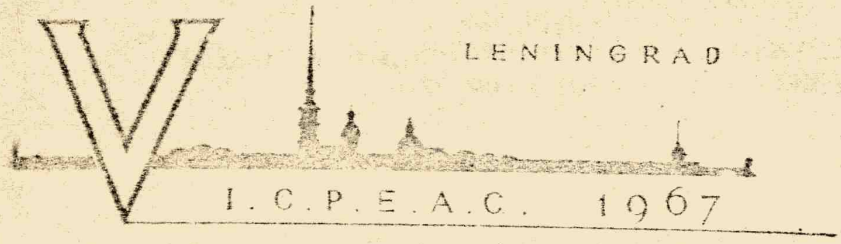

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Abstracts of papers

THE ADIABATIC APPROXIMATION FOR THE DESCRIPTION OF REORIENTATION OF THE ATOMIC ANGULAR MOMENTA UNDER COLLISIONS

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The reorientation of the angular momentum of an atom A in the P-state due to the collisions with the atoms of a gas B, having a closed electronic shell is considered. At large internuclear distances R the splitting between Σ and Π potential curves tends to zero according to the formula $\Delta E = \frac{\Delta c_n}{R^n}$ (for atom-atom collisions $n=6$, and for atom A-ion B collisions $n=3$).

Writing the wave function in the form

$$\Psi(t) = a(t) \exp\left[-\frac{i}{\hbar} c_{n\Sigma} \int_{-\infty}^{t} \frac{dt}{R^n}\right] \psi_\Sigma + \left[b(t)\psi_\Pi + c(t)\psi_{\Pi'}\right] \times$$

$$\times \exp\left[-\frac{i}{\hbar} c_{n\Pi} \int_{-\infty}^{t} \frac{dt}{R^n}\right] \tag{1}$$

we obtain for the coefficients a, b, c the following system of equations

$$\frac{da}{d\varphi} = b \exp\left[iB_n \int_0^\varphi (\sin\varphi)^{n-2} d\varphi\right],$$

$$\frac{db}{d\varphi} = -a \exp\left[-iB_n \int_0^\varphi (\sin\varphi)^{n-2} d\varphi\right], \tag{2}$$

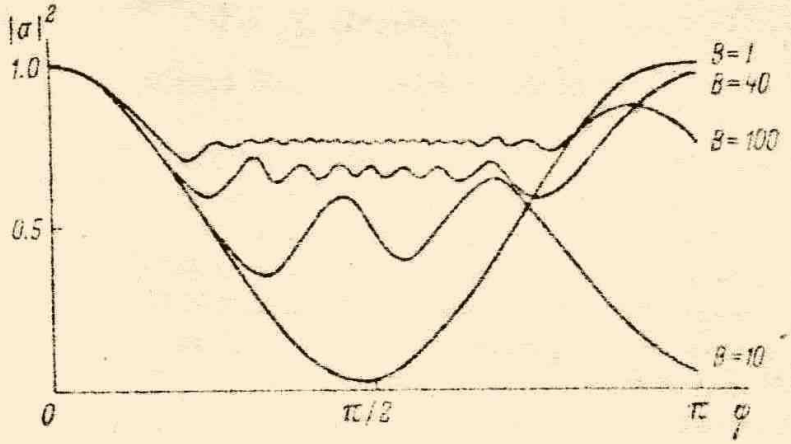
$$\frac{dc}{d\varphi} = 0$$

where φ is the turning angle of the internuclear axis ($0 \leqslant \varphi \leqslant \pi$), ρ is the impact parameter and v — the velocity of relative motion. The dimensionless parameter $B = \frac{\Delta c_n}{\rho^n \hbar v}$ (Massey parameter) is the only parameter which determines the nature of the solution.

If B_n is large, the adiabatic approximation is valid and $|a|^2$, $|b|^2$ have to be constants. The numerical solution of (2) for $n=6$ and the model case $n=2$ (when an exact analytic solution exists) can be compared with the adiabatic approximation. For the $n=6$ case and $B_6 = 1, 10, 40, 100$ the results for $|a|^2$ are shown in the figure. It can be seen that in the vicinity of the points $\varphi=0$ and $\varphi=\pi$ the adiabatic approximation fails even at large B. It can be shown that this approximation is valid only if $B_6 (\sin\varphi)^5 \gg 1$.

In this region one can construct an adiabatic solution of the system (2) by means of expansion in inverse powers of B_6. At $\varphi \approx 0$ and $\varphi \approx \pi$ the solution can be found by a simple power series expansion in φ or $\pi - \varphi$ and adjusting it with the adiabatic solution constructed. Such an approximate method enables one to calculate approximately the transition probabilities and phases, without resorting to numerical integration.

For the model system with $n=2$ the perturbation, which splits the potential curves, decreases much slower as $R \to \infty$ and the adiabatic approximation becomes applicable for all φ starting from $B_2 \approx 10$. For $B_2 \geqslant 10$ the transition probability does not exceed 0.05.



The results obtained can be used for calculating the relaxation of the density matrix of the atoms A due to the collisions with atoms B and can be applied to the theory of depolarization of resonance fluorescence, Hanle effect and related phenomena.