differences in atomic number are involved, the apparent amplitude of motion has a relative error of $\sim 2 \times 10^{-6}\, \Delta Z^2 \overline{l^2}_{ij}$. We find then, for example, that the error for a C—F bond is negligible, and the error for a C—Cl bond is about 10 per cent. If $\Delta Z$ is much greater than 10, any information about the associated interatomic spacing which is derived from the shape of the distribution function (such as amplitudes of vibration or restricted rotation or, in extreme cases, type of symmetry) must be regarded with caution unless careful corrections have been made.

Further details and experimental results will be published later.

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## Difference between the Density Distribution of Neutrons and Protons in Atomic Nuclei

In a former communication[1] I calculated the energy and distribution of nucleon density of atomic nuclei by Ritz's method in the first approximation, assuming Yukawa forces between the nucleons. In the energy expression of the nucleus, in addition to the exchange energy and kinetic zero-point Fermi energy of the nucleons, we have also taken into account the kinetic energy correction of Weizsäcker, the electrostatic Coulomb energy of protons and the Coulomb exchange energy of protons arising from the Coulomb interaction of protons. In the first approximation for the neutron density $\rho_n$ and the proton density $\rho_p$, functions of Gaussian type have been set up in the following form:

$$\rho_n(r) = \rho_{n_0} \exp(-a^2 r^2/r_0^2), \quad (1)$$
$$\rho_p(r) = \rho_{p_0} \exp(-a^2 r^2/r_0^2), \quad (2)$$

where $r$ is the distance from the centre of the nucleus, $r_0$ is the Compton wave-length of the $\pi$-mesons divided by $2\pi$, $\rho_{n_0}$ and $\rho_{p_0}$ are normalizing factors and $a$ denotes a variational parameter to be determined from the minimization of the energy.

As a second approximation of Ritz's method, the expressions (1) and (2) have been multiplied by the factor $1 + b(r/r_0)^2$, where $b$ denotes a further variational parameter. By varying the two parameters $a$ and $b$ independently of each other, the energy and the density distribution of the nucleons have been calculated in the second approximation. Thus we have obtained a small energy gain increasing with the mass number, which, however, even for the heaviest nuclei, is smaller than $\frac{1}{2}$ per cent. The change in the nucleon density is also very slight, and except for the outermost boundary areas of the nucleus, only amounts to a few per cent. Thus, in the second approximation the density distribution practically remains a function of the Gaussian type for the heaviest nuclei also. In almost all work on this subject a Gaussian density distribution has been assumed for light nuclei only; for heavy nuclei, however, in the inner parts of the nucleus a constant nucleon density has been assumed, which rapidly decreases on the boundary of the nucleus. Although our variational densities in the second approximation are sufficiently general to represent such a distribution, in spite of this the nucleon distribution we obtain from the minimization of the energy is a Gaussian-type function also for the heaviest nuclei.

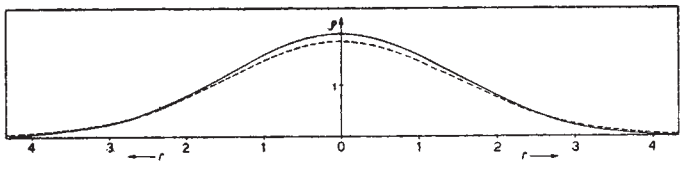


Fig. 1. Neutron density $\rho_n$ (———) and proton density $\rho_p$ (- - - - -) in the nucleus $A = 200$, $N = Z = A/2$. $r$ in $r_0$ units, $\rho_n$ and $\rho_p$ in $1/r_0^3$ units

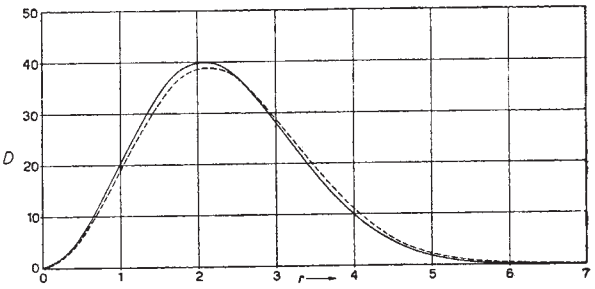


Fig. 2. Radial neutron density $D_n$ (———) and radial proton density $D_p$ (- - - - -) in the nucleus $A = 200$, $N = Z = A/2$. $r$ in $r_0$ units, $D_n$ and $D_p$ in $1/r_0$ units

In all these calculations the variations of the neutron and proton density have not been carried out independently of each other. Except for the normalization factors, which are in general different, both density functions have been assumed to be equal, both of them containing the same variational parameters. As the next step of Ritz's method, both the neutron and proton density have been varied independently of each other. Thus we have obtained a further slight energy gain increasing with the mass number, and being also for the heaviest nuclei smaller than 1 per cent. Between the neutron and proton density a comparatively small difference results. As was to be expected, due to the Coulomb repulsion, the protons are pushed somewhat towards the boundary of the nucleus. The curves of the neutron and proton density, as well as those of the radial densities $D_n = 4\pi r^2 \rho_n$ and $D_p = 4\pi r^2 \rho_p$, are represented in Figs. 1 and 2 respectively, the difference between the two density functions being more distinctly shown in the latter. As can be seen in Fig. 1, the density functions are still of the Gaussian type. Accordingly, nothing suggests in our case the tendency to form a hole in the centre of the nucleus, resulting from the Coulomb repulsion of protons, as found by Feenberg[2].

