To determine the partial width of the transition to the ground state, we used a self-absorption method wherein we investigated the absorption of the resonance radiation by a resonant absorber located between the source of the incident beam and the resonant scatterer. By determining experimentally the self-absorption effect K from the expression [1]

$$K = \Gamma_{\gamma_0} g \pi^{3/2} \lambda^2 \frac{nd}{\Delta_i} \left(\frac{1+f}{2+f}\right)^{1/2} \exp\left[-\frac{f\delta^2}{(2+f)(1+f)\Delta_\ell^2}\right] \quad (2)$$

it is easy to calculate the partial width $\Gamma_{\gamma 0}$ of the radiative transition to the ground state.

Using the experimental value of $\Gamma_{\gamma 0}$, we calculated the average distance between the levels near the initial state, using the following connection [4] between $\Gamma_{\gamma 0}$ and D:

$$\langle \Gamma_{\gamma_0} / D \rangle = 6{,}1 \cdot 10^{-15} E_\gamma^5 A^{8/3}. \quad (3)$$

The results are listed and compared in the table. From an analysis of the observed resonance cases it follows that the probability of nuclear resonance scattering increases on approaching nuclei with closed shells.

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QUANTUM YIELD OF GENERATION OF AN $H_2 + F_2$ MIXTURE

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The development of a dissociation laser using the subsequent chemical reactions occurring in a gas mixture has been the subject of a number of investigations. In particular, a laser using the mixture $H_2 + Cl_2$ was investigated in [1, 2].

In [3, 4] they describe a laser based on a mixture of fluorine compounds of the M-F type with hydrogen. When uranium hexafluoride or molybdenum hexafluoride is used the reaction mechanism apparently proceeds as follows:

$$RF_6 + h\nu \rightarrow RF_5 + F,$$
$$F + H_2 \rightarrow HF^* + H,$$
$$H + RF_6 \rightarrow HF^* + RF_5,$$

where R = U or Mo, and * denotes an excited molecule. In the latter case, however, it is clearly seen that the reaction develops spontaneously and no appreciable quantum yield can be expected in this system.

We deemed it most interesting and promising to investigate the mixture $H_2 + F_2$, since it is known [5] that the quantum yield of the reaction $H_2 + F_2 \rightarrow 2HF$ equals $\sim 10^5$, i.e., one can expect in principle a generation quantum yield much larger than unity. It must be

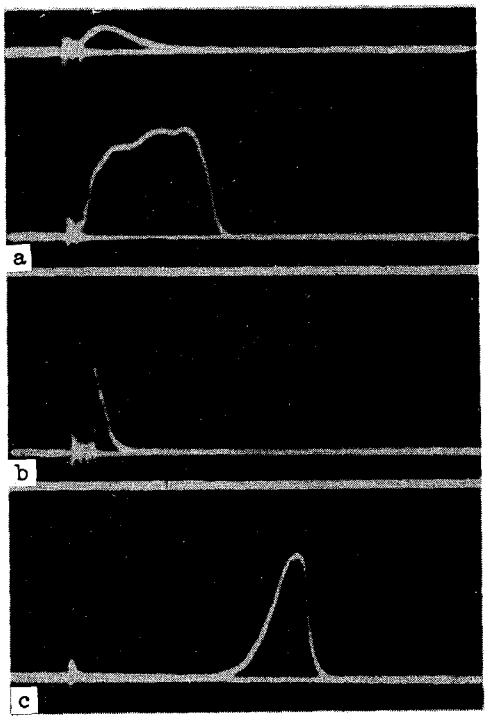
emphasized that excited HF* molecules are produced in both stages of the reaction [3, 6]

$$H_2 + F_2 + h\nu \rightarrow H_2 + 2F,$$
$$F + H_2 \rightarrow HF^* + H,$$
$$H + F_2 \rightarrow HF^* + F.$$

(We note that excited molecules are produced in the $H_2 + Cl_2$ system only in the reaction $H + Cl_2 \rightarrow HCl^* + Cl$ [6]).

