correlation is decidedly useful and should be extended. A detailed report will be presented later.

Mr. J. F. Herd[6] has described a synchronized "grid-blocking" transmitter, recently developed by the (English) Radio Research Board for sending the short pulses which are used in echo measurements. This is the circuit which we used in field measurements last summer, and described at the October meeting of the Institute of Radio Engineers in Cambridge. We have no desire to claim priority, or to dispute the usefulness and convenience of the circuit for the "Polar Year" work. However, the inherent frequency-modulation, produced by this simple type of modulated oscillator, renders it unsuitable for extensive use in the crowded channels now encountered in America, and we hope that it will not be generally adopted here. We have prohibited the use of this device in our own laboratory since October, as it is quite possible to use circuits which will produce less interference with other important services.[7] The transmitter should have frequency stability, the pulse length should be readily controllable, and should not be unnecessarily short. A description of our present apparatus will soon be offered for publication.

Harry Rowe Mimno
P. H. Wang

Research Laboratory of Physics,
Harvard University,
April 19, 1933.

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[6] J. F. Herd, Proc. Phys. Soc. (London) **45**, 221 (1933).

[7] H. R. Mimno and P. H. Wang, Phys. Rev. **48**, 501A (1933).

Band Spectrum of the H^1H^2 Molecule

The spectrum of the H^1H^2 molecule has been photographed in emission in the first order of a 21 foot grating. The bands of H^1H^2 corresponding the $H\alpha$ bands of H_2 have been measured. The Q branches have been found in considerable intensity in all of the bands measured up to the present time—namely the $0''$–$0'$, $0''$–$1'$, $1''$–$1'$, $1''$–$2'$. The R lines have been identified up to $R=4$ for the $0''$–$0'$ band. The order of intensity Q, R, P is the same as the $H_2{}^{11}$ molecule for the $H\alpha$ bands.

The rotational and vibrational isotopic shifts check the calculated values to within the accuracy of the present preliminary calculations and measurements. RP combinations have been used to check the rotational levels of the $^3\Sigma$ lower state. An electronic isotopic shift of about 2.4 wave numbers has been observed.

More than 300 new lines have been observed in the limited region studied and a more detailed analysis will be carried out. This investigation is preliminary to a study of the nuclear spin of H^2, from an analysis of the H^2H^2 bands, undertaken in collaboration with Professor G. N. Lewis, who has provided the high concentration of hydrogen isotope used in the present work.

Muriel F. Ashley

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April 17, 1933.

Search by Deflection-Experiments for the Dirac Isolated Magnetic Pole

The recent discovery of a positively charged particle of e/m similar to that of the negative electron, presumably related to the positive electron predicted by Dirac, perhaps justifies calling the attention of other experimentalists briefly to the possibility of detecting the existence of single isolated poles, as predicted by Dirac,[1] by proper deflection-experiments with magnetic or electric fields, most conveniently the former. Simple calculations made by the writer more than a year ago, in connection with Richardson's[2] suggestion of a possible relation of such isolated magnetic poles to phenomena of the penetrating radiation, indicated that with reasonable assumptions as to its mass such a single pole having a kinetic energy even as great as 10^8 electron-volts should have a path of appreciable curvature in an apparatus similar to Anderson's,[3] but this curvature, being at right-angles to that of an electrically charged particle, would not be observable with the camera axis parallel to the magnetic field, even if such a high-speed isolated magnetic pole should be an ionizing particle. No high-energy deflection-experiments reported to date would have detected such a phenomenon, with the possible exception of the recent experiments of Blackett and Occhialini[4] who used stereoscopic cameras.

By Dirac's Eq. (9) the magnetic charge on a one-quantum pole should be $\mu=hc/2e$, where μ is in magnetic units, e in electrostatic units, and h is Planck's constant divided by 2π. The force on such a one-quantum isolated magnetic pole in a magnetic field of one gauss is then 3.28×10^{-8} dyne. This is nearly 70 times the force on an electron in unit electrostatic field, and similarly 70 times the transverse force on an electron of $v\cong c$ moving in a magnetic field of unit strength. If these single poles are contained in the structure of the nucleus, their dimensions must be of the order of nuclear dimensions. They must then be comparable to the electron in size; hence their (potential) energy and rest-mass must be at least as great

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[1] P. A. M. Dirac, Proc. Roy. Soc. **A133**, 60–72 (1931).

[2] O. W. Richardson, Nature **128**, 582 (1931).

[3] C. D. Anderson, Phys. Rev. **41**, 405–421 (1932).

