between the calculated and measured quantities can be regarded as fully satisfactory.

The obtained effective masses of the carriers are in sufficiently good agreement with the masses measured by the method of "ordinary" cyclotron resonance. From Fig. 1 we get $m^*v_\alpha = 3.86 \times 10^{-21}$ g-cm/sec, $v_\alpha = 2.7 \times 10^7$ cm/sec, and $m^* = 0.15\ m_0$. According to Datars [5] $m^* = 0.14\ m_0$ for $\theta = 35°$.

In conclusion, we sincerely thank E. A. Kaner for fruitful discussions.

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RESOLUTION OF THE SPECTRUM OF AN OPEN RESONATOR WITH THE AID OF AN ECHELETTE GRATING

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It is known that a decrease in the number of natural frequencies in the generation band of an open laser resonator increases the stability of the generated oscillations. In this communication 1) we report a method of thinning out the longitudinal wave-number spectrum of open resonators. This method is based on the use of a reflecting diffraction grating of the echelette type as one of the reflecting mirrors of the open resonator (see also [1]). A distinguishing feature of such an open resonator is that the grating has angular dispersion, so that emission at a wavelength that does not correspond to the chosen grating parameter is scattered aside and the corresponding oscillation has low Q. This causes additional thinning out of the spectrum, as compared with an ordinary open resonator with flat mirrors.

We investigated experimentally a resonator operating in the 8-mm band. The diffraction grating had 11 elements and operated in the second order of the diffraction spectrum; the grating parameters were as follows: period 18.29 ± 0.02 mm, blaze angle 27°43' ± 2', width of working face 15.72 ± 0.02 mm, and height of steps 8.52 ± 0.02 mm. The power reflection coefficient at $\lambda = 8.52$ mm was 0.945. The resonator consisted of a plane mirror measuring 178 x 178 mm and a grating having the same transverse dimensions, both made of copper. The oscillations were excited through a coupling aperture in the grating, using a 7.2 x 3.4 mm rectangular waveguide oriented so that the vector $\vec{E}$ was perpendicular to the grooves of the grating. The measurement procedure was analogous to that used in [2].

At a fixed angle of inclination of the grating and at a fixed distance between the grating and the mirror, three oscillations were observed in the 27.7 - 40 Gcs band, with the same longitudinal index and with different field distributions in the transverse direction (see the table).

Spectrum of resonator with grating in the 27.7 - 40 Gcs band

No.	Frequency, Gcs	Q	Mode indices (q, n_1, n_2)
1	35.11 ± 0.005	6000 ± 10%	(16, 1, 1)
2	35.17 ± 0.02	1500 ± 20%	(16, 1, 2)
3	35.27 ± 0.05	600 ± 50%	(16, 1, 3)

In this table, q is the number of half-waves between the plane mirror and the nearest step on the grating.

For comparison we point out that, in the same range, an open resonator with two flat mirrors having the same transverse dimensions as our resonator and located at a distance equal to the distance between the center of the grating and the flat mirror, has approximately 10 modes with different longitudinal indices, at a Q of approximately 9000. Thus, the strong thinning out of the spectrum with the aid of a suitably chosen echelette is obtained at the expense of a relatively slight reduction in Q.

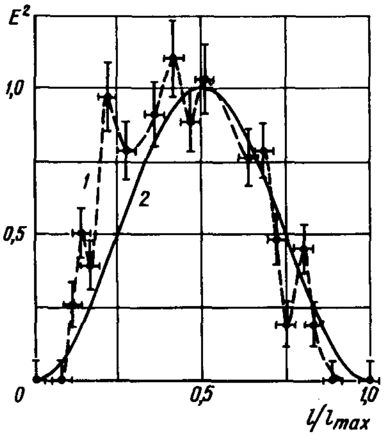

Fig. 1. 1 - Field distribution of the (16, 1, 1) mode, 2 - plot of $\sin^2(\pi l/l_{max})$.

