LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twenty-eighth of the preceding month; for the second issue, the thirteenth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Atomic Stability as Related to Nuclear Spin

As is well known, the stability of an ordinary atom nucleus is very great. For example almost head-on collisions between α-particles with velocities greater than $0.055c$ (ten thousand miles per second) with nitrogen or argon nuclei, commonly do not disrupt the nucleus, though it is true that in certain collisions the α-particle adds itself to a nitrogen nucleus and a proton is emitted at high speed. Such a high stability in a body of high positive charge does not seem probable on the basis of electrostatic forces alone, so the existence of powerful forces (partly magnetic) associated with spin and other types of quantized momenta, may be assumed. In the extra-nuclear atom, magnetic moments are associated with both orbital and with spin angular momentum, and the stability is greatest when the resultant of each of these sets of momenta is zero, or if $L=0$ and $S=0$.

The problem may be approached from the standpoint of known nuclear relations. In 1917 the writer assumed the electrons in nuclei to be associated in pairs (J. Am. Chem. Soc. **39**, 859 (1917), Phys. Rev. **15**, 73 (1920)), and it was also shown (Phil. Mag. **43**, 305 (1921)) that in almost all atoms the total number of electrons (the electronic number) is even. In addition the number of protons is in general found to be even. Such pairing suggests the relation of antiparallel spins.

It has been shown (loc. cit.) that all atomic species fall into four classes, if oddness and evenness in the number (N) of nuclear electrons, and the number (P) of protons is used as the basis of the classification. The general stability of the atoms of each class is represented by the abundance in the meteorites, in which the abundance follows very general relations, and on earth, where segregation has been more effective. See table at bottom of page. The numbers in parentheses represent later work in which species of smaller abundance have been detected.

Both the abundance and the number of known species are very much higher for class 1 than for the other classes. In fact the abundance in the meteorites for this class is 19 times that for all of the other three classes. For this class alone the known values of the quantum number i, which represents the resultant angular momentum ($ih/2\pi$), are all equal to zero, while for all of the other three classes all of the known values are greater than zero.

In class 1 the nuclear spins (in units $h/2\pi$) have been found to be zero for helium, carbon 12, oxygen 16, and for those isotopes of zinc and of cadmium which belong to class 1 (have even isotopic number). In class 2 the known values are: Li>0; F, 1/2; Na$\geq 5/2$; Cl, 5/2; La, 5/2; Pr, 5/2; Cs>0; I, large; Tl, 1/2;

Class	N	P	Z	Meteorites	Earth	Number species	Nuclear spin number	Examples
1	Even	Even	Even	95.4	87.4	71 (73)	0	O^{16}, C, He, Cd (even isotopes)
2	Even	Odd	Odd	2.1	10.8	33	1/2 to 9/2	F, La, Bi
3	Odd	Odd	Even	2.5	1.8	18 (25)	1/2	Cd (odd isotopes)
4	Odd	Even	Odd	0.0	0.0	3	1	N^{14}

and Bi, 9/2. In class 3 the odd isotopes of cadmium are supposed by Schüler and Bruck to exhibit a value of 1/2.

Class 4 represents the most unstable of all nuclei, since only three species of this type are thus far known, and all of these have only a minute abundance. The only one of these for which the spin is known is nitrogen 14, for which the spin is 1.

Unfortunately, the interpretation of the nuclear spin in terms of intra-nuclear spins, and possibly of other intra-nuclear momenta, is uncertain, though the present values seem to indicate that only the proton spins are apparent. This seems peculiar in view of the fact that the pairing of the electrons is more apparent than that of the protons. It may be possible that the nucleus is too densely packed to allow an electron spin, but it is also possible that the present apparent absence of electron spins is fictitious.

It may be assumed that one important factor in nuclear stability is to be found in the relations of the intra-nuclear spins, and also of any other types of angular momentum. Since these relations are unknown it has seemed important to show that all known data indicate that: ***In general high nuclear stability is associated with zero nuclear angular momentum*** (*zero spin*). The relations of the atomic species indicate that the limits of stability are related to other quantities, and are a function of the relation between Z and N/P, and of some other variables.

William D. Harkins

University of Chicago,
January 28, 1930.

The Unified Field Theory and Schwarzschild's Solution: A Reply

I have read with a great deal of interest Mr. Salkover's criticism (Phys. Rev. **35**, 209 (1930)) of my paper on Einstein's unified field theory and the Schwarzschild solution (Proc. Nat. Acad. **15**, 784 (1929)). I agree with Mr. Salkover that the expression for the electromagnetic potential which I used in my paper for the calculation of the tensor $V_{\beta\gamma}{}^{\alpha}$ was not correctly copied from the previous paper by Wiener and myself there referred to (Proc. Nat. Acad. **15**, 802 (1929): communicated in May, 1929). The expression given in the latter paper of course agrees with that calculated by Mr. Salkover, and also with the value of the tensor $\Lambda_{\mu\nu}{}^{\sigma}$ reported in my paper. This mistake, while vitiating my results on the Schwarzschild solution, in no way affects our previously announced conclusions, in particular the non-existence in the unified theory of an electrostatic field with spherical symmetry.

M. S. Vallarta

Massachusetts Institute of Technology,
Cambridge, Mass.,
February 3, 1930.

Scattering of Light in Sodium Vapor

An artificial chromosphere was constructed in the following manner: Sodium vapor was admitted into a cylindrical glass shell, like the region between the walls of an unsilvered Dewar flask, and a filament was inserted along the axis of the cylinder. The filament is considered to be the photosphere, and the sodium vapor shell the chromosphere. When a spectroscope was directed through the shell of vapor, at right angles to the axis, at the continuous background furnished by the filament, the "Fraunhöfer" lines were observed. When the shell was lowered so only the upper part of the cylinder was in front of the slit, resonance radiation was seen, corresponding to the flash spectrum. It was observed that the D lines appeared in absorption *at lower vapor densities than those for which they appeared in emission.*

This is in accord with the work of J. Q. Stewart and the author, (Astrophys. J. January, 1930). The reason for this is not understood. It is probably not due to quenching of resonance radiation by the hydrogen present in the sodium, since kinetic theory calculations indicate that it is necessary to assume effective collision radii of order 10^{-6} cm before a collision frequency is obtained comparable to the unloading time of the $2P$ state of sodium; though the work of Mannkopf (Zeits. f. Physik **36**, 315 (1926)) leaves some doubt on this point. Since in the experiments of R. W. Wood (Physical Optics, Pp. 575 et seq.) the vapor density was not