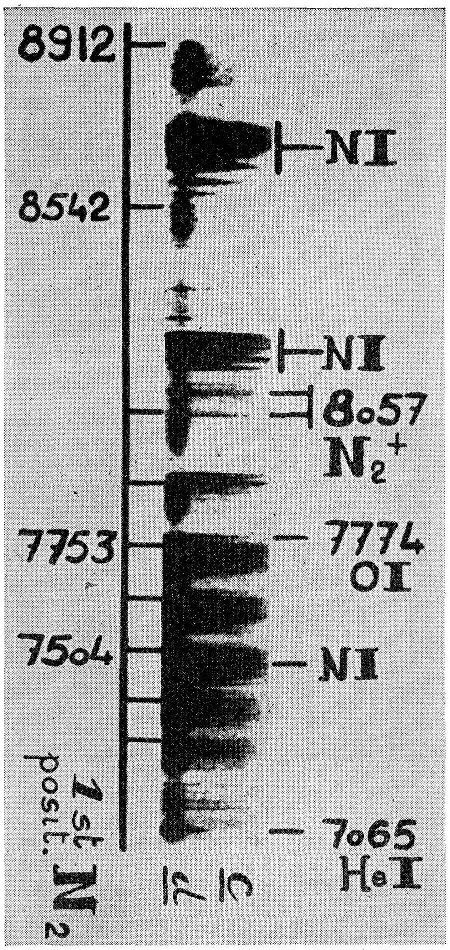

FIG. 1. Emission spectrum of a helium-nitrogen gas mixture. *d*-discharge spectrum. *c*-afterglow spectrum. In *d*, the 7065 He I line and the first positive system $B^3\Pi-A^3\Sigma$ of N_2 are very strong. In *c*, the 8057 band of N_2^+ is clearly visible.

our short duration afterglow studies into the photographic infrared.

A pulse discharge was used to excite a mixture of helium, at a pressure of 5 mm, and a small amount of nitrogen. The spectra of the discharge and the afterglow were separated by a rotating disk.

An example of the spectrum obtained is shown in Fig. 1. Part *d* of this spectrum is emitted during the discharge and part *c* during about 10^{-4} second immediately after the discharge is stopped. It is seen that relative intensities of the several spectral features are quite different in the afterglow from those in the discharge proper. The apparent electronic excitation during the discharge is much lower than during the afterglow. For example, the first positive band system, $B^3\Pi-A^3\Sigma$ ($T_e=7.4$ ev), is strong in *d* and weak in *c*. In the violet and ultraviolet region, the second positive band system, $C^3\Pi-B^3\Pi$ ($T_e=11.0$ ev) of N_2, is also very weak in the afterglow spectrum. On the other hand, high level emissions, such as the Meinel system of N_2^+, $A^2\Pi-X^2\Sigma$, ($T_e=16.8$ ev) and the N I (I.P. = 14.54 ev), N II (I.P. = 44.14 ev), and O I (I.P. = 13.61 ev) lines show a much smaller contrast between the discharge and the afterglow intensities. In the negative system of N_2^+ emitted during the afterglow the intensity of the 8057 (3, 1) band is higher than the 7828 (2, 0). On the other hand, in the auroral spectrum the (2, 0) band is the more intense.

The present results indicate that the process of excitation of the positive bands is different from that of the negative bands and atomic lines. These latter may be emitted by ion electron recombination, a process which becomes relatively more important during the afterglow.

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498-kev Gamma-Ray of Ru^{103}

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AN accurate value for the energy of the 498-kev gamma-ray from Ru^{103} has been obtained with a double-focusing beta-spectrometer of the type described by Kurie, Osaba, and Slack.[1] The gamma-ray source was double, consisting of pile-irradiated ruthenium powder sealed in a glass tube and a metal enclosure (beryllium) providing annihilation quanta from the positron-emitting sodium-22 contained inside. Gammas from the two sources simultaneously irradiated a 0.7-mil thick uranium foil radiator, and the *K*-level photoelectric lines were recorded in the spectrometer. The difference in energy between the two lines (that of the annihilation gamma being the greater) was found to 13.1±0.8 kev.

When the value 510.969±0.010 kev given by DuMond and Cohen[2] for the energy of annihilation quanta is used, we obtain the value

$$497.9\pm0.8 \text{ kev}$$

for the energy of the ruthenium gamma-ray. A value of 494 kev (presumably for this same gamma-ray) has been given by Mei, Huddleston, and Mitchell.[3]

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Pion Production and Charge Independence*

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THE purpose of this letter is to point out that the observation of pion production in nucleon-nucleon and in nucleon-deuteron collisions provides a very severe test of the assumption that the interaction between pions and nucleons is charge independent. Just as we think of the proton-neutron field as having an intrinsic isotopic spin of $\frac{1}{2}$ ($+\frac{1}{2}$ for proton, $-\frac{1}{2}$ for neutron), we may also think of the meson field as having an intrinsic isotopic spin of 1 (+1 for π^+, 0 for π^0, −1 for π^-).[1] The assumption of charge independence will then mean that we assume the interaction to be such that the total isotopic spin is not changed as a result of it.

For simplicity let us consider first the case of meson production by proton (or neutron) collisions with deuterium. Since the deuteron is in a $^3S+^3D$ state, it is symmetric in space and spin and, therefore, antisymmetric in isotopic spin. The total isotopic spin of the deuteron is therefore zero. Thus, the system proton plus deuteron has total isotopic spin $T=\frac{1}{2}$, three component of total isotopic spin $T_3=\frac{1}{2}$. After the pion has been produced, the final state will consist of three nucleons and one pion. For the three nucleons, each with isotopic spin $\frac{1}{2}$, we get as possible states $T^N=\frac{3}{2}$ or $\frac{1}{2}$. This gives us two cases to consider:

1. Final nucleon state $T^N=\frac{3}{2}$. Using the well-known transformation properties of angular momenta,[2] we may write for the final state (*t* denoting the isotopic spin of the meson)

$$\phi(T=\tfrac{1}{2}, T_3=\tfrac{1}{2})=(1/\sqrt{2})\Psi(T_3^N=\tfrac{3}{2}, t_3=-1)$$
$$-(1/\sqrt{3})\Psi(T_3^N=\tfrac{1}{2}, t_3=0)+(1/\sqrt{6})\Psi(T_3^N=-\tfrac{1}{2}, t_3=1).$$