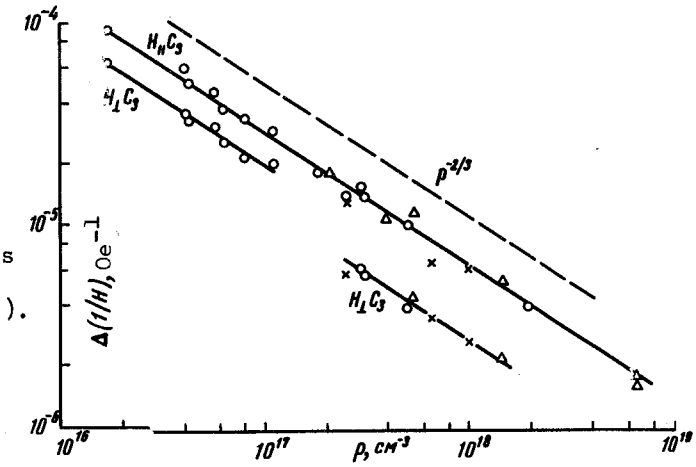

Fig. 2. Concentration dependence of the SH oscillation period at two basic field orientations: o - present results and results of [3]; Δ - results of [1]; × - results of [2] (obtained from several oscillation peaks).

A number of factors discussed in [3] indicate that the energy minimum of the valence band of tellurium is located at the vertex of a trihedral angle of the hexahedral prism constituting its Brilluoin zone. In view of the more complete data presented here on the SH effect, it seems to us that the energy minimum of the valence band is shifted from the trihedral vertex along the side edge of the prism, as follows from a recent theoretical paper [4]. This being the situation, the abrupt change of the period $\Delta_\perp$ at $\rho = (2 - 3) \times 10^{17}$ cm^{-3} can be attributed to the distortion of the Fermi surface as the latter approaches to the limiting basal plane of the Brillouin zone, and the increase of the ratio of the periods $\Delta_\parallel/\Delta_\perp$ at $\rho > 3 \times 10^{17}$ cm^{-3} can be regarded as a transition from the simple two-ellipsoid mode for the concnetration region $\rho < 10^{17}$ cm^{-3} to a more complicated singly-connected barrel-shaped surface when $\rho > 3 \times 10^{17}$ cm^{-3}.

We are grateful to G. E. Pikus for a discussion of the theoretical questions.

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REDUCTION OF THE BACKGROUND EFFECT IN MASS SPECTROSCOPY OF MOLECULAR BEAMS

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In mass sepctroscopy, the limiting measurement sensitivity is determined by the background due to the residual gases in the instrument. There are several known [1, 2] method of countering the harmful influence of this factor: improving the vacuum, different means of modulating the measured beam, statistical reduction of the mass spectra, increasing the resolution of the instrument, and others.

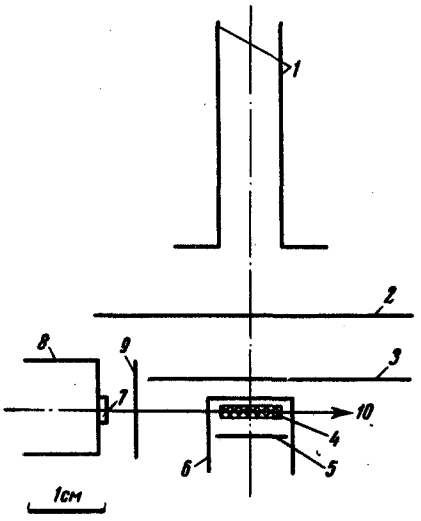
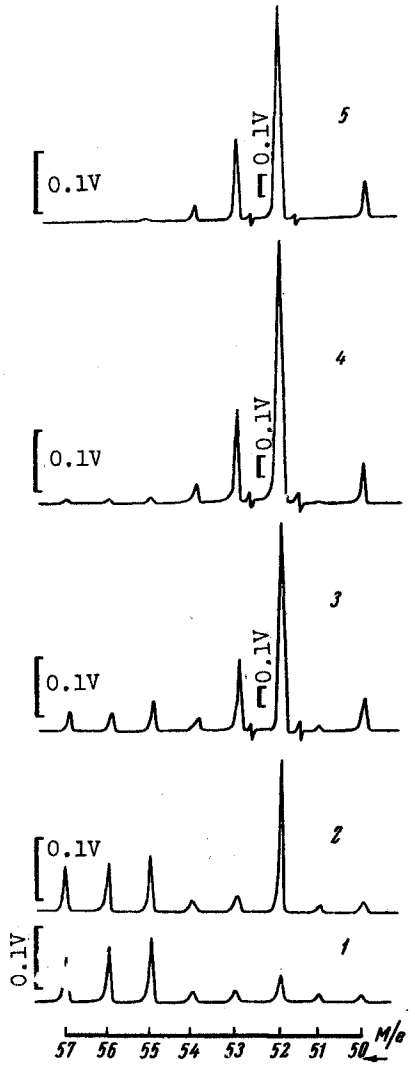
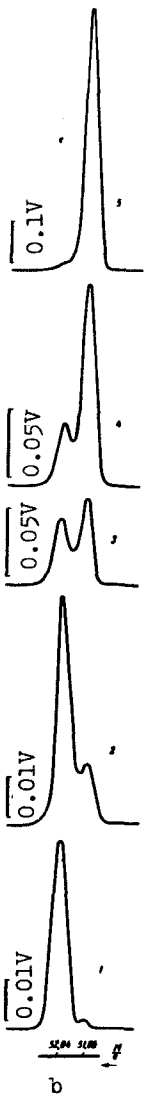


