THE GAMMA RAYS OF As^{74}

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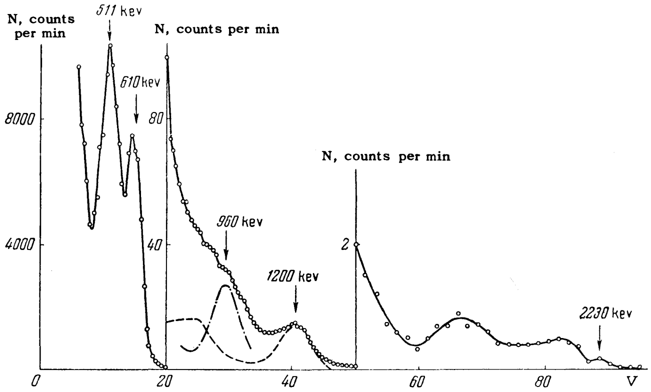
We have studied the γ-ray spectrum of As^{74} by means of a single-channel scintillation γ-ray spectrometer, using a NaI(Ta) crystal with a type FEU-S photomultiplier. The efficiency curve of the γ-ray spectrometer was obtained by taking measurements with it on standards giving known numbers of disintegrations.

The energies and relative intensities of the lines observed in the γ-ray spectrum are given below, together with the results of the latest two papers on this spectrum:



Gamma-ray spectrum of As^{74}, taken with a scintillation γ-ray spectrometer. The dashed curves show the resolution of a section of the spectrum into components.

Present work		Grigor'ev et al.[1]		Horen and Wells[2]
$h\nu$, kev	Relative intensity	$h\nu$, kev	Relative intensity	$h\nu$, kev
610±30	1	635	1	—
960±50	0.015±0.008	—	—	—
1200±30	0.023±0.008	1190	0.018±0,005	1190±10
—	—	—	—	1600±40
2230±70	~10^{-4}	>1190	<0.004	2220±20

The work of Grigor'ev et al.[1] was done earlier than ours; we received the brief communication of Horen and Wells after the completion of our measurements.

The existence of γ-ray lines of energies of 1190 and 2220 kev can evidently be regarded as established; the other two lines, at 960 and 1600 kev, still need further investigation.

[1] Grigor'ev, Dzhelepov, Zolotavin, Mishin, Prikhodtseva, Khol'nov, and Shchukin, Izv. AN SSSR, Ser. Fiz. 22, 831 (1958), Columbia Tech. Transl. in press.

[2] D. J. Horen and D. O. Wells, Bull. Am. Phys. Soc., Ser. II, **3**, 315 (1958).

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ULTRASONIC ATTENUATION IN METALS

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The attenuation of ultrasonic waves in metals at low temperatures is determined by the electron-phonon interaction. The absorption coefficient, γ, has been calculated by Pippard,[1] and Steinberg[2] has examined the corresponding change in the velocity of sound. Bömmel[3] measured the attenuation in the presence of an external magnetic field and found that γ did not vary monotonically with H. This effect was explained by Pippard[4] as a type of cyclotron resonance. Steinberg[5] carried out the calculation for transverse waves in a longitudinal magnetic field and concluded that resonance absorption does not occur in this case. Here we examine the attenuation of transverse waves in metals in a transverse magnetic field.

We regard the motion of the atoms of the lattice as given and consider the electrons to be free. We are interested in the case when $l \gtrsim \lambda$, $R \sim \lambda$. Here λ is the wavelength of the sound waves and l is their mean free path. $R = mvc/eH$, is the radius of the electron orbits. It turns out that the equilibrium electron distribution is the same as the distribution, f_0, in the absence of the sound waves. The electron distribution $f = f_0 - \chi(\partial f_0/\partial\epsilon)$ and the electric field **E** are determined by the kinetic equations

$$(1/\tau + i\omega - ikv\sin\theta\sin\varphi)\chi - (v/R)\,\partial\chi/\partial\varphi - \bar{\chi}/\tau - ev(E_x\sin\theta\cos\varphi + E_y\sin\theta\sin\varphi + E_z\cos\theta) = 0 \quad (1)$$