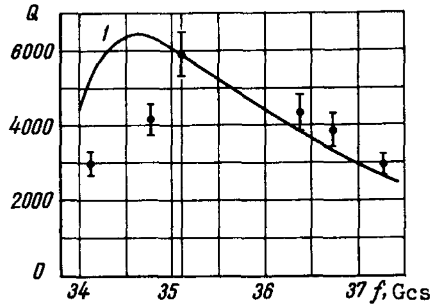

Fig. 2. Variation of Q during the tuning of the resonator. 1 - Theoretical relation, which takes into account only the wavelength dependence of the coefficient of reflection from the grating.

The distribution of the square of the electric field near the flat mirror, in a direction perpendicular to the grooves of the grating, and measured by the scattering-body method, is shown in Fig. 1 for the first mode. The solid line in Fig. 1 shows the distribution of the field in an open resonator with flat mirrors.

An open resonator with a grating can be tuned in frequency by varying the inclination of the grating and adjusting the distance to the flat mirror. The dependence of the Q on the frequency is shown in Fig. 2. It must be noted that thinning-out property with respect to the longitudinal index and the high Q remain in force at all frequencies in the tuning range.

In open resonators similar to that described here, it is possible also to increase the Q by using concave mirrors and diffraction gratings (see [3]).

The author thanks P. L. Kapitsa for interest in this work and L. A. Vainshtein and V.

P. Bykov for a valuable discussion.

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INVESTIGATION OF THE ELECTRONIC STATES OF ATOMS, MOLECULES, AND SOLIDS BY QUASIELASTIC KNOCK-ON OF AN ELECTRON BY A FAST ELECTRON (e, 2e)

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Continuing earlier investigations [1,2] of the analogs of direct nuclear reactions in the atomic-molecular region, we wish to point out the great value of the quasielastic knock-on reaction (e, 2e). The difference from work on ionization [3] lies here in the fact that it is necessary to measure for coincidence the pulses from both final electrons (Fig. 1) at fixed emission angles (see [4] regarding the (p, 2p) reaction). We shall show with three examples (impulse approximation) that this makes it possible to obtain the Fourier transform of the wave function of the knock-on electron and its binding energy. In paragraphs 1 and 2 we shall assume that the electron energies are equal ($E_1 = E_2$) and that the angles φ_1 and φ_2 are also equal (complanar symmetrical case).

1. H_2 molecule, final ion H_2^+ in state $1\sigma_g$:

$$\frac{d^2\sigma}{d\Omega_1 dE_1} \sim \left[\frac{q^2a_0^2 + \hbar^2 Z_{\mathrm{eff}}^2}{\hbar^2 a_0^2}\right]^{-4} \left[\frac{x + \sin x}{x}\right] \left(\frac{d\sigma}{d\Omega_1}\right)_{\mathrm{free}} W_n \qquad (1)$$

The cross section for free e-e scattering $(d\sigma/d\Omega_1)_{\mathrm{free}}$ is tremendous, $\approx 10^{-21}$ cm²/sr at $E_0 \simeq 5$ keV ($\varphi_1 = 45°$), so that the targets must be unusually thin (100-Å films or equivalent gas jets). Further, $Z_{\mathrm{eff}} \simeq 1.2$ (Heitler-London function), $x = qR/\hbar$, a_0 - Bohr radius, R - distance between nuclei in H_2, $\vec{q} = \vec{p}_1 + \vec{p}_2 - \vec{p}_0$, and W_n - probability of production of H_2^+ in the n-th vibrational state. $W_n = 0.06$, 0.2, and 0.3 for n = 0, 1, and 2. In the general case the ratio of the heights of the maxima in the spectrum of the energies $E_1 + E_2$ determines the spectrum of the genealogical connection [5] between the ground state of the target and the different hole states of the final ion.

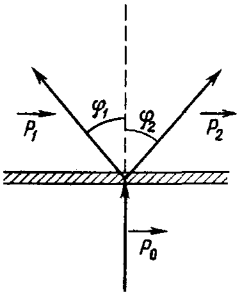

Fig. 1

2. Free electrons in a metal (plane waves):