Letters to the Editor

PROMPT publication of brief reports of important discoveries in physics may be secured by addressing them to this department. The closing date for this department is the third of the month. Because of the late closing date for the section no proof can be shown to authors. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents. Communications should not in general exceed 600 words in length.

Auger Transitions

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December 13, 1945

IN 1944, J. N. Cooper published a survey[1] of Auger transitions and the resultant doubly-ionized states. Through some oversight[2] he omitted the transition $L_{\text{I}} \rightarrow L_{\text{II}} M_{\text{IV,V}}$ which originates the $L\beta_1$ satellites in the x-ray spectrum. In all, he had some twenty-six transition groups. The final doubly-ionized state includes the same outer shell in each group, but not the same subshell. Including Cooper's omission, then, there should be twenty-seven transition groups. Of these, fifteen Auger transition groups obey the old x-ray selection rules: $\Delta j = \pm 1,\ 0$; $\Delta k = \pm 1$; Δn is arbitrary. Coster[3] looked for radiation from the transitions $L_{\text{I}} \rightarrow L_{\text{II}}$ and $L_{\text{I}} \rightarrow L_{\text{III}}$ which he noted were permitted by selection rules. He later observed extremely faint radiation,[4] i.e., these are "radiationless" transitions. The present writer[5] remarked in 1942, that "selection rules point out where the radiationless transitions are sure to occur." Of these fifteen permissible transitions in Cooper's survey,[1] four groups yield x-ray satellites, in two cases of which it is for two x-ray diagram lines (see Table I). The question properly arises as to the meaning of these circumstances: the selection rules point out and control the occurrence of significant Auger transitions. Of the permitted transitions, relatively few result in the proper initial double (or triple) ionization which gives rise to x-ray satellite groups. This in no way contradicts the Franck-Condon principle: ${}_1E_2 \gtrsim h\nu_0$, where ${}_1E_2$ is the energy difference of the Auger transition, and $h\nu_0$ is the energy of ionization of the second (outer) shell in the Auger effect. Let $\nu_1 = RZ^2(1/n_1^2)$ and $\nu_2 = RZ^2(1/n_2^2)$, then ${}_1E_2 = h(\nu_1 - \nu_2) = hRZ^2(1/n_1^2 - 1/n_2^2)$; let $h\nu_0 = hRZ^2(1/n_3^2)$. Then for the Auger effect: $(1/n_1^2 - 1/n_2^2) \gtrsim 1/n_3^2$.[6] This last equation may easily be verified, if one remembers that the initial state of the Auger effect is one of ionization. Inspection of quantum numbers reveals the last equation is verified *only* for the old azimuthal quantum number k. Substituting in the last equation, for $L\alpha_1$, $L\beta_2$ and $L\beta_1$, we have

$$1/(1)^2 - 1/(2)^2 \gtrsim 1/(3)^2 \quad \text{or} \quad 1 - \tfrac{1}{4} \gtrsim \tfrac{1}{9}.$$

For $M\alpha_1$ and $M\zeta_{1,2}$,

$$1/(2)^2 - 1/(3)^2 \gtrsim 1/(3)^2.$$

However for $M\beta$,

$$1/(3)^2 - 1/(3)^2 = 0 \neq 1/(3)^2,$$

there is no verification. Thus for five of the six satellite groups, the azimuthal quantum number, k, verifies the Franck-Condon principle somewhat roughly.

TABLE I.

Auger transition	X-ray satellite group	Parent line transition
$L_{\text{I}} \rightarrow L_{\text{II}} M_{\text{IV,V}}$	$L\beta_1$	$L_{\text{II}} M_{\text{IV}}$
$L_{\text{I}} \rightarrow L_{\text{III}} M_{\text{IV,V}}$ $L_{\text{I}} \rightarrow L_{\text{III}} M_{\text{IV,V}}$	$L\alpha_1$ $L\beta_2$	$L_{\text{III}} M_{\text{V}}$ $L_{\text{III}} N_{\text{V}}$
$M_{\text{III}} \rightarrow M_{\text{IV}} N_{\text{IV,V}}$	$M\beta$	$M_{\text{IV}} N_{\text{VI}}$
$M_{\text{III}} \rightarrow M_{\text{V}} N_{\text{IV,V}}$ $M_{\text{III}} \rightarrow M_{\text{V}} N_{\text{IV,V}}$	$M\alpha_1$ $M\zeta_{1,2}$	$M_{\text{V}} N_{\text{VII}}$ $M_{\text{V}} N_{\text{II,III}}$

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[1] J. N. Cooper, Phys. Rev. **65**, 155 (1944).
[2] My oversight as well as his, for I saw the paper in manuscript.
[3] D. Coster, Phil. Mag. **43**, 1089 (1922).
[4] D. Coster and R. DeL. Kronig, Physica **2**, 13 (1935).
[5] F. R. Hirsh, Jr., Phys. Rev. **62**, 137 (1942).
[6] Since ${}_1E_2 \gtrsim h\nu_0$, we may divide the close equality by hRZ^2, since for ${}_1E_2$, $Z \sim 50$ and for ν_0, $Z \sim 49.5$, the error in the approximation is 2 percent.

Meteoric Impact Ionization Observed on Radar Oscilloscopes

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September 29, 1945

THE short duration scattering of radio signals about 40,000 kc/sec. has been observed for fifteen years.[1] During 1940–41 it was observed and recorded by the author in frequency-modulation broadcast wave propagation tests.[2] This scattering was subsequently attributed to reflection from high density "*D*" and "*E*" region clouds ionized by high velocity meteoric impact.[3] This has been the basis of further study in the radio effects and the ionization dissipation of meteors. Of this, six objectives have been defined;

a. Determination of the virtual heights of the reflecting boundaries,
b. Application to the Maris theory of meteors to obtain accurate data for the astronomical study of masses and velocities,[3]
c. Transitions and dispersion of the ions produced by meteoric impact and the light of the night sky,
d. Correlation with the extended low frequency scattering of the Eckersley type,[4]
e. Determination of critical or limiting scatter radio-frequencies, and
f. Measurement of field-intensities and skip distances.

The first four objectives will be covered in a series of papers soon to be published by the author. The latter two represent new developments which have been brought somewhat closer to solution through wartime radio and radar operation.

The frequency of occurrence and the field-intensities[5] observed at 43,000 kc/sec. led to the supposition that the limiting or critical scattering frequency must lie above 100,000 kc/sec. This was substantiated when "echo-