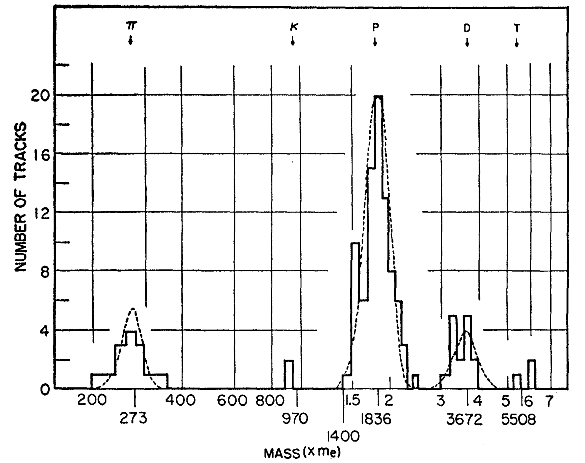

FIG. 1. Experimental mass spectrum of medium energy particles from stars: dashed curve is normal distribution with s.e. = 9%.

ticles indicates that at least 90% of the mesons have measured masses between 800 and 1200 m_e, consistent within the errors with a real mass about 965 m_e, and there seems to be no evidence for mass $\simeq$1450 m_e.

One example of a Λ^0 meson with energy several hundred Mev, decaying in flight, but not apparently connected with a star, was also found during the course of this work.

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Rotational Levels in the Beta Decay of Protactinium Isotopes

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(Received July 14, 1955)

ACCORDING to the Bohr-Mottelson unified model,[1] aspects of collective nuclear motion and of individual particle motion are coupled. In regions well removed from closed shells the coupling strength is very great and gives rise to the rotational excited states. For even-even nuclides the energies of these levels are proportional to 1.00:3.33:7.00. The levels are in the 2+, 4+, and 6+ states, respectively, and are de-excited by a cascade of $E2$ transitions. A number of these transitions has been already reported.[1]

In an investigation of the beta decay of protactinium isotopes[2] indications were found of rotational levels in the even-even daughter nuclides (U or Th). In Table I is listed a part of the results of beta-spectrometric measurements of Pa^{228}, Pa^{230}, Pa^{232}, and Pa^{234} (UZ) done in a 30-cm double-focusing magnetic beta-ray spectrometer.[3] More detailed information of these investigations will be published in *Physica* and in *Arkiv för Fysik*.

Column 2 shows the energy values of the gamma transitions which were supposed to be $E2$ radiations. According to Gellman *et al.*[4] and to Rose[5] low-energy $E2$ radiations are mainly converted in the $L_{\rm II}$ and the $L_{\rm III}$ subshells, the conversion probability in the $L_{\rm I}$ subshell being very slight. The theoretical $L_{\rm III}/L_{\rm II}$ conversion ratios[5] for $Z=85$ and $Z=55$ are represented in Fig. 1 by the drawn and the dashed lines, respectively. The dots indicate experimental data of $E2$ transitions in nuclides with $Z\geqslant 80$, while the triangles represent the data in nuclides with Z between 50 and 80. The $L_{\rm III}/L_{\rm II}$ conversion ratios we observed in the decay of the protactinium isotopes are represented by crosses. In most cases, our experimental data agree with the theoretical expectations for $E2$ transitions.

Assuming that these gamma rays de-excite the rotational levels above the ground levels of the daughter nuclides, the energy ratios of these levels are as given in column 4. These values agree with the predictions of the Bohr-Mottelson model. In column 5 the $\hbar^2/2J$ values were calculated from the lowest gamma-ray energies. The figures show a decrease of $\hbar^2/2J$ with increasing mass number, due to a larger deformation of the nuclides.

The Bohr-Mottelson model not only predicts the occurrence of rotational levels on the ground state, but also on higher excited states. In the odd-A nuclides, the presence of the latter has been discussed by Asaro and Perlman.[6] A first indication of it in the even-A nuclides was reported by Slätis *et al.*[7] In Pu^{238}, they found two close-lying levels at about 1.03 Mev above the ground state which were assumed to form a rotational band system. The energy difference between these levels agrees fairly well with the energy of the first rotational level above the ground state (44.1 kev).

In Th^{228} two excited levels were found at 1.070 and 1.125 Mev; a similar configuration was supposed to be

TABLE I. Results.

