Comment on a Paper by W. E. Bowls, "Second Townsend Coefficient"

The discussion of the possible ionization of mercury by metastable nitrogen molecules calls for some comment even at this late date. Unfortunately, my attention was attracted to this paper[1] only recently, and yet I feel that these remarks may help others in future considerations involving metastable nitrogen molecules.

The energy of the metastable $A^3\Sigma$ level of nitrogen has now been definitely established at 6.14 volts, and the commonly quoted 8.2-volt value should not be used. The value of 9.77 volts, as given by Saha and Mathur, is undoubtedly their value for the energy that can be transferred by active nitrogen. Now the fact that the energy of the metastable state is less than the 10.39 volts required for the ionization of mercury should not deter anyone from supposing that active nitrogen can ionize mercury vapor. The 10.4- and the 9.77-volt values for the energy that can be transferred in active nitrogen are obtained from experiments on the Lewis-Rayleigh afterglow, and it is now well established that strong afterglows possessing auroral and night-sky spectra can be produced. At the present time the writer is observing a high pressure afterglow of quite long duration which is bluish-white in color because of the N_2^+ and second positive bands in the blue-violet and blue-green. The energy required for the excitation of the auroral N_2^+ bands is 18.65 volts for the zero vibrational level and a little higher than this for the higher vibrational levels. It is safe to say therefore that the energy transferred in the auroral afterglow is greater than 19 volts, i.e., almost twice the ionization potential of mercury.

It seems proper to remark that the 15.50-volt value for the ionization potential of N_2 has now been obtained by Worley and Jenkins, and this value should be used instead of the 16.7-volt value quoted by Bowls.

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[1] W. E. Bowls, Phys. Rev. **53**, 298 (1938).
[2] J. Kaplan, Phys. Rev. **54**, 176 (1938).
[3] R. E. Worley and F. A. Jenkins, Phys. Rev. **54**, 305 (1938).

Elastic Scattering of Fast β-Particles by Atomic Nuclei

In continuation of previous work,[1] the elastic scattering of β-particles in the energy range 0.7–1.2 Mev by iodine nuclei has been examined with a cloud chamber. The preliminary results show that the scattering is from one-half to one-third of that predicted by Mott's theory. Our collected data are given in the following Table I.

TABLE I. *Values of the ratio R of the calculated to the observed elastic scattering in the angular range 20° to 180° for β-particles in the energy range 0.7 to 1.2 Mev.*

ELEMENT	ATOMIC NUMBER Z	R
N	7	1.1
I	53	2.5
Hg	80	7.0

We have not been able to account for the results by a straightforward modification of the potential field and it seems unlikely that any small adjustment of existing theory will explain the discrepancy. It is possible that the anomalous elastic scattering process is closely connected with the processes of inelastic scattering and pair production, both of which are anomalous. Since the problem may also be closely connected with β-disintegration, it may well be one of nuclear type in which the motion of the particle can no longer be considered as taking place in the general potential field of the remainder of the system. Finally the anomalous behavior may set in suddenly at a particular energy, as is certainly the case with pair production. This energy consideration alone might be sufficient to account for the normal behavior of the K electron since the energy of the latter, even in the heaviest elements, is much smaller than that with which we are concerned.

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Absorption of Slow Neutrons of Different Energies by B, Co and Mn

We have measured the absorption of neutrons of different energies by various substances, using a Ra-Be source in paraffin and the usual Geiger-Müller tube and scale-of-eight counting system.

With boron absorbers, our geometrical conditions in experiments with C and D neutrons were nearly those of a parallel beam; three thicknesses of absorbing material ranging from 0.02 to 0.1 g/cm² were used. At these energies with other absorbers and at higher energies, measurements were made with, usually, only two absorber thicknesses. Absorption coefficients were evaluated by the method of Frisch.[1] Some of the results are shown in Table I.

TABLE I. *Absorption coefficients, in cm²/g, of* B, Mn *and* Co *with different detectors.*

ELEMENT	C (Rh)	D (Rh 44″)	Ag 22″	I 25′	Br 18′	Ag 2.3′	Mn 150′
B	30.0	5.35	2.46	0.97	0.82	≏0.2	
Mn	0.14	0.015	<0.003	0.02	0.04	<0.003	0.80
Co	0.32	0.08	0.03	0.04			

The boron absorption coefficients agree, in general, with those already reported by other workers.[2] Our value for the D neutrons is, however, somewhat higher, giving 0.94 v for the resonance level of Rh. For I neutrons, our value agrees with those of Frisch and of Norling and Fleischmann, and we confirm the latter in placing the Br level at a somewhat higher energy than the I level.

The coefficient of self-absorption for Mn, determined with a thin detector and a thin absorber, is unusually low. It is seen that the Mn resonance band extends well into the region of the I and Br resonance energies. The ratio of the Mn absorption coefficients for C and D neutrons is 9,

whereas the same ratio for boron is 5.6, suggesting a resonance level for Mn in the thermal region also.

The fact that the absorption by Co of I neutrons is greater than that of Ag neutrons, shows the presence of a resonance band for Co in the region of the I energy level.

These and other results will appear in more detail.

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A Remark on the Latitude Effect of Cosmic Rays

New measurements of the cosmic-ray latitude effect[1] show that the latitude, where the effect begins, remains the same in the whole atmosphere. This behavior denotes that the existence of a "critical latitude" is produced, not by atmospheric absorption,[2] but by absence, in the incident radiation, of rather slow rays;[3] they either are deflected by the sun's magnetic field or do not exist at all in the primary spectrum. We wish to call attention to a consequence of this conception, which possibly may permit us to decide, if the hard component, considered here alone, is primary in origin, or secondary—as recently suggested by some authors.[4]

If the component is a secondary one, its latitude effect accompanies that of the primaries and the critical latitude will be the same at *all* depths.

But if the hard rays are themselves primaries, the constancy of the critical latitude is limited to depths $x<E_{\min}/s$ only, where s is the specific ionization and $E_{\min}$ the threshold value of the energy spectrum. Only rays of energies higher than $E_{\min}$ are able to reach to depths $x>E_{\min}/s$ since the maximum range of an ionizing ray of energy E is always $R=E/s$, whatever may be the kind of its energy loss. Therefore, with increasing depth the critical latitude will shift to lower values, nearer the equator, exactly as is shown by the absorption theory. It can be calculated by the well-known equation $E_\lambda=sx$, where E_λ is the threshold energy imposed for incoming rays by the earth's magnetic field. Such a shift was observed by Clay[5] for rays which had penetrated more than one atmosphere. If his result could be confirmed definitively, it would prove a primary origin for the hard component.

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