A quartz tube of length $\ell \sim 500$ mm diameter, with fluorite windows at the Brewster angle, was filled with the $H_2 + F_2$ mixture, and was then illuminated with flash lamps for ~ 10 μsec. The capacitor-bank energy 3as 250 J at $U_{bank} = 20$ kV.

The resonator was confocal, with gold coating, and with a 1.5 mm exit hole in one of the mirrors. The radiation receiver was a Ge:Au crystal cooled with liquid nitrogen.



Sweep duration 140 μsec

The figure shows the synchronized flash and lasing pulses, respectively. We see that the lasing pulse is much larger than the flash pulse, whereas in $MoF_6 + H_2$ mixture the lasing stops together with the illumination (Fig. b).

Since the mechanism of formation of the active centers in both cases the same, it is obvious that when the $H_2 + F_2$ mixture is used the stretching of the lasing is due to the developing chain reaction.

At an illumination duration 250 μsec and a capacitor-bank energy 2500 J at $U_{bank} = 4$ kV, the lasing pulse is shorter and starts later than the illumination (Fig. c).

In the latter case, attention is called to the waveform of the lasing pulse. The leading front develops exponentially with $\tau \sim 10^6$. This indicates that active centers accumulate during the "induction" period, and the lasing begins when the number of active centers produced during the photolysis time is sufficient for a rapid course of the reaction. The shortening of the pulse can be attributed to heating of the mixture during the time of the "induction" period.

On the basis of the experiments, knowing the absorption coefficient of fluorine and the spectral distribution of the intensity in the flash lamp, it is possible to estimate the generation quantum field. Under our conditions it turned to be ~ 100. The generation energy yield in terms of the absorbed energy is ~ 10. Although it must be noted that the total energy yield, relative to the energy stored in the capacitor bank, is much less than unity. By suitable choice of the radiation source, this coefficient can be greatly increased.

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EQUATION OF STATE OF ALKALI METALS

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Precision measurements of alkali metals, or more accurately of the isotherms $\Omega_0(P)$ (Ω_0 - volume of unit cell), have recently been undertaken in a wide pressure interval [1 - 3]. The results have revealed a sharp deviation from linearity and a nearly universal character of $\Omega_0(P)$ for various metals, provided the curves are plotted in coordinates $\Omega_0(P)/\Omega_0(0)$ and $P/B_{(0)}$, where $\Omega_0(0)$ and B(0) are the volume of the unit cell and the reciprocal compressibility for normal conditions, i.e., at P = 0 and T = 0. The recently obtained general results on the multielectron theory of metals [4 - 7], which has developed primarily with emphasis on the analysis of the phonon spectra of metals, the binding energies, the compressibilities, and the elastic moduli, makes it also possible to obtain equations of state for nontransition metals. In this case the equation of state is obtained in simple and physically lucid form, which requires no cumbersome band calculations at all. It is of interest to compare the theoretical results with the experimentally obtained data.

The dependence of the pressure on Ω_0 can be obtained by directly differentiating the expression for the total energy with respect to the volume. In a metal, the static energy (we neglect the zero-point oscillations) can be represented in the form

$$E = E_i + E_e , \tag{1}$$

where E_i is the energy of a lattice immersed in a homogeneous negative background, and the total energy of the electron system in the field of the fixed ions, E_0, is obtained in the form of a series in powers of the pseudopotential of the electron-ion interaction, V_q [4, 5]

$$E_e = \sum_{m=0} E^m . \tag{2}$$

Accordingly, the general expression for the pressure is

$$P = P_i + \sum_{m=0} P^m \tag{3}$$

(for details see [7]). For crystals having cubic symmetry and one atom per unit cell, the value of E_i is well known. We then obtain readily for P_i

$$P_i = -(Z^2e^2/\Omega_0^{4/3})\,\xi. \tag{4}$$

(ξ = 0.480 for a body centered lattice).

$P^{(0)}$ is the pressure of the interacting electron gas, and $P^{(1)}$ is the pressure