and the electromagnetic field equations

$$E_x = (4\pi is^2/\omega c^2)\,j_x,$$

$$E_z = (4\pi is^2/\omega c^2)\,j_z, \quad E_y = (4\pi is/\omega)\,\rho. \quad (2)$$

where

$$\rho = (3Ne/mv^2)\,\bar{\chi}, \quad \bar{\chi} = \int \chi d\Omega/4\pi, \quad (3)$$

$$j_x = (3Ne/4\pi mv)\int \chi\sin\theta\cos\varphi d\Omega - Neu_x, \quad (4)$$

$$j_z = (3Ne/4\pi mv)\int \chi\sin\theta\sin\varphi d\Omega - Neu_z, \quad (5)$$

s is the velocity of sound, **u** the velocity of the atoms in the lattice, N the number of atoms (and electrons) per cm^3. The field **H** is directed along the z axis and the wave vector **k** is along the y axis. A solution of Eq. (1) is

$$\chi = \frac{eR\exp(2\pi R/l')}{\exp(2\pi R/l') - 1}\exp(ikR\sin\theta\cos\varphi) \times \int_0^{2\pi} d\psi\,[E_x\sin\theta\cos(\varphi+\psi) + E_y\sin\theta\sin(\varphi+\psi) + E_z\cos\theta + \bar{\chi}/el] \times \exp[-R\psi/l' - ikR\sin\theta\cos(\varphi+\psi)], \quad (6)$$

where $l' = v\tau/(1+i\omega\tau)$. Making use of (2) and (3) we find $\bar{\chi}/el \ll E_y$. The discussion below will be confined to the case when $l \gg R$.

We consider waves polarized parallel to the field H ($u_x = 0$). From (5) and (6) we obtain

$$j_z = A\sigma E_z - Neu, \quad (7)$$

where

$$\sigma = Ne^2\tau/m,$$

$$A(z) = 6z^{-1}\Big[(1+z^{-2})\int_0^z J_0(t)\,dt - J_1(z) - z^{-1}J_0(z)\Big],$$

$$z = 2kR. \quad (8)$$

Substituting in (2) we obtain

$$E_z = mu/e\tau(A+iB), \quad (9)$$

where $B = \omega c^2/4\pi s^2\sigma$. Calculation shows that $B \ll A$ for $\omega < 10^8\ \sec^{-1}$.

In one second the lattice loses an amount of energy

$$\dot{Q} = {}^1/_2\,\mathrm{Re}(NeuE_z), \quad (10)$$

and the absorption coefficient is

$$\gamma = 2\dot{Q}/NMu^2s = m/Ms\tau A, \quad (11)$$

where M is the atomic mass.

If the sound waves are polarized perpendicular to the field ($u_z = 0$), then in this expression A_1 must be substituted for A, where

$$A_1(z) = {}^3/_2\,z^{-1}\Big[(1+3z^{-2})\int_0^z J_0(t)\,dt - 3J_1(z) - 3z^{-1}J_0(z)\Big]. \quad (12)$$

From Eqs. (8), (11), and (12) it follows that $\gamma(H)$ has a succession of maxima. Their position is not, however, determined by the simple conditions indicated by Pippard[4] and Steinberg.[5]

In conclusion I would like to thank V. P. Silin, under whose direction this work was carried out.

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[2] M. S. Steinberg, Phys. Rev. **111**, 425 (1958).
[3] H. E. Bömmel, Phys. Rev. **100**, 758 (1955).
[4] A. B. Pippard, Phil. Mag. **2**, 1147 (1957).
[5] M. S. Steinberg, Phys. Rev. **110**, 772 (1958).
[6] M. S. Steinberg, Phys. Rev. 110, 1467 (1958).

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FREE ENERGY OF STRONG ELECTROLYTES

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THE diagram technique, developed by the author[1] to calculate the paired correlation function in classical statistical physics, was used to determine the free energy of a strong electrolyte, i.e., of a system of charged particles which is neutral as a whole, in which the interaction potential of the particles V(x) behaves arbitrarily at small distances (and corresponds to a repulsion of particles) and goes at large distances into the pure Coulomb potential $Z_1Z_2e'^2/r$ (where $e' = e/\sqrt{\epsilon}$) for particles with charges Z_1 and Z_2 in a medium with dielectric constant ϵ.