Nuclear Structure, γ-Ray Fission, and the Expanding Universe

PROF. G. W. TODD[1] has put forward evidence against the suggestion that the positron is a constituent of the nucleus. He states that for a definite atomic mass P, and a definite atomic number Z, the arrangement of α-particles, neutrons, etc., in the atomic nucleus should be such as to give a unique structure for the nucleus. Allowing the possibility of positrons, but excluding the possibility of unattached electrons, Todd constructed the following arrangement for the unique structure :

$\frac{1}{2}(Z - K)$ α-particles + $(P - 2Z + 2K)$ neutrons + K positrons

where $K = 0$ or 1, whichever makes $\frac{1}{2}(Z - K)$ an integer.

For reference, Todd's table for α- and β-ray transformations from uranium is given below (n stands for neutron and p for positron) :

	Nucleus			Radiation
UI	46α +	$54n$ +	$0p$	α
↓ UX$_1$	45	54	0	β
↓ UX$_2$	45	54	1	β
↓ UII	46	50	0	α
↓ Io	45	50	0	

We find as UX$_1$ is transformed into UX$_2$, the following change takes place : $0 \rightarrow 1p + 1\beta$, the positron remaining in the nucleus.

Prof. Todd asks : Where do the electron and positron come from in this change ? If we accept the suggestion that a γ-ray of sufficient energy may undergo fission into a positron and an electron in the strong electric field of the nucleus, the apparent anomaly may be explained. Now β-ray emission was preceded by emission of α-particles, and if some α-particles, without getting out of the nucleus, just shift their positions from higher energy levels to lower levels, there would be emission of energy which would appear as γ-ray radiation. Some of the γ-rays would very likely undergo fission into positrons and electrons within the nucleus. The positron of the γ-ray would attach itself to the nucleus and thus increase the atomic number by one, and the β-particle would escape.

We find that as UX$_2$ is transformed into UII, a new α-particle is created according to the transformation :

$$4n + 1p \rightarrow 1\alpha + 1\beta,$$

the α-particle remaining in the nucleus. This transformation can also be explained by assuming that an α-particle is an aggregate of four neutrons and two positrons, and also a positron and an electron were created out of a γ-ray, and the two positrons combined with the four neutrons to form the α-particle. It may be pointed out that a β-ray transformation is usually accompanied by γ-ray radiation. The binding energy of a proton is presumably great, and so its dissociation into its constituent parts cannot be spontaneous. Naturally we come across a comparatively small number of neutrons and positrons.

Dirac has suggested the possibility of a negative proton[2]. A plausible hypothesis may be formulated according to which super γ-rays or cosmic ray photons may also undergo fission into positive and negative protons. A proton has the energy of $9{\cdot}4 \times 10^8$ electron volts, and a cosmic ray photon may have the energy of the order 10^{11} electron volts.

The breaking up of a photon into an electron and a positron or into a positive proton and a negative proton, may be helpful in explaining why our universe started expanding from the Einstein universe. We know that, mass for mass, matter exerts less gravitational attraction than radiation. So the conversion of radiation into matter will lessen the gravitational factor. Therefore if by some method the photon breaks up into two material particles, the Einstein universe will start expanding. Possibly radiation, as well as the fundamental material particles, already existed in the Einstein universe. Some of the photons broke up into constituent particles in the electric field of already existing charged particles and thereby started expansion.

I also feel that the final end of the universe as predicted by Sir James Jeans, due to all matter ultimately dissolving away into radiation, may not happen, as materialisation of radiation is possible, and electrons, positrons, positive protons and negative protons can be created or re-formed out of the photons. It may also be mentioned here that Prof. Tolman established the possibility of a universe in which reversible processes take place, without entropy reaching a maximum or free energy a minimum.

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[1] NATURE, **132**, 65, July 8, 1933.
[2] *Proc. Roy. Soc.*, A, **133** ; 1931.

Afterglow of Carbon Dioxide

IN a recent paper[1] it has been shown that carbon dioxide, when excited to luminescence by an electrical discharge in a vacuum tube, possesses a blue-violet afterglow having a spectrum similar to that obtained by burning carbon monoxide in air or oxygen. The spectrum has now, on the suggestion of Prof. A. Fowler, been produced from a modified source which is brighter than the afterglow in the gas at low pressure.

A powerful uncondensed spark from an 18-in. induction coil was passed between water-cooled aluminium electrodes in a spherical bulb of about three litres volume ; the spark was horizontal ; the distance between the electrodes was variable, but the best results were obtained with a separation of about five centimetres. The bulb was filled with carbon dioxide at a pressure of about a quarter of an atmosphere. It was observed that the spark, which resembled an arc, was accompanied by a blue glow above it. This glow persisted for a fraction of a second after the cutting off of the discharge.

The spectrum of this glow has been examined between 6000 A. and 2900 A., and found to be similar to the spectrum of the afterglow at low pressure and to that of the carbon monoxide flame. The water vapour band at 3064 A., which was such a prominent feature of the spectrum of the afterglow, was, however, not observed when the gas was