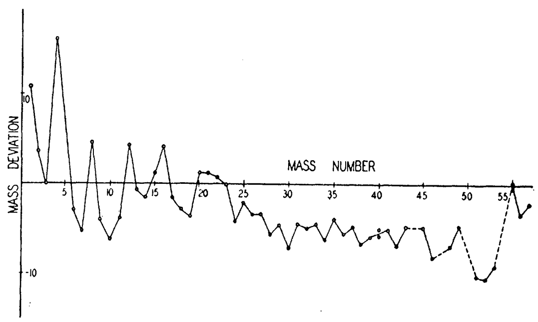

FIG. 1. "Mass deviation" as a function of mass number.

mass number A. The well-known variations up to Ne^{20} are shown and the absence of any marked irregularities from Ne^{20} to Ca^{40} is in good agreement with the supposition that the $3d$ shell is being filled in this region.[3] After mass number 40 the irregularities become more pronounced and between Cr^{53} and Mn^{55} a strong fluctuation occurs. This strong fluctuation may in part be due to error in the mass of Fe^{56} upon which the points at 55, 56 and 57 depend, but it is doubtful if all the sharp rise can be explained in this way. The indication is that a sudden increase in mass occurs upon the addition of either the 30th neutron or the 25th proton. Since if short range forces operate we expect the $4f$ shell to be in process of being filled for either of these numbers, it is hard to understand the presence of a fluctuation at all. A possible explanation is that the fluctuation corresponds to a simultaneous filling of both proton and neutron shells. The simplest way of achieving this is to suppose that after Ca^{40} the neutrons fill the $3p$ and $3s$ shells while the protons occupy $3s$ and $4s$ shells. This would then give a simultaneous filling of shells at 30 neutrons and 24 protons, meaning a low mass for Cr^{54} and a relatively high value for Mn^{55}. A measurement of the packing fractions of the three chromium isotopes would be of great interest in checking this suggestion.

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Anomalous Scattering of Neutrons by Helium

It is known[1,2] that neutrons of about one Mev energy show an anomalously high scattering cross section in helium. The variation of the scattering cross section with neutron energy in the region from zero up to one Mev has not been carefully investigated, and it was the purpose of the present work to obtain data in that region.

Neutrons from the reaction $C^{12}+D^2 \rightarrow N^{13}+n'+Q$ were used as a source. Magnetically analyzed deuteron beams up to 1.6 Mev energy were produced by the Rice pressure Van de Graaff generator. Since $Q=-0.28$ Mev, neutrons in the forward direction have an energy of 1.2 Mev at this maximum bombarding energy. The paraffin target was not more than about 15 kv in thickness.

The ionization current produced in a Wulf electroscope filled with 45 pounds of hydrogen was observed when the neutrons from the carbon reaction were allowed to enter the instrument within about 20° of the forward direction of the incident deuteron beam. The ionization current was obtained as a function of the incident deuteron energy. The corresponding energy of the neutrons was calculated, using the above Q value. The spread in neutron energy arising from target penetration of the deuterons, angular deviation from the forward direction (0°–20°), and spread of deuteron energy is not more than about 3 percent.

The electroscope was then filled with 25 pounds of helium and the observations were repeated, the ionization current in helium being obtained as a function of neutron energy.

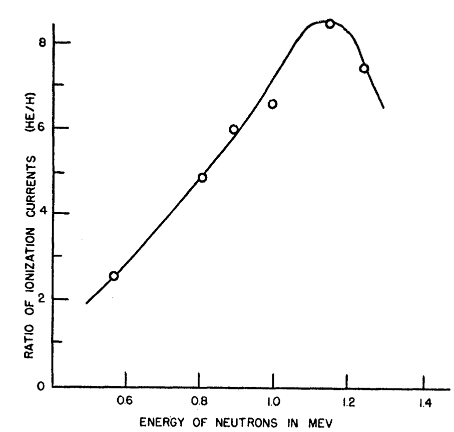

FIG. 1. Ratio of observed ionization currents in helium and hydrogen as a function of neutron energy. The maximum has been normalized to 8.6, the value of σ_{He}/σ_H for neutrons of about one Mev energy.

It is known[3] that strong γ-rays are obtained when carbon is bombarded by deuterons, and the ionization current produced by these γ-rays was taken into account. This, however, together with the natural background, constituted only a fraction of the total ionization current observed.

