mental observations on KBr, mentioned above, suggest that the condition determining the observed breakdown field is the requirement that this field be sufficiently strong to dissociate the excitons.

* Fellow of the American-Scandinavian Foundation.

[1] R. C. Buehl and A. von Hippel, Phys. Rev. **56**, 941 (1939).
[2] A. von Hippel, Zeits. f. Physik **75**, 145 (1932).
[3] H. Fröhlich, Proc. Roy. Soc. **A160**, 230 (1937).
[4] R. J. Seeger and E. Teller, Phys. Rev. **54**, 515 (1938).
[5] G. Malmlöw, Arkiv f. Matem., Astr. och Fysik **30B**, 1 (1943).
[6] F. Seitz, *Modern Theory of Solids* (McGraw-Hill Book Company, Inc., New York, 1940), footnote 3, p. 563.

Integral and Rational Numbers in the Nuclear Domain and Their Significance*

ENOS E. WITMER
Randal Morgan Laboratory of Physics, University of Pennsylvania, Philadelphia, Pennsylvania

September 16, 1946

THE pure number hc/e^2 is $861=\frac{1}{2}(42\times 41)$ to a very high degree of precision. This, we believe, is both exactly *true* and *significant*. Also $2M_p/861$ is the binding energy of the deuteron within experimental error. This energy, or the corresponding mass, is designated a *deuterium unit*. One-twelfth of a deuterium unit is called a *prout*. Thus the mass of a proton, M_p, is exactly 5166 prouts. The mass of a neutron is 5173 prouts. Comparison with the best experimental data shows that in all probability the masses of all stable nuclei in the ground state up to and including Ne^{21} are integral numbers of prouts. This leads to the idea that the *masses of all stable nuclei in the ground state are an integral number of prouts*. The nuclear mass of O^{16} comes out to be 82,012 prouts, from which it is possible to calculate the value of a prout to eight significant figures. It is

$$1\text{ prout}=0.000195039909\pm(26\times 10^{-12})\text{MU}.$$

The masses of the proton and neutron are, respectively,

$$M_p=1.00757617\text{ MU},\quad M_n=1.00894145\text{ MU}.$$

A study of the binding energy per particle in prouts seems to indicate that this quantity never exceeds the integral value 48, although it comes very close to 48 in a number of cases. In fact this quantity probably lies between 47 and 48 for all stable nuclei between $Z=22$ and $Z=42$. Between $Z=42$ and $Z=84$ it drops gradually to about 42 prouts per particle.

Furthermore the evidence just given together with other evidence lends some support to the idea that each "shell" of protons in the nucleus has 42 protons.

The values of the disintegration energies in α-emission and the energies of γ-rays in γ-emission support to a considerable extent the idea that the masses of nuclei in excited states are always a rational number of prouts. This would be a natural generalization of the result just given.

Also the magnetic moments of nuclei appear to be integral multiples of $\mu_{N/4\times 42}$, where μ_N is the nuclear magneton.

The experimental value of $\beta\equiv M_{p/m}$ is compatible with the assumption that it is $(16/15)\times 42\times 41$. If this is so, the mass of the electron is given by

$$m=45/16\text{ prouts}.$$

The value of

$$\gamma\equiv e^2/GM_p^2\text{ is in the neighborhood of }e^{2\times 42}.$$

All this shows the great importance of the number 42.

It is suggested that all intrinsic observable nuclear quantities are rational multiples of a natural unit for that quantity. The term intrinsic nuclear quantity does not include such quantities as cross sections where interaction with an external entity is involved.

This dominance of integral and rational numbers appears to be irreconcilable with a theory of the nucleus in which the constituent particles are held together by forces which are continuous functions of continuously varying space coordinates, *even with quantization*. This seems to point to the necessity of "quantizing" the space and time coordinates. What the detailed nature of such "quantization" is remains to be seen. Now this idea fits in quite well with the importance of the number 42. For the Riemann-Christoffel tensor of space-time has 21 *different* components. It is suggested that the importance of the number 42 derives from this source, the factor 2 coming perhaps from spin.

All this leads up to the idea that nuclear structure is to be explained with the aid of a quantized space-time, in which the component, of the Riemann-Christoffel tensor are not identically zero. In the limit of macroscopic matter this must yield the Einstein equations of gravitation. In such a theory the integers and rational numbers mentioned above would appear as derived quantities.

It is hoped that our long article on this subject will appear very soon.

* See also E. E. Witmer, Proc. Nat. Acad. Sci. **32**, 283 (1946).

Determination of Nuclear Spin from the Stark Effect of Microwave Rotational Spectra

W. V. SMITH
Department of Physics, Duke University, Durham, North Carolina

December 11, 1946

DAKIN, Good, and Coles[1] have observed the quadratic Stark effect of a linear molecule (OCS) at 24,320 megacycles, obtaining a splitting of about 4 megacycles in the $J=1$ to $J=2$ transition for an electric field of 1070 volts per cm. This observation suggests a means of extending to microwave regions the method of obtaining nuclear spins from the intensity ratio of rotational spectrum lines. Such intensity ratios occur, for instance, in symmetric tops with 3 identical atoms such as $CHCl_3$, where the $K=0,\ 3,\ 6\cdots$ sublevels of each J level are strong (S), while the sublevels $K=1,\ 2,\ 4,\ 5,\ 7,\ 8\ \cdots$ are weak (W). The ratio S/W is given by[2]

$$S/W=1+\frac{3}{4(I^2+I)},$$

where I is the nuclear spin. At 10,000 to 25,000 megacycles, however, the different K sublevels for a given J are spread over a band of less than a megacycle, so that this effect is not very useful.

If, however, a d.c. electric field is applied to the gas, the multiplet separation is large particularly since for