where $V_0 \cos\varphi$ is the accelerating potential; $\bar{\epsilon}$ – the mean value of the quanta emitted by the electron at the given energy E; $a_1 - \bar{a}_1$ – the deviation (fluctuation) of the number of quanta emitted per unit time, from its mean value; the coefficient Q is determined by the accommodation parameters

$$Q = 2 + \bar{\psi}_\Phi - \bar{\psi}_Д + \bar{\psi}_H / |n|, \tag{6}$$

where $\bar{\psi}_F$ and ψ_D are the averages of $\psi(\theta)$ over focussing ($n < 0$) and defocussing ($n > 0$) sectors. The calculations show that $Q \simeq 4$. Note that the coefficient E of $d\eta/dt$ in (5) can be neglected in that range of energy where radiation (and its fluctuation) is important. Assuming a linear time dependence, we can solve Eq. (5). For the mean square of η, we find:

$$\bar{\eta^2} = \frac{55\sqrt{3}}{64}\frac{\hbar c}{e^2}\frac{q}{\sigma}\frac{\bar{\psi}_H}{Q|n|}\operatorname{ctg}\varphi_0\frac{mc^2}{E}, \tag{7}$$

where the factor $\bar{\psi}_H / Q|n|$ is approximately equal to $1/|n|$. Equation (7) can be used to find the azimuthal dimensions of the electron concentration, which are of some interest for evaluation of loss by coherent radiation.

The largest radial deviation ρ_{max} of the instantaneous orbit is determined by (1), when $\psi(\theta)$ is given its maximum value $\psi_{max}(\theta)$. Using (1), (2), (5), and (7) we obtain the mean square value:

$$\bar{\rho^2_{max}} = (55\sqrt{3}/96)(\hbar R/mc)(\psi^2_{max}/Q|n|^2)(E/mc^2)^2. \tag{8}$$

Note that exactly the same correction characterizes the instantaneous orbit in a strong focussing betatron, in which the radiation losses compensate on the average. The evaluations show that, near the center of steadiness ($\sqrt{|n|}\,\nu \simeq \pi/2$) the factor $\psi^2_{max}/Q|n|^2 \simeq 10/|n|^2$, while in the case of weak focussing[2,3] it is replaced by the expression $1/(1-n)(3-4n)$, which, for $n \sim 0.6$-0.7 is $\simeq 10$. The small dependence of θ^2_{max} on E or t is explained by the influence of powerful extinction linked to the large magnitude of the mean radiation losses. This extinction has a simple physical meaning. It can be shown that it corresponds to the fact that when the orbit is displaced along the radius, the particle radiates in such a way that the change of its energy tends to restore the instantaneous orbit in its equilibrium position.

If, for instance, we let $H_{max} \approx 10^4$ oersteds, then, according to Eq. (8), we get the evaluation $(\rho^2_{max})^{1/2}_{cm} \lesssim E^{3/2}_{BeV}/|n|$, which shows that even for $E \simeq 5 \div 10$ BeV is only of the order of a centimeter. The considered effect has thus, by itself, no appreciable effect on acceleration.

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Auger Effect in Heavy Atoms

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EXCITED atoms, in which one of the interior electrons (say a K-electron) is missing, undergo transitions to a lower energy state by means of radiation of a quantum or by a nonradiative transition with the emission of an electron (Auger Effect). The total number of transitions per unit time $(1/c)_\epsilon$ has been obtained for the nonrelativistic case for arbitrary Z with the aid of the Coulomb function.[1] Only in the case of the interaction of L-electrons (for $Z = 47$) has the screening of the atomic nucleus been taken into account.[2]

In first order perturbation theory,

$$\frac{1}{\tau} = \frac{2\pi}{k}\,|\,V(n_1l_1m_1,\ n_2l_2m_2\,|\,100,\ kl'm') - V(n_2l_2m_2,\ n_1l_1m_1\,|\,100,\ kl'm')\,|^2$$

and

$$\frac{1}{\tau} = \frac{2\pi}{k}\,|\,V(n_1l_1m_1,\ n_2l_2m_2\,|\,100,\ kl'm')\,|^2$$

