The foregoing suggests immediately a method for decreasing the transition effect. The counter walls must be made so thin, $\sim 10^{-4} - 10^{-5}$ cm, that the relativistic growth of the ionization loss is not suppressed in them. This can be done by placing the counter in additional pressure chambers or by constructing multisectional counters with thin intermediate walls.

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COHERENT EXCITATION OF ATOMS PASSING THROUGH A CRYSTAL

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It was suggested in 1965 that nuclei [1] or atoms [2] can be excited coherently when they pass through a single crystal.

Our article is devoted to experimental results demonstrating that this effect is observed when He^+ ions pass through a single-crystal silver film.

The physics of this phenomenon is considered in sufficient detail in [1] and reduces, in the roughest approximation, to resonant excitation of the atoms (or nuclei) when the transition frequency $\nu_{tr} = (E_{exc} - E_{gnd})/h$ coincides with the frequency $\nu_0 = v_0/a_0$ of "collision" of the atom (nucleus) passing through the crystal with the crystal atoms (v_0 is the particle velocity and a_0 is the distance between the atoms in the crystal).

For the hydrogen-like atom He^+, whose levels are 0 eV (n = 1), 40.80 eV (n = 2), 48.37 eV (n = 3), 51.0 eV (n = 4), ..., such a resonance occurs on passage through a single-crystal silver film (a_0 = 4.07 Å) for a transition from the ground state n = 1 to the excited state with n = 4, at an energy E_{He^+} = 526 keV. By the same token, the He^+ beam passing through the silver film should contain, in addition to the ions excited as a result of various incoherent processes (single collisions, pickup of electrons by He^{++} ions, etc.), also a certain admixture of coherently excited ($n = 1 \rightarrow n = 4$) He^+ ions.

On leaving the film, the excited He^+ ions will radiate. The $n = 4 \rightarrow n = 3$ transition lies in the visible region (λ = 4685 Å). It can be readily separated by optical spectrometry devices (spectrometer, interference filter) from the

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photons having different wavelengths and emitted by the residual gas by the walls of the observation chamber under the influence of the direct and scattered helium-ion beams.

The existence of coherent excitation is uniquely connected with an increase of the intensity of the $n = 4 \rightarrow n = 3$ transition at a helium-beam energy ∿526 keV (since the number of He^+ atoms with $n = 4$ is larger at this beam energy).

Figure 1 shows the experimental setup. The photons emitted from the He^+ ions were excited by passing through a thin (1100 ± 100 Å) single-crystal Ag target film, and were registered simultaneously by two detectors tuned to λ = 4685 Å (the $n = 4 \rightarrow n = 3$ transition).

In detector I, the 4685 Å line was separated by the exit slit of an ISP-51 spectrometer, and its intensity was registered by an FEU-13 photomultiplier.

In detector II, the 4685 Å line was separated by an interference filter designed for this wavelength, and was also registered by an FEU-13 photomultiplier.

The helium beam passing through the silver was likewise monitored by two methods: with an integrator that registered the charge of the transmitted beam, and with a semiconductor counter registering the number of α particles scattered in the silver target through a relatively large angle (∿40 - 50°).

The single-crystal silver film of thickness 1100 ± 100 Å and orientation (100) was obtained by evaporation on rock salt in vacuum [3].

The crystallographic axes of the film was oriented by using the channeling [4] of the He^+ ion beam in the target, as observed on a zinc sulfide screen placed in the path of the beam passing through the target.