Fig. 1. Diagram of employed ion source with molecular gun: 1 - deflecting plates, 2 - accelerating lens at ground potential, 3 - drawing lens at 4700 V, 4 - cross section of electron beam of intensity 100 μA, 5 - drawing electrode, 6 - ionization chamber at 5000 V, 7 - sample, 8 - evaporator, 9 - collimating diaphragm, 10 - molecular beam.



a



b

Fig.2. a - Mass spectra obtained at the following deflection voltages (volts): 1) 0, 2) +3, 3) +9, 4) +15, 5) + 18. The smaller scale on curves 3, 4, and 5 pertains only to M/e ≈ 52. b - Forms of lines M/e ≈ 52 at the following deflecting voltages (volts: 1) -3, 2) 0, 3) +2, 4) +4, 5) + 13.

In the present investigation, the background was reduced by using the difference between the particle velocity distribution functions in the background and in the investigated molecular beam.

The particle distribution with respect to the velocity projections on a chosen direction was analyzed by a previously described deflection method [3, 4].

It is known from the general kinetic theory of gases that the distribution function with respect to the velocity projections on a given direction of particles of an isotropic gas in equilibrium is given by the expression

$$f_1 = A_1 \exp(-Mv^2/2kT_1).$$

This expression holds with sufficient accuracy for the background gas contained in an ionization chamber having a temperature T_1.

The distribution function with respect to the velocity projections of the particles of the molecular beam entering the chamber from the molecular gun, whose temperature is T_2, is

$$f_2 = A_2 v \exp(-Mv^2/2kT_2).$$

The remaining symbols in the expressions are standard.

By applying different deflecting voltages on plates 1 (Fig. 1) we can gradually adjust to maximum value the distribution functions of the analyzed beam.

If $T_1 \approx T_2$, then the background is reduced by a factor not less than 2.7, and the useful signal increases by a factor of more than 2. This effect increases with increasing ratio T_2/T_1.

The layout of the ion source is shown in Fig. 1, and the results of testing this method are shown in Figs. 2a, b, where the deflection voltages at which the presented mass spectra were obtained are indicated.

The mass spectra shown in Figs.2a and and 2b were scanned by varying the magnetic and electric fields, respectively.

It is seen from Fig. 2a that at zero voltage on the deflecting plates (this corresponds to the traditional mass-spectroscopic measurements), the lines of chromium isotopes, molecular beams of which were passed through the ionization chamber at a temperature $T_2 = 1370°K$, are "lost" in the corresponding lines of the background. A gradual variation of the electric field intensity between the deflecting plates leads to a separation of chromium isotopes that are almost unaffected by the background (in our case, at 15 - 18 V).

Fig. 2b shows the changes in the form of the line with $M/e \approx 52$ (recorded at a lower rate than in Fig. 2a). The change of the line shape upon variation of the deflection voltage is clearly evident.

Obviously, the proposed method will be the more effective, the larger the distance between the maxima of the distribution functions of the background and of the beam, other conditions being equal. The displacements of the most probable rates of the background and of the beam turned out in our experiments to be somewhat larger than the theoretical ones, possibly as a result of the larger inhomogeneity of the effectiveness of ion production in different regions of the ionization chamber.

A more detailed description of the setup and of the results obtained with it is being readied for publication.

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HIGHLY EXCITED STATES OF ATOMIC NUCLEI

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Recent experiments on inelastic scattering of electrons [1] and protons [2] by nuclei have revealed highly-excited resonant states of the nuclei. An attempt was made to interpret the results of these experiments within the framework of the usual shell model [1 - 3], it being assumed that the indicated resonance correspond to excitation of the internal shells. It turned out here, however, that the energies of the $^1S_{1/2}$, $^1P_{1/2}$, and $^1P_{3/2}$ levels increase with increasing atomic weight, reaching in the case of $^1S_{1/2}$ the values 40 MeV for A = 16 and 60 - 80 MeV for A = 40 [1, 2]. This contradicts the usual shell model, according to which the depth of the potential well is of the order of 45 - 55 MeV, and concequently the energy of any level should be smaller than this quantity.

The purpose of the present paper is to describe a possible resolution of this contradiction.

It is appropriate to recall that, according to modern many-body theory, a so-called single-quasiparticle branch of the spectrum exists in the vicinity of the Fermi surface for a system of interacting Fermi particles. The excitations (quasiparticles) behave like a system of non-interacting particles moving in a certain average self-consistent field. In general, this field is nonlocal.

According to this point of view, the shell model describes a quasi-single-particle excitation spectrum of the system. Owing to the strong interaction between the nucleons of the nucleus, there are no sufficiently convincing calculations of the parameters of the self-consistent field on the basis of the forces acting between the free nucleons. These parameters are usually chosen such as to make the calculated spectrum of the low-energy excitations (i.e., the excitations at the Fermi surface) coincide with the experimentally observed ones. It turns out that the depth of the potential well must be assumed, at least for medium and heavy nuclei, to equal 50 - 55 MeV, and its radius to equal approximately the nuclear radius $R = r_0A^{1/3}$; the nonlocality can be neglected. Thus, by definition, the assumed potential well should describe only the spectrum of the low-lying excitations, and not at all the positions of the deep levels of the nucleus far away from the Fermi surface. In order to find the positions of the deep levels, it is ncessary to determine the quasi-single-particle potential not at the Fermi surface, but far from it. In this case, likewise,