TABLE

Transition	Selenium Isotope	Frequency, mc
	82	8756.7
	80	8771.05
4_{31}—4_{32}	78	8786.05
	77	8793.95
	76	8801.85
	82	9127.75
	80	9138.55
2_{20}—2_{21}	78	9149.65
	77	9155.85
	76	9161,50
	82	13827.7
	80	13862.65
9_{54}—9_{55}	78	13899.3
	77	13918.3
	76	13937.8

the calculated and the experimental data. This is attributed to the failure to allow in the calculations for the centrifugal perturbation, which is large for this molecule. To find the constants of the centrifugal perturbation, it is necessary to measure the frequencies of a few more transitions; this will be done in the future.

In conclusion, the authors thank G. Ia. Vzenkova for preparing the HDSe compound.

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"Seniority" Quantum Number Selection Rules in Nuclear Reactions

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A "SENIORITY" quantum number appears in the theory of atomic and nuclear shells[1-4]. Let us denote this by v. At the present time, the degree of accuracy of this quantum number has not been established. The question of the correctness of v is closely related to the question of the accuracy of jj coupling, although it does not entirely coincide with the latter. For the purpose of obtaining the required experimental information, it is necessary to investigate the satisfying of the selection rules for v in nuclear reactions. These rules can be derived in a very simple way on the basis of the results given in the articles referred to above.

1. In a reaction involving the capture or emission of a j nucleon (initial configuration j^n, final configuration j^{n+1}, or vice versa) $\Delta v = \pm 1$.

In particular, stripping in even-even nculei, for example, with an $f_{7/2}$ shell, should not lead to the formation of a resultant nucleus in the excited state $J = 7/2-$, $T = T_{gr}$ with $v = 3$ (the ground state of the initial nucleus has $v = 0$ and $J = 0$; the ground state of the final nucleus, with the exception of Ti^{49}_{22} and V^{49}_{23}, has $v = 1$ and $J = 7/2-$). However, such excited states of nuclei with $f_{7/2}$ shells have not yet been observed experimentally.

2. For $M1$ or $M3$ transitions in nuclei where there are only neutrons outside of the filled shells (for example, Ca^{43}_{20}), or only protons (for example, V^{51}_{23}), which are characterized by the configuration j^n, $\Delta v = 0$.

Thus the selection rules in Ca^{43} and V^{51} for v forbid an $M1$ transition from any level of the $(f_{7/2})^n$ configuration to the ground level of this configuration with $v = 1$, $J = j = 7/2-$, which is ground level for these nuclei.

3. For $M1$ or $M3$ γ-transitions in the case of a j^n configuration formed by neutrons and protons ($|M_T| < n/2$): $\Delta v = 0, \pm 2$, $\Delta T = \pm 1.0$; when the isobaric spin T of the initial and final states is zero, $\Delta v = 0$.

For $E2$ radiation the selection rules for v will be $\Delta v = 0, \pm 2$. These have no practical value.

Selection rules 1 are intuitively clear and require no explanation. Selection rules 2 and 3 can also be derived by a very clear method. We shall now discuss selection rules 2.

The wave function of a state of configuration j^n with seniority v can be written as:

$$\Psi^J_M(n, v) = \sum_P (-1)^P P \Psi^0_0(1, 2)$$

$$\ldots \Psi^0_0(n-v-1, n-v)\, \Psi^J_M(v, v);$$

where the P are permutation operators of n numbers: $(-1)^P = +1$ when P is even and -1 when P is odd. It is important to note that even in other cases where such a wave function of the j^n configuration is broken up into factors, none of the factors can be a symmetric function (antisymmetrization of a function which is symmetric with respect to even two particles gives a vanishing result). Thus no factor can be $\Psi^{J'}_{M'}(1, 2)$, where J' is odd (j is a half integer).

The operator of a $M1$ transition is a pseudovector operator; therefore, the matrix element vanishes for a transition between a state with the wave function $\Psi^0_0(1,2)$ and a state with the wave function $\Psi^{J'}_{M'}(1, 2)$, where J', as we have seen, can only be even. This simply denotes that transitions with $\Delta v \neq 0$ are forbidden.

It is expedient in practice to investigate experimentally the satisfaction of the selection rules for v only for nuclei which are heavier than Ca^{40}_{20}, since nuclei between O^{16}_8 and Ca^{40}_{20} evidently do not possess a shell structure, $1d$ and $2s$ configurations are highly mixed.

In particular, for nuclei with a $1f_{7/2}$ shell these experiments can determine whether jj or intermediate coupling takes place[5] and whether collective interactions are significant. v will be a good quantum number only when j– is a good quantum number and collective effects are unimportant. Experimental investigations of the accuracy of v are naturally performed through experimental investigations of the accuracy of j [6].

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Gamma Quanta Emitted by I, Rh and Co Nuclei in Thermal Neutron Capture

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THE most reliable data on the energy and the absolute yield of γ-quanta emitted by nuclei upon thermal neutron capture have been obtained by Kinsey's group[1] and by the Soviet scientists Groshev, Ad'iasevich and Demidov[2,3]. In Kinsey's work[1], only γ-rays with energies greater than 3 mev were detected while in the work of Ref. 2, the spectrum of γ-quanta with energies greater than 0.3 mev was investigated. Meanwhile, measurements carried out with the help of scintillation spectrometers[4,5] proved the presence of discrete lines in the low energy part of the spectra. The authors working with scintillation spectrometers were not able to determine the absolute intensities of the observed lines.

In the present work, the energies and absolute intensities of γ-quanta with energies of 50 to 600 kev emitted by I, Rh and Co nuclei during thermal neutron capture were determined. In the work, a scintillation spectrometer was used with a NaI (Tl) crystal of cylindrical shape (height 9 mm, diameter, 28 mm). The resolving power of the spectrometer, η, depends on the energy of the γ-quanta (E_γ) according to the law

$$\eta = 186\, E_\gamma^{-1/2} + 2.5, \qquad (1)$$

where E_γ is expressed in kev and η in percent. In experiments carried out with radioactive emitters having monoenergetic γ-ray spectra, the efficiency of the spectrometer ϵ_Φ, was determined, enabling one to convert the area of the photo peak to the number of γ-quanta falling on the NaI (Tl) crystal.

A heavy water physics research reactor[6] was used in this work as a source of thermal neutrons. A well-collimated beam of neutrons came out of a horizontal channel in the reactor shielding. A target of the material being investigated was located in the center of the beam. A NaI(Tl) crystal and a photomultiplier tube were placed under the target, and were carefully shielded with lead and with boron carbide. A channel of 10 or 15 mm diameter, used as a collimator for γ-rays coming from the target to the NaI(Tl) crystal, was located in the spectrometer shielding. The aperture of the γ-ray collimator was covered with boron carbide of 0.3 gm/cm^2 thickness, blocking the passage of thermal neutrons scattered in the target.

In the measurement of γ-rays from the capture of neutrons, measurements were made with an open beam of thermal neutrons, N_0, and with a beam of neutrons filtered at the exit of the neutron collimator by a B_4C shield (N_1). The effect of thermal neutrons in the target N is equal to the difference