for the interaction of electrons with parallel and antiparallel spins, respectively. Here we have the matrix elements of the operator $V = 1/|\mathbf{r}_1 - \mathbf{r}_2|$, which corresponds to a transition from a state with quantum numbers n_1, l_1, M_1; m_2, l_2, m_2 to a state with quantum numbers 1, 0, 0; l', m' and with momentum k of the emerging electron (atomic units are used here). In the radial integral which enters into the matrix element, the important region is evidently $r_1, r_2 \leqslant 1/Z$. In this region the wave function of the initial state coincides with the Coulomb function with accuracy to a normalization factor A_{nl}. To find A_{nl}, we make use of the fact that the initial and Coulomb functions are quasi-classical for $r \gg 1/Z$. If we write out the quantization rule and the normalization condition for them, we get, after some simple transformations,

$$A_{nl} = B_{nl} \sqrt{(n^3/Z^2)(\partial E_{nl}/\partial n)},$$

where B_{nl} is the normalization coefficient of the Coulomb function, E_{nl} is the energy of the corresponding level. In this case, it is assumed in the calculations that for $n = 1, 2$, $A_{nl} = B_{nl}$.

For large n_2 and for $n_1 = 2$,

$$1/\tau = A_{l_1 l_2}\, \partial E_{n_2 l_2} / \partial n_2 ,$$

where $A_{l_1 l_2}$ is almost independent of n_2. Therefore, replacing the sum over n_2, beginning with $n_2 = 3$, by an integral, we can write the total number of Auger-transitions per unit time in the form:

$$(1/\tau)_\Sigma = (1/\tau)_{L-L} + \sum_{l_1=0}^{1} \sum_{l_2=0}^{2} A_{l_1 l_2} \int_{n_2=3}^{\infty} (\partial E_{n_2 l_2}/\partial n_2)\, dn_2 + \sum_{l_1=0}^{1} A_{l_1 3} \int_{n_2=4}^{\infty} (\partial E_{n_2 3}/\partial n_2)\, dn_2 + \ldots$$

$$= (1/\tau)_{L-L} - \sum_{l_1=0}^{1} \sum_{l_2=0}^{2} A_{l_1 l_2} E_{3 l_2} - \sum_{l_1=0}^{1} A_{l_1 3} E_{43} - \ldots ,$$

where small terms of the type

$$A_{l_1 l_2} (\partial E_{n_2 l_2}/\partial n_2)(\partial E_{n_1 l_1}/\partial n_1) \qquad (n_1 > 2).$$

are discarded.

In the first approximation,

$$(1/\tau)_\Sigma = (1/\tau)_{L-L} - \sum_{l_1=0}^{1} \sum_{l_2=0}^{2} A_{l_1 l_2} E_{3 l_2} .$$

We can put $E_{3 l_2}$ in the form:[3]

$E_{3l} = -(Z - s_l)^2/18$, where s_l is the screening constant

For $(1/\tau)_{L-L}$, making use of the well-known results of reference 2, we obtain for $Z = 47$, after some computation,

$$(1/\tau)_\Sigma = 45{,}9 \text{ atomic units} \qquad (1)$$

A quantity defined from experiment is the coefficient

$$\alpha_K = Z^4 (1/\tau)_\Sigma / (1/\tau)_{\rm rad},$$

where $(1/\tau)_{\rm rad}$ is the number of radiative transitions per unit time. For $Z = 47$: $(1/\tau)_{\rm rad} = 0.197$ atomic units.[4] Making use of Eq. (1), we obtain $\alpha_K = 1.14 \times 10.^6$ The experimental value is[4] $\alpha_K = 1.14 \times 10.^6$ Calculation with the help of the Coulomb functions gives $\alpha_K = 1{,}65 \cdot 10^6$.

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Scattering of Fast Neutrons by Semitransparent Nonspherical Nuclei

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THE scattering of fast neutrons by an opaque nonspherical nucleus with spin zero has been studied by Drozdov[1,2]. The scattering of fast neutrons by an even-even semitransparent nonspherical nucleus is considered in the present work.

According to Bohr and Mottelson[3,4], the even-even nuclei in their rotational states have the form of an ellipsoid of revolution and the wave function of such a state is a spherical harmonic $Y_{lm}(\omega)^*$, where l, m are the spin of the nucleus and the projection of that spin, ω represents the angles ϑ, φ which characterize the direction of the axes of symmetry of the ellipsoid. The rotational levels are determined by the formula $E_l = (\hbar^2/2I)\, l(l+1)$, $l = 0, 2, 4, \ldots$, where I is the effective moment of