated in accord with vector-dominance scheme [2]. In terms of the effective mass of the pair of produced muons, we have in order of magnitude, in accord with Fig. 1b (cf.

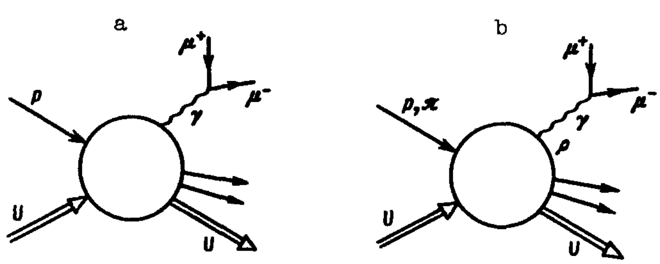

Fig. 1

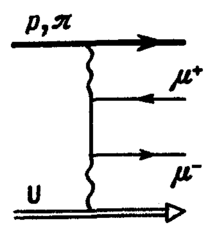

Fig. 2