The ratios of these corrected ionization currents in helium and hydrogen are shown in Fig. 1. The ratio plotted in Fig. 1 may also be regarded as a measure of the ratio σ_{He}/σ_H of the cross section for neutron scattering in helium and in hydrogen, if (a) the recoil protons and recoil α-particles show the same spatial distribution, and (b) the ratio of the number of ions collected in helium to the number collected in hydrogen remains constant for various neutron energies. Since both recoil protons and recoil α-particles are believed to show spherical symmetry in their spatial distribution in a moving coordinate system, condition (a) is probably satisfied. The electroscope collected ions over a region large compared to any recoil track lengths, and hence condition (b) is also fulfilled.

The ratio σ_{He}/σ_H has been normalized in Fig. 1 to 8.6 at its maximum value; this is the previously observed[1,2] ratio of the absolute cross sections at that point. At the time of this experiment it was not possible to obtain neutrons of higher energy from carbon because of generator voltage limitations, but it is hoped that these measurements may be extended in the near future. Below 0.6 Mev neutron energy, the yield is quite small, so that ionization currents in the electroscope were of the order of the natural background. Furthermore, small effects from $d-d$ neutrons, arising from deuteron contamination of the target, would become correspondingly quite large at these low energies, and hence points below 0.6 Mev were not thought to be reliable. However, Carroll and Dunning[4] have shown that σ_{He}/σ_H for thermal neutrons is only 0.05.

The curve rises smoothly to a maximum at about 1.1 Mev; if it is continued symmetrically beyond this maximum, the resonance shows a half-width of nearly 0.6 Mev. This is in agreement with cloud-chamber work which has been done here.[2]

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Dispersion of Supersonic Waves in Cylindrical Rods

In a recent issue of this journal a paper[1] appeared on the dispersion of supersonic waves in cylindrical rods. A number of experimental results were reported and compared with the theory of Giebe and Blechschmidt.[2] It was shown that agreement was good out to the region where the theoretical "dead zone" begins, but at higher frequencies the theory quoted was quite inadequate.

As certain work, which was reported by the writer some years ago, seems to have escaped attention, it seems worth while to recall here some of the results obtained at that time which are relevant to the recent paper by Shear and Focke and which amplify certain of the conclusions reached by these authors.

When a sound wave is propagated down a cylindrical tube filled with liquid, it has been shown[3-5] that dispersion of the wave occurs at frequencies corresponding to those of the resonant radial vibrations of the column. In the neighborhood of these resonant frequencies the longitudinal wave is propagated only with difficulty and what might be called a "dead zone" exists.

That this "dead zone" also exists for tubes was shown later by Giebe and Blechschmidt,[2] who obtained satisfactory agreement between their experimental results and data calculated from the simple theory of coupled oscillations.

It was thought at one time[6] that this same type of anomalous dispersion occurred for solid cylindrical rods. The curves upon which these views were based, however, were apparently inaccurate at the higher frequencies and it seems probable that certain resonances were attributed to longitudinal vibrations which actually belonged to other modes, e.g., torsional or flexural. Later experimental work by Röhrich[7] and now confirmed by Shear and Focke[1] has shown that the "dead zone" does not exist for solid rods, and, in fact, it is not predicted by the theory which should correctly be applied to this particular case. This theory is that due originally to Pochhammer,[8] summarized by Love,[9] and discussed in detail a few years ago in several papers.[10,6]

In a concluding paper published in 1934[11] the writer considered longitudinal vibrations for the three cases mentioned above and offered a suggestion for the absence in the last case of the "dead zone" which was so striking a phenomenon in the first two cases. This suggestion was that for the solid rod shear forces were of very great importance and would prevent anomalous dispersion and hence the dead zone from occurring. A theoretical discussion showed this to be the case.

Thus it appears that the limitations of the theory discussed by Shear and Focke exist because this particular theory is applicable only to the special and limited case of a tube. If in each case the appropriate theory be considered, it has been shown that the experimental confirmation is quite gratifying.

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On the Dynamics of Complex Fission

In a letter of the same title[1] we pointed out that our coefficients of the higher order terms in the potential energy of distortion of a liquid drop, the radius of which is described by the expression $r=R(1+a_0+a_2P_2+a_4P_4)$, do not check those given by Bohr and Wheeler.[2] Dr. Wheeler has explained that the discrepancy arises from the fact that the coefficients α_2 and α_4 as used in their Eq. (22) are not as defined in their paper and that (22) is obtained by using another definition based on spheroidal harmonics.[3] Our definition gives a_4 positive at the a_2-a_4 saddle point for the range of x from zero to one. The interpretation of this fact as given in Section two of our letter is partially incorrect. The equatorial bulge which a positive a_4 would introduce is so small that it does not compensate for the equatorial constriction automatically brought in by the second harmonic, as was pointed out to us by Dr. Wheeler. For values of x sufficiently far from unity the drop in its critical shape develops a concavity about the equatorial belt. We cannot conclude that the positive value for a_4 is