LETTERS TO THE EDITOR

PHYSICS

Particle Structure

It has been shown^{1,2} that an empirical model of Nature exists in which many natural constants equal functions of π . The dimensional units are defined by the equations $C = 1$ and $\hbar = \lambda_e = 2$ (λ_e is the Compton wave-length of the electron). Charge squared then equals $2a$ (a is the fine structure constant) and $M\lambda$ equals 4π (M is mass).

Particle structure can be described in terms of the properties of the particle and the constants characterizing the particle. In this suggested model the formation of the electron ($\mp \mp$) and the positron ($\pm \pm$) involves the combination of three units of rest mass π and field $2 \exp - \pi^2/2$ to give a particle with rest mass 2π and a charge squared equal to $2 \exp (-\pi^2/2 + 2 \exp (-\pi^2/2 + 2 \exp - \pi^2/2))$ or $2a$ (ref. 2). The energy of combination equals π . There are now two components each contributing a mass of π and a charge squared of a . Rest mass and energy are interconvertible but charge is constant and therefore conversion of energy to rest mass will only increase the rest mass of a component.

In the formation of the charged π meson the mass of the components equals $M\lambda/e^2 = 4\pi/2a$:

$$4\pi/2a + 4\pi/2a \rightarrow (8\pi/2a - 2\pi) + \text{energy } (2\pi)$$

Energy of combination equals 2π , indicating meson formation corresponds to a strong interaction similar to that involved in electron formation.

If components of opposite sign for charge and mass combine the result is a particle of zero mass and zero charge or a neutrino.

The charged π meson decomposes into a muon and a neutrino. The neutrino formed could have meson components or it could be a double neutrino since it has unique properties³. The masses involved are:

$$(8\pi/2a - 2\pi) \rightarrow (6\pi/2a + 2\pi) + 2(\pi/2a - 2\pi) \text{ energy}$$

There appear to be two neutrino components or two neutrinos as indicated by the energy term.

Formation of the neutral π meson involves components of opposite charge:

$$(\mp) + (\pm) \rightarrow (\mp \pm) = \pi^0 \text{ meson}$$

$$4\pi/2a + 4\pi/2a \rightarrow [8\pi/2a - (1/2a - 2\pi)] + \text{energy } (1/2a - 2\pi)$$

Loss of energy on particle formation involves the charge factor since charge neutralization occurs.

Resonances may correspond to rest masses, for components, which are multiples of $4\pi/2a$. Combinations of these components may give particles of high mass and a very short life.

Elementary particles may combine to give higher mass particles. Helium is an example. The charged K meson may be a similar combination:

$$4(8\pi/2a - 2\pi) - (4\pi/2a - 1/2a) \text{ energy} = K^\pm$$

The neutral K meson has two distinct lifetimes involving two particles of slightly different masses. This suggests the dual formulation:

$$4(8\pi/2a) - [4(\pi/2a - 2\pi) - (1/2a \pm 2\pi)] \text{ energy} = K^0$$

There are alternative possibilities, but this shows the various mesons can be accounted for with little deviation from accepted ideas. In all cases the calculated and observed rest masses differ by less than one electron mass. The model can be extended to hyperons¹. The life of the particles may be related to the mass terms representing the particles, thus making possible extension of the model to these constants.

A simple model of Nature exists which is in good numerical agreement with many observations and which is readily expandable to include other observations.

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¹ Horning, S. C., *Nature*, **195**, 587 (1962).

² Horning, S. C., *Nature*, **196**, 158 (1962).

³ Danby, G., et al., *Phys. Rev. Letters*, **9**, 36 (1962).

Neutron Capture in the Samarium Isotopes and the Formation of the Elements of the Solar System

RECENT theories concerning the formation of the elements are based on neutron capture, and are subject to quantitative experimental tests through radiative capture measurements¹⁻³. This communication reports 30 keV neutron capture measurements for the isotopes of samarium. 2-20-g samples of electromagnetically separated samarium isotopes as Sm_2O_3 were used with the ORNL 3-MV pulsed Van de Graaff, providing the neutrons via the lithium-7 (p,n) reaction. A Moxon-Rae counter detected the capture γ -rays as in an earlier tin isotope measurement³.

The isotopes samarium-150 and -148 are shielded from r -process¹ production by stable neodymium-150 and -148. Thus the s -process only should have contributed to their creation in stars, and the products of their neutron capture cross-sections near 30 keV and their natural abundances should be nearly equal. From the measured cross-sections we find the ratio (Table 1, col. 5) to be 0.94 with a relative uncertainty estimated at 10 per cent. Combining additional data for the ratio only, we get 1.02 (± 6 per cent). The expected average ratio in the mass region 120-200 is perhaps a 1 per cent decrease per mass unit⁴, or 0.98 for this case. The results thus strongly confirm the s -process nucleosynthesis prediction. The r -process abundances derived for the other isotopes are in reasonable agreement for the odd and even isotopes separately but show an unexpectedly large odd-even effect. The number (N_r) for samarium-152 was derived ignoring the minor s -process branch (β^- decay of 93 yr. samarium-151); however, a large but uncertain percentage of the branch returns to samarium-152. Thus the r -process abundance given in Table 1 for samarium-152 could be increased by a few per cent, resulting in even closer agreement with N_r of samarium-154.

The samarium-149 precursor of samarium-150 in the s -process additionally has one of the few extremely large thermal neutron cross-sections (40,800 barns at 0.0254 eV). That for samarium-147 is about 500 times smaller (90 barns). This ratio is even larger in the neighbourhood of the 0.1 eV resonance. The ratio remains greater than 400 for neutron temperatures up to 2,000° absolute. Thus the present results leave little possibility for significant neutron exposure in solid² or even molten bodies of solar system material either terrestrial or, as Murthy and Schmitt have recently shown⁵, for representatives of the chondrites, carbonaceous chondrites and achondrites.

If we assume $N_s \sigma_c$ to be constant from atomic weight $A = 148$ to $A = 150$ the selective depletion (via thermal neutron capture) of samarium-149 should be apparent in the residual abundance assigned in Table 1, column 7, to the r -process. As the thermal cross-sections of samarium-148 and samarium-150 are comparable with that of samarium-147 or smaller⁶, perhaps a