[4] P. M. S. Blackett and G. P. S. Occhialini, Proc. Roy. Soc. **A139**, 699–726 (1933).

and probably considerably greater than that of the electron. Even if the mass is $(70)^2$ as great, the force on such a unit-pole being 70 times that on a fast-moving electron in the same magnetic field, the path-curvature is consequently still roughly comparable, especially when relativity considerations are taken into account. Langer gives the figure for the mass as $1/4\alpha^2=4700$ times that of the electron and Richardson gives the rough factor 500 times the mass of the electron.

Since it is improbable that such a high-speed isolated magnetic pole would have the same type of interaction with atomic structures as high-speed electrically charged particles, perhaps the most promising direction for observational attention is that of the "non-ionizing links" referred to by Blackett and Occhialini, and of similar non-ionizing connections giving rise to nuclear phenomena in "neutron" experiments and very likely to be expected in high-voltage nuclear disintegration experiments. In addition, of course, the behavior of unusual highly ionizing particles should be scrutinized to insure that their identity is correctly established. One experiment adapted to the detection of such high-energy isolated magnetic poles has been a part of our projected program for some time, waiting on the acquisition of a magnet of suitable dimensions. Other tests requiring smaller magnetic fields and dealing with a lower energy region are being undertaken.

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April 17, 1933.

A Nitrogen Disintegration by a Very Fast Neutron

I have recently photographed in nitrogen a very remarkable disintegration fork caused by a beryllium neutron. If conservation of momentum be assumed, the energy of the incident neutron may be computed from the lengths of the times of the fork and the angle between them to be $17(10)^6$ volts. This is greatly in excess of the energies attributed to neutrons by Chadwick or I. Curie and F. Joliot, and may be compared with the $16(10)^6$ volt neutron reported by Harkins, Gans and Newson.[1] The peculiarity of this fork which is so marked is that it is due to a neutron which owed its origin to beryllium being bombarded by α-particles from *polonium*. The maximum energy which may be released in these circumstances is $(\mathrm{Be}^9+\mathrm{He}^4-\mathrm{C}^{12}-n^1)+E^\alpha$. The energy set free by the mass-change is $6.9(10)^6$ volts and E^α for polonium is $5.4(10)^6$ volts, a total of $12.3(10)^6$ volts. The discrepancy, amounting to $4.7(10)^6$ volts, cannot be due to experimental error, since the fork is a good one and may be accurately measured. The probable error is not over $(10)^6$ volts in the energy of the neutron.

This particular fast neutron is not generous with its great energy: the recoiling nucleus (B^{11}) and disintegration particle (He^4) are of ordinary energies. The "loss" in energy amounts to $13.6(10)^6$ volts. This could possibly be accounted for by allowing the creation of a slightly heavier B^{11} than one measured in the mass-spectrograph. The excess weight due to complete absorption of the $13.6(10)^6$ volts would be too slight to be observable.

Franz N. D. Kurie

Sloane Physics Laboratory,
Yale University,
April 19, 1933.

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[1] W. D. Harkins, D. M. Gans and H. W. Newson, Phys. Rev. **43**, 584 (1933).

New Lines in the Electronic Band Spectrum of Neutral OH

By the use of high-frequency excitation and a very rapid flow of water vapor through the tube, the general background radiation obtained in photographing the electronic band spectrum of water vapor has been greatly reduced. As a result, it has been possible to bring out various faint lines not previously reported that lie on the short wave-length side of the 3064 (0, 0) band. The very high initial purity of the water and the repeated distillations while in use served to produce a spectrum entirely free from any trace of either carbon monoxide or nitrogen. It therefore seems justifiable to consider that the faint lines found are due to water vapor and not to impurities.

Nine of the lines lie between the lines of the ${}^{RR}R_{21}$ branch of the 3064 band which lies just beyond the main band head on the high-frequency side. Four of these are evidently additional lines of this branch. The remaining five agree well with the computed values of the ${}^{RR}R_{21}$ branch of the isotope OH in which H has an atomic weight of 2 and it is suggested that they may be due to this cause. The lines cannot be additional members of the main ${}^{RR}R_{21}$ branch as their frequencies do not check with the computed frequencies of these. This region would appear to be more favorable for the observation of possible isotopic lines than any other as the corresponding main lines are quite strong and the region in which the isotope lines should fall is sufficiently free from other lines to make observation of a number of them possible with a Hilger E-2 quartz spectrograph. The use of an instrument of greater dispersion would appear inadvisable because of the faintness of the lines.

The diagram shows the relative positions of the ${}^{RR}R_{21}$ branch of the 3064 band, our new lines, and the calculated position of the isotope ${}^{RR}R_{21}$ branch. The five lines nearest the band head would be unresolved with the dispersion