ω propagate at an angle to each other. An analysis of the corresponding equation has shown that when the space-time synchronism conditions are satisfied $(\omega_1 + \omega_2 = 2\omega; \Sigma\vec{k}_i = 0)$ the threshold scattering has the same order of magnitude as in the degenerate case. Apparently one can hope that such a mechanism of scattering can be used to produced parametric amplifiers and generators which can be tuned in a wide range. The dispersion present in real isotropic media makes it possible to satisfy the synchronism conditions in the tuning range from 0.1 ω to 1.9 ω. Particularly favorable cases for lowering the scattering threshold are those in which any one of the frequencies of the interacting waves or their pairwise sums and frequencies are close to the natural frequencies of the transitions in the medium.

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STRONG-CURRENT PLASMA ACCELERATOR WITH CLOSED ELECTRON DRIFT

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Two types of injectors are in use in thermal nuclear research: pulsed plasma guns and ordinary ion sources. For a number of reasons, neither can be regarded as an appropriate source for a thermonuclear reactor. An "ideal" plasma injector would be a source with pulse duration from 10 μsec to 10 msec, capable of ensuring impurity-free ion currents on the order of 0.1 - 1 kA with particle energy in the 1 - 10 kV range. Such injectors can be produced by using the principle of the plasma accelerator with closed drift, described in a number of papers (see, for example, [1]). We developed and investigated a strong-current plasma accelerator, a diagram of which is shown in Fig. 1.

The physical process in the system reduces, in general outline, to the following. Owing to the presence of a radial magnetic field, it is possible to produce a distributed longitudinal electric field in a coaxial accelerating channel by creating a potential difference between the anode and the cathode. Under the influence of the crossed fields, the electrons drift in azimuth

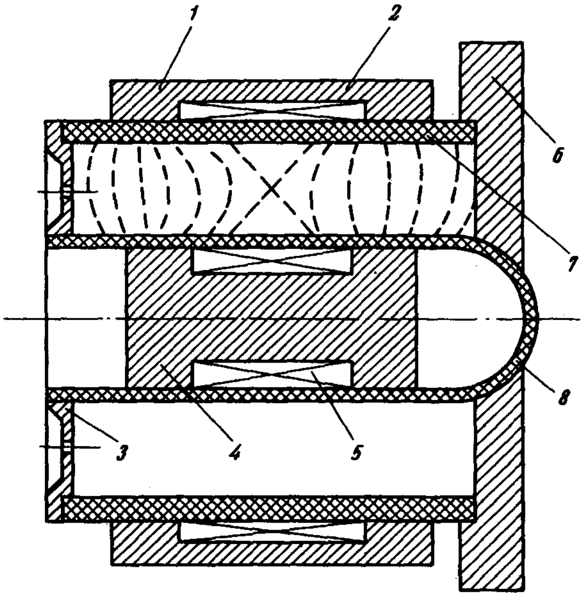

Fig. 1. Diagram of accelerator:
1 - external magnetic circuit,
2 - coil, 3 - anode, 4 - internal magnetic circuit, 5 - coil, 6 - cathode, 7 - external insulator,
8 - internal insulator.

and also drift gradually towards the anode as a result of collisions with the ions and with the walls, or as a result of various types of oscillations. The departing electrons are replaced by new ones coming either from gas ionization in the accelerating volume, or from the cathode. The gas is fed through openings in the anode. The produced ions are accelerated by the longitudinal electric field to an energy that corresponds to the applied potential difference, and depart from the accelerator. The magnetic fields are chosen such that the ion Larmor radius is larger than the spatial half-period of the magnetic field, and the electronic radius is much smaller, In this accelerator it is easy to control the outgoing ion current, by varying the supply of working medium, whereas the energy of the particles emerging from the accelerator is determined essentially by the applied potential difference. In order for the ion current to interact as little as possible with the walls, the magnetic field in the accelerating channel is made "lenslike." Since the magnetic force lines in a rarefied plasma with low temperature are equipotential lines, the current is electrostatically focused in the accelerator. The principle of such a focusing was first proposed in [2]. Besides the electrostatic focusing, there is also magnetic focusing in this system. The construction elements of the accelerator are shown in Fig. 1. The gas is admitted in pulses by an electromagnetic valve. The working gas is hydrogen. The cathode is the output flange of the instrument and the walls of the vacuum volume, in which arcs are produced along the wall during the discharge. The initial pressure in the volume prior to the admission of the gas is $\sim 5 \times 10^{-5}$ mm Hg.

