γ-ray, and at low temperatures using a 184-keV. non-resonant γ-ray. An unannealed zinc oxide absorber was studied. Measurements were taken on annealed (14 hr. at 650° C.) and unannealed zinc spinel (zinc oxide–alumina). Because of difficulty in placing the active gallium atoms in the proper lattice positions in the spinel, no resonance was expected, and none was observed. The results of all our measurements are summarized in Table 1. The magnetic fields used were in all cases approximately 500 oersted. The only significantly non-zero resonance is found in the annealed zinc oxide at low temperatures.

Table 1

Material	Annealed	γ-Energy	Temperature (° K.)	Resonance (per cent)
ZnO	yes	93 keV.	<2·17	0·080 ± 0·008
ZnO	no	93	<2·17	−0·06 ± 0·06
ZnO	yes	93	300	0·005 ± 0·003
ZnO	yes	184	<2·17	0·02 ± 0·02
Spinel	yes	93	<2·17	0·016 ± 0·014
Spinel	yes	93	300	0·02 ± 0·03

Despite the minute resonance strength observed in zinc oxide, the ratio of the resonance strength to the energy resolution is larger than for any other resonance thus far reported (about three times larger than has been obtained with the 14-keV. line in iron-57[3]), and hence the 93-keV. γ-ray of zinc-67 provides the possibility for the most precise nuclear clock available. We are at present attempting to enhance the observable resonance through the utilization of resonant scattering methods, and are studying the isotope shift expected when the isotopic constitutions of source and absorber are different.

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Mass of Elementary Particles

PROF. A. J. RUTGERS in *Nature* of September 19, 1959, and Dr. R. L. Worrall in *Nature* of February 27, 1960, pointed out that the ratio of proton to electron mass could be calculated from simple functions. It appears that the masses of most elementary particles can be calculated, approximately, using three quantities, h, Planck's constant, a, the fine structure constant, and e, the base of the natural logarithms. The calculated values obtained are in good agreement with the known values.

Worrall suggests the following equation for calculating the mass of the proton:

$$M_p = \text{mass proton} = (10^4/2e)\ M_e$$

where M_e is the mass of the electron. Since $e^2 \sim 10^3 a$, it is possible that the fine structure constant is involved. $M_p \sim (5e/a)\ M_e$.

Meson masses can be calculated in the following way:

$$\text{Mu meson: } 1/e\ (4/a)\ M_e \sim 202\ M_e$$
$$\pi \text{ meson: } (2/a)\ M_e \sim 274\ M_e$$
$$K \text{ meson: } (7/a)\ M_e \sim 959\ M_e$$
$$\text{Hyperon: } (7/5)\ M_p \sim 2{,}585\ M_e$$

The observed masses are almost exactly equal to the calculated masses.

The hyperons may have the following structure:

$$1{,}840 + 959/e + 959/e \sim 2{,}545\ M_e$$
$$1{,}840 + 959/e + 274/e \sim 2{,}295\ M_e$$
$$1{,}840 + 959/e \sim 2{,}190\ M_e$$

Since a binding energy may also be present, these calculated values are not unreasonable. However, if they are correct the factor e appears to be important. There is a mass decrease on particle formation through action of the factor $1/e$ as suggested by Worrall. However, the factor could be $1/(10^3 a)^{1/2}$.

The electron mass can be expressed in terms of frequency and c^2 by the equation:

$$h/M_e = c^2/v \sim 7 \cdot 3 \text{ cm.}^2/\text{sec.}$$
$$7 \cdot 3 \sim 10^3 a \sim e^2$$
$$h/e^2 \sim 9 \times 10^{-28}$$

There are now three nearly equal quantities involved in mass calculations. Meson masses can be expressed as follows:

$$\text{Mass of mu meson} = (1/e)\ 4\ h/a\ (c^2/v)$$

It seems reasonable to suppose there is some connexion between the three quantities in the above equation. The ultimate equation may involve only h/c^2, a conversion factor dependent on the units used, and an energy-level factor.

In view of the importance of the problem, the above relationships perhaps deserve consideration.

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BIOPHYSICS

Flow of Blood through Narrow Tubes

IN a recent communication, Haynes[1] describes experiments on the flow through capillary tubes of suspensions of erythrocytes in standard acid–citrate–dextrose and proposes an equation relating volume flow in unit time to applied pressure. He also refers to my use of Casson's equation[2] for somewhat similar results obtained by various authors on blood (treated with coagulants) from a number of species[3,4]. Although Haynes's comments are entirely correct so far as they go, it seems that the matter requires further clarification.

The essential point is that, to further our understanding of the sigma phenomenon in full blood, it is greatly advantageous to be able to describe the flow-curves over a wide experimental range of shear-rate by means of two parameters the variation of which with capillary radius can then be quantitatively studied. Such studies would be less interesting for suspensions of erythrocytes alone than for full blood, except that Dr. Haynes evidently finds (private com-