Daughter nuclide	E_γ(kev)	$L_{\rm I}$	$L_{\rm II}$	$L_{\rm III}$	$E(2+):E(4+):E(6+)$	$\hbar^2/2J$
$_{90}Th^{228}$	57.48	—	1	1.00	1:3.24	9.6
	128.64	—	1	0.75		
$_{90}Th^{230}$	52.8	—	1	0.85		
	(121.3)				1:3.30	8.8
$_{92}U^{232}$	47.2	—	1	0.90		
	109.1	—	1	0.45	1:3.31:6.80	7.9
	(175.3)	—	1			
$_{92}U^{234}$	43.0	—	1	0.85		
	99.2	—	1	0.75	1:3.31:6.87	7.2
	152.6	—	1	0.50		

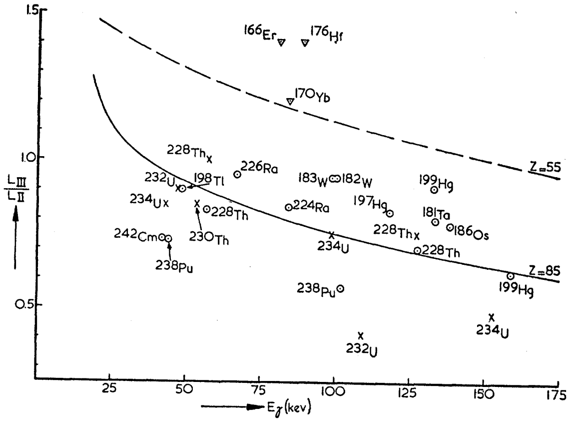

FIG. 1. L_{III}/L_{II} conversion ratios of $E2$ transitions.

present at 1.010 and 1.065 Mev in Th^{230}. In U^{234}, excited levels at 1.145 and 1.190 Mev were observed. Although the level schemes of these nuclides are not unambiguous, it is quite likely that these close lying levels also represent a rotational band system.

The author wishes to thank Professor Dr. G. J. Sizoo for his interest in this work. This investigation is part of the research program of the "Stichting voor Fundamenteel Onderzoek der Materie" (F.O.M.) which is financially supported by the "Nederlandse Organisatie voor Zuiver-Wetenschappelijk Onderzoek" (Z.W.O.).

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Elementary Particles as Self-Maintained Excitations

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(Received March 24, 1955)

IT is well known that contemporary theories of elementary particles are unsatisfactory for two reasons. On one hand the coupling of the various particles with the electromagnetic field and with each other is not sufficiently understood, this lack of understanding manifesting itself in the illfamed divergence problems (which can be "removed" in a fashion in some special cases by so-called renormalization procedures); on the other hand the origin of the masses of the various particles remains a complete mystery, this fact manifesting itself in the necessity of introducing for each newly discovered particle its mass phenomenologically into the theory.

It is the purpose of this Letter to propose a line of attack which promises to remove these two difficulties in one stroke at an early stage of the theory, i.e., prior to quantization of the field variables which describe the "particle."

Consider the following simple model. We imagine a "particle" to be a self-maintained excitation of a medium, described in terms of the usual electromagnetic potentials A_μ and a spinor field ψ of vanishing mechanical mass, so that the following gauge-invariant and Lorentz-invariant variational principle is satisfied:

$$\delta\int L d\tau=0;\quad L=\hbar c i\psi^\dagger \sum_\nu \gamma_\nu\left(\frac{\partial}{\partial x_\nu}-\frac{i\epsilon}{c}A_\nu\right)\psi -\frac{1}{16\pi}\sum_{\mu,\nu}\left(\frac{\partial A_\nu}{\partial x_\mu}-\frac{\partial A_\mu}{\partial x_\nu}\right)^2-\frac{1}{8\pi}\left(\sum_\mu \frac{\partial A_\mu}{\partial x_\mu}\right)^2, \quad (1)$$

where

$$\psi^\dagger=i\psi^*\beta;\quad \gamma_k=i\alpha_k\beta;\quad \gamma_4=\beta;\quad \gamma_\mu\gamma_\nu+\gamma_\nu\gamma_\mu=2\delta_{\mu\nu};\quad x_4=ict. \quad (2)$$

Independent variation of $\psi^\dagger$ and A_ν yields the field equations

$$\sum_\nu \gamma_\nu\frac{\partial\psi}{\partial x_\nu}=\frac{i\epsilon}{c}\sum_\nu \gamma_\nu A_\nu\psi, \quad (3)$$

$$\sum_\mu \frac{\partial^2 A_\nu}{\partial x_\mu^2}=-4\pi\hbar\epsilon\psi^\dagger\gamma_\nu\psi. \quad (4)$$

On the potentials A_ν we impose, as usual, the condition

$$\sum_\nu \frac{\partial A_\nu}{\partial x_\nu}=0. \quad (5)$$

We shall now label any solution of this nonlinear simultaneous system of Eqs. (3), (4), (5) a "particle," provided some reasonable boundary conditions are satisfied by that solution. Regions in which the current appearing on the right-hand side of Eq. (4) is negligible will be called the "exterior" of the particle, and regions in which this current is appreciable will be called the "interior" of the particle. One might say that in this primitive model photons and neutrinos are considered as basic building stones, each acting as the glue, as it were, which holds the other together, and thus forming a compound called "particle."

Now any regular stationary solution for the interior which can be joined to a solution for the exterior corresponding to, say, an electric pole and a magnetic dipole, would reveal itself to an external observer as a stable particle, carrying charge and magnetic moment. The mass of the particle can be defined then in terms of the