of magnitude given by recent experiments. Here we have another possibility of being able to explain the existence of various heavy particles and, at the same time, to remove part of the infinities. Nevertheless, we should like to remark in a general sense about the provisional character of our theory. First, it has been recognized that higher order corrections might seriously modify the results obtained. Second, the consequence of the mass relation (7) is of such a radical nature that we cannot determine discrete values for the masses of elementary particles. We feel that, besides the phenomenological prescription of the compensation, another principle would be necessary for us to solve this problem. Third, granted that we ignore such a circumstance for a time, we are still required to introduce more cohesive mesons in order to be consistent with the experimental fact that there may be numerous mesons. For instance, the evidence for χ-mesons ($\sim 1470\ m_e$) and ζ-mesons ($\sim 550\ m_e$) suggests a possibility of considering two kinds of cohesive mesons, namely, c_1 mesons ($\sim 1474\ m_e$) for the nucleon, and c_2 mesons ($\sim 595\ m_e$) for the heavy nucleon. Of course, the latter gives rise to a new infinity for the nucleon which may be canceled out by assuming a third cohesive meson. Finally, we are still not sure of a scheme to take into account the τ-meson and κ-meson (if it is a Fermion).

At any rate, we may conclude from this work that there may be intimate relations between masses of elementary particles and some of the divergences inherent in the current field theory.

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Pure Nuclear Quadrupole Spectrum of Bi^{209} in Bismuth-Triphenyl*

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Pure nuclear quadrupole resonance in solids, observed first by Dehmelt and Krüger[1] in 1949, has now been found for several nuclei. This type of spectrum has, however, not been previously investigated for Bi.

The only stable bismuth-isotope, Bi^{209}, has a spin $I=9/2$ well established from optical spectra.[2] The quadrupole moment also has been optically determined[3] as $Q(Bi^{209})=0.39\times10^{-24}$ cm^2. Corresponding to the spin value of 9/2, the nuclear quadrupole spectrum is expected to consist of four lines, all of which have been found in $Bi\phi_3$ by use of super-regenerative detection techniques described by Dehmelt and Krüger.[1] The observed frequencies which are given in Table I can be fitted to the theoretical values[4] for the case of deviation from axial symmetry:

$$\nu_1=(1/24)eQq_{zz}[1+9.03333\epsilon^2-45.690667\epsilon^4],$$
$$\nu_2=(2/24)eQq_{zz}[1-1.338095\epsilon^2+11.7224048\epsilon^4],$$
$$\nu_3=(3/24)eQq_{zz}[1-0.185714\epsilon^2-0.12329457\epsilon^4],$$
$$\nu_4=(4/24)eQq_{zz}[1-0.080952\epsilon^2-0.00425796\epsilon^4],$$

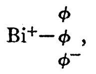
ν_1 to ν_4 corresponding to the transitions $\pm\frac{1}{2}\leftrightarrow\pm\frac{3}{2}$, $\pm\frac{3}{2}\leftrightarrow\pm5/2$, and so on.

The calculated frequencies ν_1, ν_2, ν_3 are obtained when ν_4 is assumed equal to the observed value and $\epsilon^2=7.875\times10^{-3}$ is used for the asymmetry parameter. The quadrupole coupling constant then is $eQq_{zz}=669.06\pm0.13$ Mc/sec.

TABLE I. Comparison between calculated and measured frequencies.

	Measured Mc/sec	Calculated Mc/sec	Line half-width kc/sec
ν_1	29.785	29.7815	~25
ν_2	55.214	55.2075	~15
ν_3	83.516	83.5089	~20
ν_4	111.438	assumed	~20

In $Bi\phi_3$, bismuth forms three covalent bonds with some ionic character. The structure can be described as



$$\begin{array}{c}\phi\\ Bi^+-\phi\ ,\\ \phi^-\end{array}$$

since from the difference of the electronegativity values $x_{Bi}=1.8$ and $x_C=2.5$, about 35 percent ($\approx\frac{1}{3}$) ionic character is expected.[5] The rather large observed Bi coupling reveals that the Bi bonding orbitals are not pure p but have significant s character. It is s admixture which accounts for the fact that an appreciable field gradient exists, and therefore, quadrupole coupling is observed in the $Bi\phi_3$ molecule. Three pure p bonds would lead to a vanishing field gradient q_{zz}.

The quadrupole coupling constant found in the molecule can be expressed as fractions of the coupling constant for an unbalanced atomic $6p$ electron:[6]

$$eQq_{zz}(Bi\phi_3)=3\alpha(1+2\beta)eQq_{zz}(p),$$

α denoting the fractional s admixture and β the ionic character of the Bi$-$C bonds. The coupling per $6p$ electron, $eQq_{zz}(p)$, can be evaluated from the doublet separation of a single p electron in the $6s^26p^3$ configuration of atomic Bi. A simple but probably not very accurate approach is linear extrapolation from the measured doublet separation of $6p$ for Bi V, which equals 2.8×10^4 cm^{-1}, and of $6s^26p$ for Bi III, which is equal to 2.18×10^{-4} cm^{-1}; in this way one obtains, $\Delta\nu(p, \text{Bi I})=1.4\times10^4$ cm^{-1}. With $Z_1=79$ this gives $q_{zz}(p, \text{Bi I})=5.2\times10^{16}$ esu. With the optical value of Q this yields

$$eQq_{zz}(p)=1500 \text{ Mc/sec}.$$

Comparison with the value observed in the $Bi\phi_3$ molecule leads to

$$3\alpha(1+2\beta)=669/1500.$$

From this, with $\beta=0.35$, one obtains 8 to 9 percent s admixture, which is in accordance with general expectations of hybridization in the nitrogen group of elements.

The rather large asymmetry of the field gradient, $\epsilon\approx9$ percent, could be caused by bond strains which are to be expected for this rather bulky molecule in the crystalline state.

The $BiCl_3$ quadrupole spectrum has also been investigated. A number of lines have been found, but the spectrum has not yet been analyzed.

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The Diamagnetism of an Enclosed Electron Gas

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In recent papers, Osborne[1] and Steele[2] discuss the diamagnetism of a free electron gas in a finite container from the point of view of number theory. In these papers interesting effects are uncovered