The density distributions of the nucleons determined in this way can be used to calculate various nuclear properties and constants. Thus they have been applied to calculate the angular momentum distribution of nucleons. We have obtained for the neutron and proton numbers, at which an $s$-, $p$-, $d$-, $f$-, $g$-, $h$-, $i$-, . . . neutron or proton appears in the nucleus for the first time: 1, 2, 8, 20, 42, 74, 119, . . . . These numbers are in good agreement with the corresponding neutron and proton numbers 1, 3, 9, 21, 41, 71, 113, . . . obtained from the wave-mechanical shell model[3].

A more detailed account of these calculations will be given in the *Acta Physica Hungarica*.

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## Wave Hypothesis of Moving Irregularities in the Ionosphere

THE existence of moving irregularities in ionospheric regions has been demonstrated by a number of workers using a wide variety of radio techniques[1], and information regarding their properties is accumulating rapidly. The motions are frequently described in terms of 'winds'; but, as has been repeatedly stressed, the observations need not imply any large-scale movement of the atmosphere. Indeed a number of fairly general considerations can be advanced in support of an alternative view, that a propagated wave-like disturbance is the cause. At the suggestion of Mr. J. A. Ratcliffe, I have begun a theoretical examination of the magneto-hydrodynamic effects involved in such an interpretation.

It is found that travelling atmospheric disturbances, governed by pressure oscillations and gravitational forces, will be accompanied by electromagnetic oscillations which can, under special resonant conditions, become large. The corresponding amplification of the associated electron motions would render such disturbances particularly susceptible to detection by radio methods. Gravity tends to confine the movement of these disturbances to the horizontal plane, though a vertical component is introduced by the effects of cross-conductivities and temperature inhomogeneities. If these, and similar complications, are neglected, it is found that conditions are particularly favourable for disturbances of quasi-period

$$\tau \sim 2\pi \sqrt{2/\gamma(\gamma - 1)}\, C/g, \qquad (1)$$

and group speed

$$V_G \sim C \sqrt{(\gamma - 1)/2\gamma}, \qquad (2)$$

in which $\gamma$ is the ratio of specific heats, $C$ the speed of sound, and $g$ the acceleration due to gravity. No preferred directions of travel relative to the earth's magnetic field appear at this stage, but they can be introduced, in some circumstances, by taking detailed account of electron motions and cross-conductivity effects.

It is natural to associate these resonant oscillations with the large-scale $F_2$-region disturbances observed by Munro[2], in which the numerical density of electrons may change by as much as 25 per cent. They appear to have a fundamental motion in the horizontal plane, with a secondary vertical component superimposed, in agreement with the theoretical predictions. Again, the larger amplitudes and shorter fractional durations (relative to $\tau$), associated by Munro with longer periods, receive plausible explanation in terms of varying resonance conditions.

If typical values for these disturbances, say, $\tau \sim 25$ min. and $V_G \sim 7$ km./min., are inserted directly in (1) and (2), the estimates $\gamma \sim 1{\cdot}1$ and $C \sim 35$ km./min. result. The corresponding temperature ($\sim 1{,}000°$ K.) is in good agreement with other estimates for this region, but the specific heat ratio is appreciably lower than one would expect from the usual considerations. Martyn[3], however, was led to a similar result when considering the bounding of ionospheric disturbances, and he pointed out that low values of $\gamma$ might well occur in regions where ionization was taking place. In any event, (1) and (2) do not take into account a number of factors which will be operative in practice, and so should only be considered as order-of-magnitude relations; as such, they appear to be quite satisfactory.

Favourable conditions are also obtained when

$$\tau \sim 2\pi \sqrt{2/\gamma}\, C/g, \quad V_G \sim C/\sqrt{2\gamma}, \qquad (3)$$

but these values do not appear to correspond to any disturbances so far reported.

No detailed analysis of the higher-frequency radio-star and $E$-region fluctuations has been undertaken as yet; but they appear amenable to a wave interpretation, and many of their properties can be profitably discussed on this basis.

In view of its potentialities and initial successes, the wave hypothesis might well be kept in mind when further analyses of the experimental data are undertaken.

This investigation, which is continuing, is supported by the National Research Council of Canada through a special scholarship. Full details are to be published at a later date.

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## Measurement of Temperatures of Metal/Mould Interfaces

MANY workers have attempted to observe metal/mould interface temperatures in metal castings by means of thermocouples with sheathed hot-junctions. However, since the temperature gradient in the refractory sheath is high, such measurements are liable to considerable error. We have therefore made measurements on an experimental steel casting with an unsheathed platinum / platinum - 13 per cent rhodium hot junction, the metal of the casting being used as intermediate metal; the two wires were simply pushed through the mould wall some 0·3 cm. apart. The technique has the following advantages: (i) it eliminates errors due to the temperature gradient across the sheath; (ii) it minimizes thermal lag; (iii) it ensures accurate location of the hot junction at the metal/mould interface, since the hot junction is formed at the points where the molten metal comes into contact with the thermocouple wires.