Light of the Night Sky

Last spring, during the preparation of a high pressure auroral tube, a number of afterglow spectrograms were obtained of the stage of the clean-up in which the cyanogen bands were very strong, the so-called cyanogen stage. Some ten new members of the tail bands in the CN violet $^2\Sigma \rightarrow ^2\Sigma$ system were observed, all of them between λ3000 and λ3400. We have made the hypothesis that the tail bands, all of which originate on levels with $v=10$ or higher, were enhanced in the cyanogen glow in a manner analogous to the enhancement of the green sequence of the first-positive group of nitrogen in the auroral glow. A comparison was then made between the wave-lengths of the tail band heads as given by Jenkins, and the list of unidentified night sky radiations of Gauzit.[1] The agreement, which is quite satisfactory, is indicated in Table I.

TABLE I. *Comparison of lines in the CN tail bands with unidentified lines in the light from the night sky.*

CN Tail Bands	Night Sky
4085	4083
4035	4036
3992	3990
3954	3950
3921	3921
3895	3891
3697	—
3666	3660
3632	3633
3505	3501
3470	3471
3438	3446

Rough measurements indicate that the ten new members agree with other night sky radiations. Thus the night sky excitation appears to produce selectively the tail bands of cyanogen.

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[1] Gauzit, J. de phys. **5**, 527 (1934).

Origin of Cosmic Rays

The paper "Cosmic Rays on the Pacific," [1] reports the failure to observe an excess of intensity of the radiations in the Northern Hemisphere required by the extra-galactic theory of the origin of cosmic rays. Instead of abandoning the theory, however, the authors cling to it with the explanation that either the sun's motion with the rotation of the galaxy is only a small fraction of the 300 kilometers per second estimated by the astronomers, or that the rays are trapped within the galaxy and share its motion. Certain seasonal changes are also described which, to quote the authors, "indicate that the origin of the change is atmospheric rather than astronomical, . . . such atmospheric conditions might for example include the electric potential gradient, or the Heaviside layer." This latter idea, of changes in the intensity of the radiations being caused by the earth's electric field, appears to be moving in the direction of the suggestion advanced by this writer[2] to the effect that the radiations themselves are caused by an extension of the earth's field, not merely *changes* in their intensity, and that they originate not by some mysterious process in outer space, but in the outer reaches of our own atmosphere simply as a result of the acceleration of ions in the electric field.

It is generally conceded that the primary radiations do consist largely of high speed electrified particles. The most logical place then in which to seek their origin is not in thermal processes of the interiors of remote stars, nor in the primeval explosions postulated by Lemaitre but simply in an accelerating electric field. The earth's electric field has been measured up to a height of only 10 kilometers, a distance most minute compared with the dimensions of the earth. It has been found to decrease up to these heights, of course, but a reduction of field strength is to be expected in regions of increasing conductivity. If the field increases again after passing through the regions of high conductivity, as seems to be indicated by the auroral and other data referred to in the paper by Holmes, it could conceivably amount to the 10^8 or 10^{10} volts required. If these values do not seem quite high enough, there exists the possibility, or rather the probability, of still higher fields on the giant planets Jupiter and Saturn, which might account for the extremely high energy particles occasionally observed. Repeated reports of, and subsequent denials of, the extremely small sidereal effect could then be attributed to the changing relative positions of Earth, Saturn and Jupiter. Such a simple origin would also explain the fact that a slight sidereal effect is noted in the plane of the ecliptic but not the northern excess at right angles to the plane. Such an origin would also be consistent with the other two effects reported in the paper, namely the steady poleward increase of intensity after passing the knee, and the decrease in intensity when the earth is nearest the sun, since the outer electric field would then be smaller due to increased ionization and consequent conductivity.

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[1] Compton and Turner, Phys. Rev. **52**, 799 (1937).
[2] M. C. Holmes, "A Terrestrial Origin for Cosmic Rays," J. Frank. Inst. **223**, 495 (1937).

Radioactive Isotopes of Element 43

Professor E. O. Lawrence kindly gave to one of us a molybdenum target which had been bombarded for many months with deuterons in the Berkeley cyclotron. The target arrived on January 6th, 1937 and the measurements which we report started on February 24th, 1937. All short-lived radioactive substances have thus escaped detection.

The molybdenum sample was analyzed chemically and it has been shown that its radioactivity is due to radioactive isotopes of element 43.[1] The following investigation is made on a sample precipitated together with Re by sulphuretted hydrogen and on a sample precipitated by means of nitron. Other samples prepared from other reactions or deposited electrolytically show the same absorption curves for the activity, taking into account the absorption by the substance itself, but we did not follow their radioactivity over a long period of time.

In Fig. 1 we report (curve *a*) the decay curve of the activity measured with an ionization chamber closed by two Al foils of 1μ thickness. The sample was wrapped in a 2.8 mg/cm^2 Al foil. All radiations had to pass the foils of the ionization chamber and the wrapping of the sample.