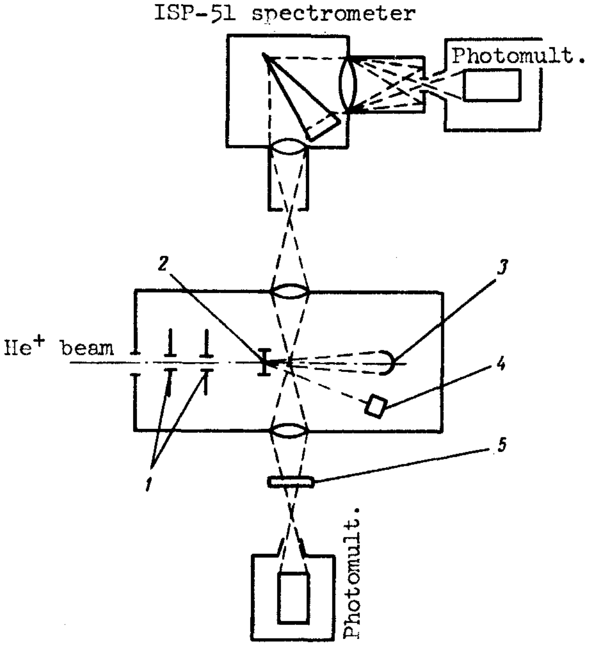

Fig. 1. Experimental setup: 1 - diaphragms, 2 - single-crystal Ag film; 3 - integrator, 4 - semiconductor counter, 5 - interference filter.

Figure 2 shows one of the experimental plots of the intensity of the 4685-Å line emitted by the He^+ beam passing through the target as a function of the incident-beam energy. The plot shows measurements performed in a rather narrow incident-beam energy region near 570 keV, where preliminary investigations of a larger energy interval have revealed an increase of the 4685 Å line intensity. We note that after subtracting the He^+-ion bremsstrahlung losses in the silver film after passing through the channel (∿40 keV), the energy 570 keV agrees within 10 - 15 keV with the value 526 keV at which resonant excitation of the He^+ from the ground state to the state with $n = 4$ is expected. By the same token, in our opinion, the coherent excitation of He^+ occurs only when the energy of the He^+ atom emerging from the single-crystal Ag film coincides with the "resonant" energy 526 keV. This is apparently to be expected, for if the He^+ were to be excited inside the target, then it would become immediately ionized, since the probability of ionization of an excited atom is larger than the probability of

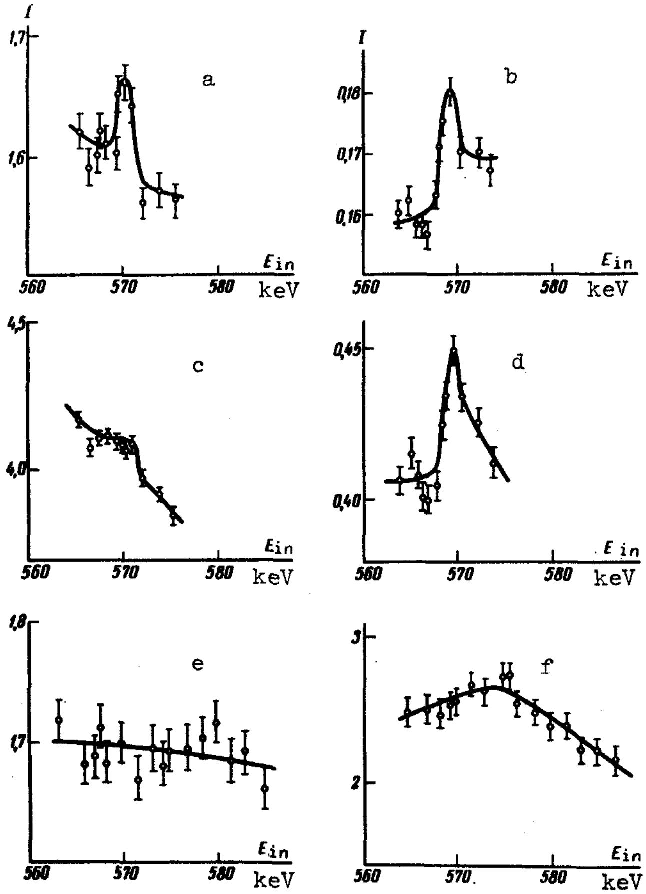

Fig. 2. Radiation intensity of a beam of He^+ ions passing through a single-crystal silver film vs. the energy of the He^+ ions: a - reading of detector I (ISP-51) with a semiconductor-counter as monitor; b - reading of detector I (ISP-51) with a semiconductor-counter as monitor; c) reading of detector II (interference filter) with an integrator; d) reading of detector II with a semiconductor detector; 4) reading of detector I, integrator monitor, angle between the normal to the silver surface and the beam α = 5°; f) detector I, semiconductor counter, α = 5°.

ionization of an atom in the ground state.

The observed intensity burst cannot be attributed to any interaction between the beam and the silver surface, since a slight tilt of the film plane (3 - 5°) (meaning absence of beam channeling!) causes the effect to vanish.

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