LETTERS

Discovery of the electron

I and many other physicists will be grateful to you and Dr Kusch for publishing his illuminating paper entitled "The Electron Dipole Moment" (PHYSICS TODAY, Feb. 1966, page 23). One detail, however, the author should be asked to substantiate or withdraw: his attempt to remove from the 19th century the credit for discovering the electron. An excellent account of the events is given in *The Life of Sir J. J. Thomson* by Lord Rayleigh (Cambridge University Press, 1942, pages 76 to 123), which every physicist should read. The contributions made by Faraday, Helmholz, Leland, G. J. J. Stoney, Lamour, C. T. R. Wilson, Rutherford, Townsend and others are all presented, but it is difficult to feel there was any error in giving credit to Thomson for the discovery of the electron in 1897.

W. B. LEWIS, the author of this letter, is senior vice president of Atomic Energy of Canada Limited, holds a PhD from Cambridge and is a Commander of the Order of the British Empire. He is a member of the scientific advisory committee for the UN and the International Atomic Energy Agency.

The following quotation from Helmholtz's Faraday Lectures of 1881 sets the scene: "The most startling result of Faraday's law is perhaps this. If we accept the hypothesis that the elementary substances are composed of atoms, we cannot avoid concluding that electricity also, positive as well as negative, is divided into definite elementary portions, which behave like atoms of electricity. As long as it moves about in the electrolytic liquid, each ion remains united with its electric equivalent or equivalents. At the surface of the electrodes decomposition can take place if there is sufficient electromotive force, and then the ions give off their electric charges and become electrically neutral" (page 90).

C. T. R. Wilson in 1896, from his observations of the "rainlike condensation on x-ray ions," deduced a good value for the ionic charge but did not publish this result (page 101).

G. J. J. Stoney introduced the word "electron" in 1891. His suggestion was adopted by Larmor and the word was taken into use by Lorentz and others. Thomson continued to use his original word "corpuscle" until much later (page 95).

A personal recollection by Lord Rayleigh reads: "In the summer of 1897 J. J. was bubbling over with enthusiasm over his work on cathode rays. The first I heard of it was from himself. . . . He began to unfold to me what he had been doing —telling me that the cathode rays had now 'turned out' to be particles, and particles quite different from atoms" (pages 93 and 94).

Thomson published, in *Philosophical Magazine* (Oct. 1897), the first successful application of quantitative methods to cathode-ray stuff. It was necessary to assume that the charge was carried on a much smaller mass than the hydrogen atom. His methods "brought into quantitative relation the current carried by or with the cathode rays, the heating effect when they impinged on a solid, the electrostatic and magnetic deflections and the driving potential difference" (page 92).

In 1899 evidence for the electron was presented by Thomson to the British Association and the French

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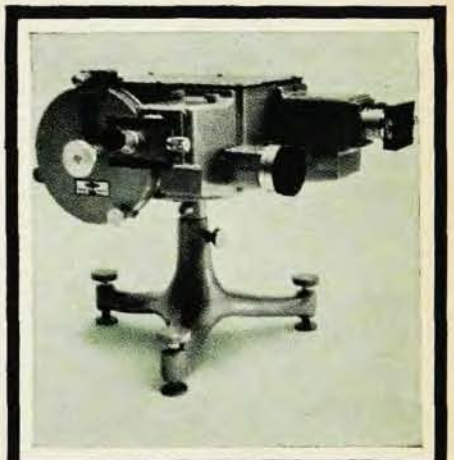

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Association. His evidence included e/m (the ratio of charge to mass) for cathode rays (5×10^7 coulombs per gram), ultraviolet light corpuscles (7.3×10^7 C/g) and incandescent carbon corpuscles (8.6×10^7 C/g), and the charge e for Röntgen-ray ions (2.2×10^{-19} coulombs) and ultraviolet light corpuscles (2.3×10^{-19} C).

Thomson concluded that the first three kinds of particles were identical and had the same e/m. Having determined e for the UV corpuscles he necessarily attributed the same specific charge to the other two. Townsend had shown the same charge on the hydrogen ion in electrolysis (page 113).

Even the variation of e/m with the energy of the corpuscles was known at about that time, and a paper by Sir Ernest Rutherford and A. G. Grier, communicated to the American Physical Society in April 1902, noted the conclusion from this theory (by then current) that "a portion of the effective mass is electrical in origin." The paper was published in the September 1902 issue of *Philosophical Magazine*.

Discovery of the electron did not wait for Millikan, who showed that ions changed the charge on oil drops by simple multiples of $\pm e$ and allowed the electric charge in the conducting plates to distribute as in a continuous electric fluid. His measurements were regarded as accurate, but unfortunately they contained greater errors than he suspected.

W. B. Lewis
Atomic Energy of Canada Limited
Chalk River, Ontario, Canada

Campus democracy

I read with great pleasure the answers given by several prominent scientists to your questions about evaluation of physics teaching ("Should Students Grade Professors?", PHYSICS TODAY, Jan. 1966, page 64). I couldn't agree more with the general opinion that evaluation of a teacher by his students is not only commendable but indispensable. Therefore I feel that further comment is needed regarding a few of the ideas expressed by one of the interviewed professors.

Professor Arnold Arons is quoted as saying, "I do not believe that a sound educational institution, with high academic standards, can possibly operate as a democracy. To see the chaos and debilitation that result from too much deference to student opinion, one has only to look at some of the Latin American universities that have been unfortunate enough to let student feedback take the form of student voice in university government."

I believe the ultimate proof that a particular university is a sound educational instituion and has high academic standards *is* its ability to operate as a democracy since its prime goal is not to teach mathematics, biology or law, but to educate human beings to live in a democratic society. When Professor Arons talks about "too much deference to student opinion," it seems to me he implicitly postulates that students don't have a natural right to express their opinions about internal university problems and that it is the faculty's deference and benevolence that give students a voice in such matters. Professor Arons sems to forget that in the ultimate analysis the students *are* the university—or at least the most important part of it. If their natural right to a voice is not recognized we may very easily fall into the paradox of having students who, as citizens, are considered old and mature enough to go to the polls and vote for the man they want to be President of the United States, but too young and inexperienced to know what may be good or bad for their small community, the university.

I was a student for seven years in Argentinian universities and a teacher for more than two years, and I can say that Professor Arons's remarks about Latin American universities are, unfortunately, true. But they are not the whole truth: the other side of the coin is that when the universities were ruled through a vertical structure, and the voice of the students not only was not heard