This decay curve is apparently fairly closely exponential, but from absorption measurements it is easily shown that it does not correspond to the curve for a single substance.

In Fig. 2 we give the absorption curves of the radiations. Curve *a* is taken on February 24, 1937 and curve *b* is taken on the same sample on November 11, 1937. They are drawn with different scales in order to have the same ordinate with an Al absorber of 2.8 mg/cm.^{2} They show that the radiation emitted alters its composition with time. On the other hand there is a short-lived radiation which has, in our samples, a very small activity compared with the long period ones and it is difficult to obtain the periods of the different components of the total activity just by subtracting from the total activity the activity with the longest period, etc., according to the standard procedure.

We have therefore taken absorption curves of the total radiation in Al foils at different times. We have analyzed these curves in exponentials and we have plotted the amplitude of the components as a function of time (Fig. 1 curves *b*, *c*, *d*). This process is open to question for many reasons, but we could not find a better one applicable to our case. The experimental curve is very accurately reproduced by the sum of three components. Its equation according to our measurements is

$$y = 1082 \exp(-491x - t/130) + 100 \exp(-90x - t/72) + 16.7 \exp(-2.6x - t/118)$$

y = activity; x, absorber thickness in g/cm^2 Al; t, the time in days.

Thus we find 3 components with half-value periods of 90.50 and 80 days and half-value thickness of 1.4; 7.65; 264 mg/cm^2 Al, respectively.

Of course it is hard to be sure that there are only these three activities or to trust very much in the exactness of the half-value periods especially of the latter two. The period of the hardest component could very well be the same as the period of the softest one.

Molybdenum has seven stable isotopes all with the comparable abundances and it is impossible to assign the masses of the radioactive nuclei formed most probably by the usual reaction:

$$A_Z{}^M + D_1{}^2 = B_{Z+1}{}^{M+1} + n_0{}^1.$$

The radiation emitted is mainly due to electrons as shown by magnetic deflection experiments; there is also a γ-radiation; the third (harder) component is chiefly due to it. One may suggest tentatively that this component is due to γ-rays accompanying the disintegration corresponding to the softest component.

Our warmest thanks are due to Professor E. O. Lawrence and to the staff of the Radiation Laboratory (Berkeley) which by their invaluable gift made this investigation possible.

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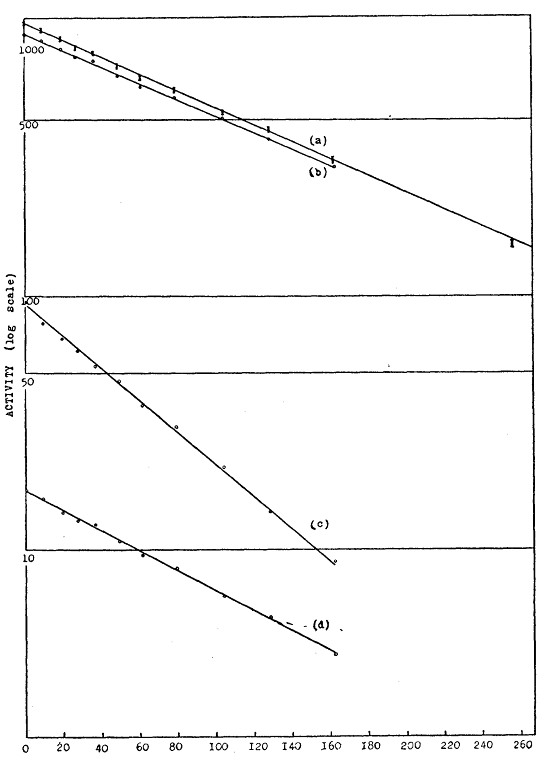

FIG. 1. (*a*) Decay curve of the activity of radioactive isotopes of element 43. (*b*), (*c*), and (*d*) Plot of the amplitude of the three component activities as a function of time.

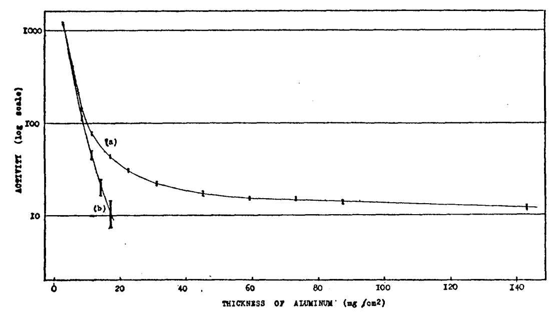

FIG. 2. Absorption curves of radiations from radioactive isotopes of element 43. Curve *a* is taken on February 24, 1937 and curve *b* is taken on November 11, 1937.

[1] C. Perrier, E. Segrè, J. Chem. Phys. 5, 712 (1937).