further cooling by the salt was more than offset by heat influx. Taking this into account, it is likely that the temperature corresponding to the highest observed velocity of 33.9 m/sec. was above 0.3 or 0.4°K

Due to this heat influx (and the relatively small dependence of velocity on temperature near 1°K) the marked velocity increases were observed only for initial fields approaching 12 kilogauss. This is illustrated in Table II where the maximum velocity following each demagnetization is given for the corresponding initial field strength.

As the result of the fundamentally opposite nature of Tisza's[1] and Landau's[2] expectations for second sound behavior in the extreme low temperature range, a choice on the basis of this present evidence is not difficult. Tisza predicted a systematic decrease in velocity with decreased temperature, setting in near 1.5°K and presumably continuing toward zero velocity at absolute zero. Landau conversely predicted a strong increase in velocity as temperature is lowered below 1°K. This latter prediction appears thus far to be substantiated.

This should not necessarily be taken as evidence against London's[6] original hypothesis of helium II as a condensed Bosé-Einstein gas. In fact the recent experiments of D. Osborne *et al.*[7] showing non-superfluidity in He^3 are exceedingly strong evidence for the condensation theory. Rather one would expect that a reformulation of Tisza's second sound picture would be desirable, based on the Bosé-Einstein hypothesis, but with the assumption of no phonon entropy carried by the superfluid. Fundamentally Tisza's and Landau's formulations accrue from essentially the same thermodynamic relationship, the distinction lying in the manner of its interpretation. In the upper temperature range Tisza's analysis appears completely adequate.

In a recent paper Pomeranchuk[8] predicted that impurities in helium II (in the form of He^3) might preclude Landau's predicted sharp rise in velocity with decrease in temperature below 1°K. For the He^3 concentration in our helium II (gas-well helium) this does not appear to be the case.

By reducing the heat leak it is hoped that future measurements can be made at lower temperatures and under conditions which permit reliable temperature determinations.

* Tisza[1] in fact has suggested that relaxation type dispersion should appear at temperatures well below 1°K.

** This substantiates the doubts expressed by one of the authors[3] over the reliability of his own low temperature data in earlier second sound measurements.

† Supported by the ONR, Contract Na-onr-12-48.

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On the Tripartition and Quadripartition of Uranium Nuclei

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WE have been surprised that several recent publications about tripartitions of uranium nuclei make no reference to the French results on this subject,[1] or make reference only to the preliminary results,[2] omitting the detailed report[3] published by Mr. Tsien San Tsiang, Mrs. Ho Zah Wei[4] and the writers.

Therefore, we wish to point out that our work had been undertaken after the presentation at the Meeting on Fundamental Particles held in Cambridge (England) on July, 1946, by Green and Livesy of uranium fission tracks photograph showing the emission of long range light particles. We think we were the first to publish a correct interpretation of this new fission process in our publication "Sur la tripartition de l'uranium provoquée par capture d'un neutron."[5] We were also the first to publish a mass determination of the light fragment.[6] We published the first experimental evidence of quadripartition of uranium nuclei.[7] A preliminary report of our work was given in English in a letter to the editor of the Physical Review[8] as well as in Nature;[9] in these two communications we announced that a more detailed report was to be published in the Journal de Physique et le Radium.[3] Mr. Tsien San Tsiang published a detailed theoretical interpretation of these phenomena in that same journal.[10]

The first photograph of nearly symmetrical tripartition (with fragment of masses: 127, 77 and 32 mass unit) was published in our paper in Nature on June, 1947.[9]

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The Future Nuclear Interaction

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IN the future theory the energy of interaction of nucleons may be expressible in the form $V=OJ$ where O is an operator containing the isotopic, Dirac matrix, and positional coordinates of the nucleons and J is the Green's function of the field. Recently promising forms of J have been derived from a generalized linear field theory.[1] It remains, however, to fix O on a theoretical basis.

In conformity with the second form of a proposed principle of generalization[1] we might seek an appropriate operator among the various developments of one-meson theory. To determine the suitability of the final result of such developments and to detect inadmissible assumptions we propose three tests to augment those previously formulated.[2]

I. The interaction must be well-behaved in the limit of zero-meson mass, reducing to a reasonable Newtonian or Coulombian interaction.

II. Dipole terms must have as co-factors a natural length which is characteristic of the nucleons, rather than the field, in correspondence with the classical case.

III. The infinite self-energies and inadmissible interaction singularities among static and relativistic terms must vanish when Yukawa's potential is replaced by our generalized meson potential.

In applying these tests to the four interactions derived by Kemmer[3] (Eq. (67a–d)) we find that the eight terms with factors κ^{-2} fail with respect to all three tests. Most of these defects may be removed, however, by a trivial modification of Kemmer's development. We first assign the role of the classical potentials to the ϕ's in the scalar and vector cases and the χ's in the pseudovector and pseudoscalar cases and the role of the classical field strengths to the χ's and the ϕ's in the corresponding cases. With this identification we see that four of the interaction Lagrangians ((39a), (39b), (40c), and (40d)) correspond to the classical interaction of a pole with the field whereas the other four correspond to a dipole interacting with the field. In conformity with the corresponding principle in the latter cases we must associate with the coupling constants (f_a, f_b, g_c and g_d) a length a, presumably $\hbar/Mc$,[4] which is characteristic of the nucleon. We may do this simply by multiplying these four of Kemmer's coupling constants by $a\kappa$, a step which does not disturb the subsequent development. The final explicit interactions are improved considerably by this modification and we are left with only two defective terms, one each in $V_g{}^b$ and $V_f{}^c$. These terms have their origins in the more difficult and subtle questions connected with auxiliary conditions. In one development of these interactions by the writer they do not appear at all. In another they are replaced by innocuous terms. It must be noted that the uniform introduction of the factor a_K in all coupling constants or the equivalent device commonly employed,[5] while giving interactions which satisfy tests II and III, is not permissible according to test I. In particular the Newtonian and Coulombian static fields then are lost in the limit of zero-meson mass.