The electric system of the apparatus has made it possible to obtain an aperiodic discharge with a discharge current having at the maximum an amplitude from 0.5 to 3 kA at an

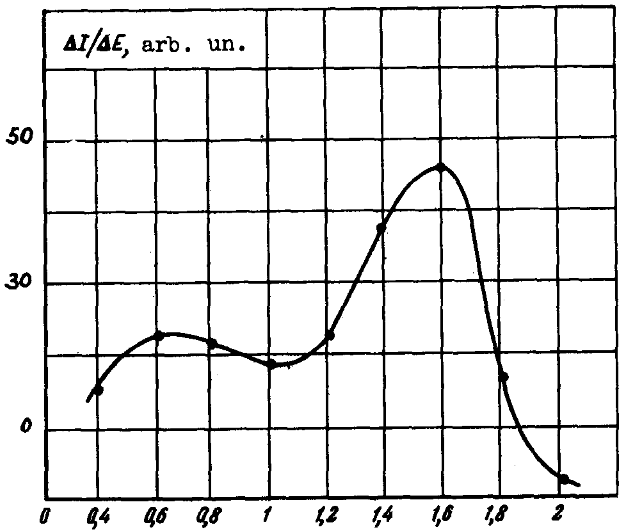

Fig. 2. Ion spectrum.

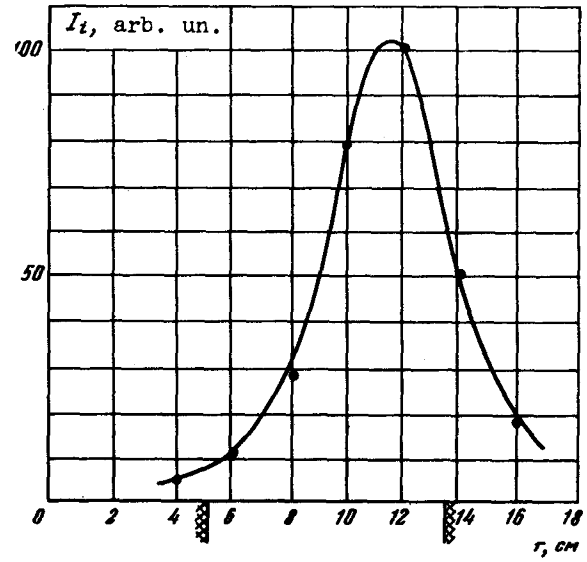

Fig. 3. Distribution of $I_1(r)$. The origin is at the center of the instrument. The cross hatching shows the location of the accelerating channel.

average current duration ~5 msec. The discharge voltage had a nearly rectangular waveform.

This accelerator makes it possible to obtain an ion current on the order of 1 kA with particle energy ~3 kV. Inasmuch as the principal problem of the investigation at this stage was to ascertain the main physical features of the accelerator operation, the measurements were made essentially not in a mode in which the instrument operates at its extremal parameters with respect to the current and particle energy, but in some intermediate regime, in which the discharge voltage was 2 kV, the discharge current 0.78 kA, the hydrogen input was $\dot{m} = 7 \times 10^{-3}$ g/sec, and the characteristic value of the magnetic field in the channel was 450 Oe.

The energy of the ions leaving the accelerator was measured by two methods, with an electrostatic ion analyzer [3] and with a multielectrode probe. The ion analyzer was mounted on the rear flange of the vacuum chamber at a distance of approximately 2.5 meters from the accelerator cutoff. The obtained particle spectrum, which is shown in Fig. 2, leads to the conclusion that the ion flux contains besides the main group of ions, which have an energy close to the discharge voltage, a considerable number of particles of lower energy, and this may be connected with the existence of an ionization zone which is "smeared" over the volume of the accelerator. The average ion energy in this operating mode, calculated from the obtained curve, is 1.3 keV. With increasing discharge voltage, the average ion energy increases accordingly.

The results obtained in measurements with a multielectrode probe mounted 15 cm from the cutoff of the instrument, opposite the center of the accelerator gap, agrees sufficiently well with the results presented above. The same probe was used to measure the ion current from the instrument. The ion-current radial distribution is shown in Fig. 3. The current of the ions, summed over the entire cross section of the flux, is about 70% of the discharge current in the given mode.

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THE POMERANCHUK EFFECT AND MAXIMUM ENERGY OF COSMIC ELECTRONS

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For galactic magnetic fields, $H = (3 - 10) \times 10^{-6}$ Oe [1], the condition for the applicability of the formulas for radiation deceleration [2] of electrons is satisfied up to values

$$\frac{E}{mc^2} = 10^{25} - 10^{26},$$

where E and m are the total energy and mass of the electron.

Inasmuch as the force of deceleration of an ultrarelativistic particle by radiation is proportional to the square of the energy, we find by considering the energy loss due only to