Letters to the Editor

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Coincident Bursts in Small Ionization Chambers*

C. G. MONTGOMERY AND D. D. MONTGOMERY
*Sloane Physics Laboratory, Yale University, New Haven, Connecticut***
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EVIDENCE has already been reported[1] to show that many bursts of ionization occurring in a large unshielded ionization chamber result from nuclear disintegrations in the chamber walls rather than from showers of electrons from the atmosphere. Similar conclusions have also been drawn by other experimenters.[2] These observations have been extended to smaller chambers by measuring bursts occurring simultaneously in two spherical chambers 3 inches in diameter and coincidences between bursts and the discharges of a counter set that detected electrons in air showers. The chambers were similar to those of R. T. Young[3] who made observations of bursts under lead shielding. A pressure of 200 lbs./in.^{2} of argon was used and the bursts were recorded photographically by means of an electrometer tube, a galvanometer, and a motor-driven camera. The counter discharges flashed a lamp which also made a record on the sensitive paper. The two chambers were separated 9 cm center to center and three counter trays were placed at various distances in the same horizontal plane. The ionization produced in the chamber corresponded to that from about 10 or more electrons traversing the chamber, or to an energy loss in the chamber of about 1.5 Mev. The counter trays each had an area of 350 cm^2 and hence their efficiency for the detection of an air shower in the range of densities involved was very nearly 100 percent.

Observations were made both at sea level and at an elevation of 3500 meters at Climax, Colorado. The size-frequency distribution of bursts is approximately a power-law distribution with an exponent which increases slightly with increasing size of burst. For the integral distribution the exponent is about 3. It was found that no coincidences between the chambers or between chambers and counters occurred that could not be explained by the finite resolving time of the apparatus. This resolving time was determined by the galvanometer period and by the speed of the photographic recorder and was found to be 1.5 sec. The fraction f of the bursts which were coincident fortuitously is equal to $2NT$, where N is the rate of occurrence of the bursts and T the resolving time. The observed values of N were between 100 per hour and 10 per hour and hence f was between 8.6 percent and less than 1 percent, depending on the sizes of bursts considered. Similarly the observed triple coincidences could also be accidental. We must conclude therefore that air showers do not contribute appreciably as a cause of the bursts in these chambers.

Since the chamber walls were thin ($\frac{1}{32}$-inch steel) and care was taken to remove all heavy material from the neighborhood of the chambers, cascade showers produced locally also cannot be the cause of the bursts observed. Heavily ionizing particles must therefore be invoked. By a lucky accident, one of the spheres was contaminated with a source of alpha-particles and observations made at low pressure showed about 10 times as many bursts in one chamber as in the other. At the high pressure[3] used, however, the numbers of bursts in the two chambers were the same. The alpha-particle ionization was suppressed by recombination in the weak field near the chamber walls and did not contribute. The bursts must therefore be explained by heavily ionizing particles of long enough range to bring them within the high field region of the chamber. Protons, fast alpha-particles, and slow mesons produced by nuclear disintegrations in the chamber walls remain as possible sources of the ionization bursts. From the known range-energy relation, a single slow meson would have to have an energy between 4.1 and 1.5 Mev to produce a burst. It seems unlikely that many such particles are present.

* A preliminary account of these observations was presented at the Cambridge meeting of the New England Section of the American Physical Society, May, 1948.

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1 C. G. Montgomery and D. D. Montgomery, Phys. Rev. **72**, 131 (1947).
2 Bridge, Hazen, Rossi, and Williams, Phys. Rev. **74**, 1083 (1948); H. Carmichael, Phys. Rev. **74**, 1667 (1948).
3 R. T. Young, Phys. Rev. **52**, 559 (1937).

Microwave Absorption Spectra of Paramagnetic Salts*

YU TING, ROY C. WEIDLER, AND DUDLEY WILLIAMS
Ohio State University, Columbus, Ohio
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WE have recently observed magnetic resonance absorption in the following paramagnetic salts: chromium fluoride, CrF_3, chromium bromide, $CrBr_3$, chromium sulfite, $Cr_2(SO_3)_3$, manganese tartrate, $MnC_4H_4O_6$, manganese carbonate, $MnCO_3$, manganese acetate, $Mn(C_2H_3O_2)_2$, and ferric ammonium sulfate $FeNH_4(SO_4)_2\cdot 12H_2O$. With incident radiation of wave-length 3.3 cm, intense absorption was noted when the external magnetic field was in the range 3000–4000 gauss; the observed absorption peaks were in the vicinity of 3500 gauss. In the measurements completed thus far, powdered samples of the salts were mounted in a resonant cavity. Further work on single crystals of the above salts is in progress.

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The Variational Method for the Continuous Wave Function of an Electron in the Field of a Neutral Atom

SU-SHU HUANG
Yerkes Observatory, University of Chicago, Williams Bay, Wisconsin
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SINCE L. Hulthén first formulated the variational method for the treatment of the continuous spectrum[1] in the quantum theory, several papers have appeared[2] in which his method has been applied to problems of nuclear scattering. In this note we shall generalize Hulthén's principle for the case of electron scattering by a neutral atom.

Considering first the simplest case of a free electron in the field of a neutral hydrogen atom, we have the following asymptotic form for the wave function

$$\psi_\infty=(2l+1/4\pi)^{\frac{1}{2}}\{(l/\gamma_2)^{-\gamma_1}P_l(\cos\theta_2)\sin(k\gamma_2-l\pi/2+\eta)\\ \pm(e/\gamma_1)^{-\gamma_2}P_l(\cos\theta_1)\sin(k\gamma_1-l\pi/2+\eta)\}.\quad(1)$$

(We have adopted the Bohr radius and Rh as the unit of length and of energy, respectively. The other symbols have their standard meanings.)