Assuming tentatively that the pi-meson is the principal nuclear force meson then $(a_K)^2=(m/M)^2\sim 1/40$. We come then to the important physical conclusion that only if the fine structure constants (α_p for pole coupling and α_d for dipole coupling) are related by $\alpha_d\sim 40\alpha_p$ will the static interactions arising from dipole coupling be of the same order of magnitude as the static pole interaction. Since α_d is then greater than one we are forced to strong coupling for this part of the interaction. On the other hand if we assume $\alpha_d\sim\alpha_p$ we find that the effects of dipole coupling are small compared to the static pole interactions and, in fact, are of the same order of magnitude as the relativistic pole interactions. Thus the assumption of simultaneous pole and dipole coupling is an undesirable complication. Indeed, the complication is even greater than indicated by Kemmer's treatment which does not bring out the pole-dipole interference terms and which discards contact interactions.[6] We can, nevertheless, utilize the Kemmerian interactions, with the suggested modifications, by regarding them as eight distinct interactions four of which, the pole cases, have a more elementary nature. Three of these cases, the scalar-scalar, the vector-vector and the pseudovector-pseudovector[7] have large static terms, but they are not promising nuclear interactions. The pseudoscalar-pseudoscalar, a synthesis of the first two,[8] and the four dipole cases give rise to more interesting interactions which, however, are too small in the case of a one-meson field for $\alpha<1$. In a later communication we shall discuss the possibility that these latter interactions, in conjunction with a generalized multiple-meson field, may contain the correct nuclear interaction.

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Mass Assignment of Xenon Activities Produced in Fission

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THE electromagnetic isotope separator[1] of this Institute has been used in order to ascertain the mass-numbers of the Xe isotopes produced in fission. The gaseous fission products from neutron irradiated uranium oxide were fed to the ion source and the active isotopes collected on a thin aluminium plate. This method has recently been used by J. Koch, Copenhagen, in an investigation of the Kr isotopes produced in fission (private communication). The method of determining the mass numbers, corresponding to the different activities, was the same as used for the mass assignment of 43^{m} Hg^{199} [2] and 53^{d} Hg^{203}.[1]

TABLE I. Summary of results.

Element	Mass number	Half-life	Parent isotope (according to Seaborg's tables and our measurements)
Xe	133	~5.4 d	
Xe	135	9.1 hr.	
Xe	137	3.5 min.	I^{137} 22.0 sec.
Xe+Cs	138	30.0 min.	I^{138} 5.9 sec.

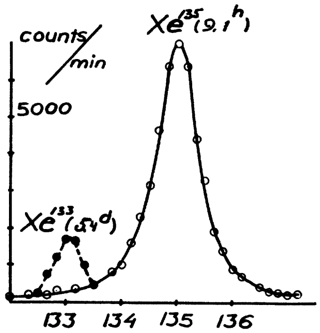

FIG. 1a. The activity of the 5.4 d and 9.1 hr. xenon isotopes. Dotted curve is the 5.4 d activity, measured 3 days after the 9.4 hr. activity and drawn to a 5 times larger scale.

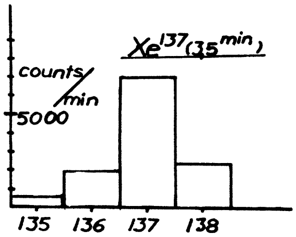

FIG. 1b. The activity of the 3.5 min. Xe isotope measured immediately after separation and 8 minutes after stopping the cyclotron.

Figures 1a, b, and c show the measured activity as a function of the position on the collector plate and the results are summarized in Table I. This confirms that the assignments of these isotopes in Seaborg's tables[3] are correct (the mass numbers 137 and 138 were classified as *B* and *D*).

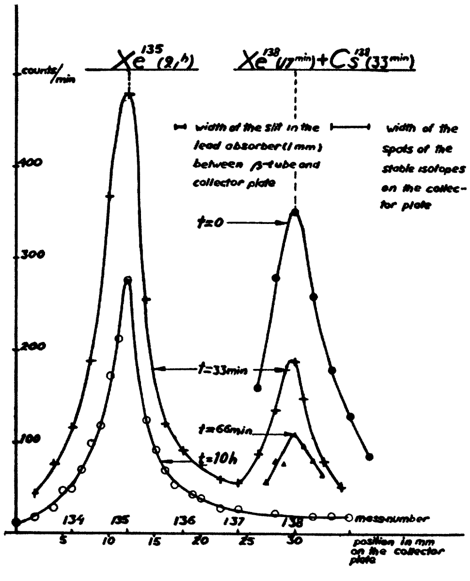

FIG. 1c. The activity of the 17 min. Xe and 33 min. Cs isotopes.