remedy for that great scourge, and who lost his life in Mexico City in May, 1910, from the fever which he was engaged in studying.

WE learn from the *Journal* of the American Medical Association that a campaign was opened in December in the United States to raise funds for the medical schools for women in India, China and Japan, which, if secured, would insure a gift of $500,000 from John D. Rockefeller. Dr. Tehyi Hsieh, Dr. Ida Scudder, principal of the Women's Medical College, Vellore, India, and Dr. Mabel M. Manderson, former dean of the North China Medical College for Women, Peking, toured the United States lecturing for this movement. It was announced recently by the Woman's Foreign Missionary Society of the Methodist Episcopal Church that more than $2,800,000 had been raised for the six oriental colleges for women.

ASSOCIATE PROFESSOR C. M. SPARROW, of the University of Virginia, has been promoted to a full professorship of physics.

AT the University of Cambridge, Mr. J. B. S. Haldane, New College, Oxford, and Trinity College, has been appointed Sir William Dunn's reader in biochemistry, Mr. A. Hutchinson, Pembroke College, university lecturer in crystallography, and Dr. C. Shearer, Clare College, university lecturer in embryology.

DISCUSSION AND CORRESPONDENCE

RADIATION A FORM OF MATTER: UNPROVEN

WHAT is there about relativity that compels so many of its expositors to confuse terms hopelessly, to fail to distinguish between definition and proof, to adopt a spurious logic that would never be countenanced in another connection? Can it all be accounted for by the mental confusion that usually attends the use of well-known words to denote ideas that are new and more or less foreign to those previously denoted by them? Questions of this kind arise on reading such articles as Professor A. H. Compton's letter entitled "Radiation a form of matter,"[1] in which he claims to have demonstrated "that, according to the common significance of the word, radiation must be considered as a form of matter."

His demonstration consists of two parts. First, he maintains that the existence of radiation pressure is proof that the radiation possesses mass; second, matter has been defined as "that which possesses mass or inertia"; hence radiation is matter.

That the first conclusion involves a logical fallacy should be evident to any one who is acquaintd with the thump that can be given by a compressional wave traveling along a spiral spring, even though he were unacquainted with the physics of the prerelativity era. The existence of radiation pressure shows that there is a transmission of momentum with the wave, but this does not require that the inertia concerned with this momentum pertains to and travels with the radiation.

As regards the second part of the demonstration, it should be evident that nothing new can be proven by a verbal definition. We are concerned with groups of phenomena, ideas, concepts, not with mere words. Definite words are chosen to denote definite groups of phenomena, ideas or concepts; and it is only as we comprehend these that we understand the true significance of the word.

If a word is used to denote but a single property, then its definition merely names that property; for example, "Energy is the capacity for doing work." Such definitions are equivalent to mathematical identities; having found that one of the two terms of the definition is applicable to a given case, it is a mere truism to say that the other is likewise applicable, it adds nothing whatever to our knowledge of the subject under consideration. Such definitions classify by means of a single property, connotate nothing, convey no implication either of similarity or of dissimilarity between other properties of the items that are grouped together by this classification.

If a word denotes, not a property, but a group of units each possessing many properties, some common to all units of the group, others differing from unit to unit, the proper conception of the significance of the word can be conveyed best in the manner employed in educating infants, by pointing out numerous diverse units belonging to the group. The verbal definition of such a word must be ex-

[1] SCIENCE, 52, 716, December 22, 1922.

ceedingly complex if it is even approximately complete. In practise, the definition of such a word is designed to serve merely as an aid to classification, and consists in the naming of only a few properties, in many cases of but one, that appear to be common to all units of the group and to be possessed by no unit belonging to any other group, all other properties common to the several units being connotated only. Definitions of this connotative kind can never be regarded as final, nor be used to prove that a given unit is properly designated by the word defined. If the properties of the unit in question are such as to conflict with the connotations of the definition, then the proper conclusion is that the verbal definition is unsatisfactory, that it does not serve to distinguish unambiguously from other units those of the group designated by the word defined. To adopt any other policy is to deny that there is any connotation, to claim that the word merely designates the property or properties named in the definition; in other words, to claim that the definition is of the kind previously considered.

As commonly used, "matter" and "material" denote a group of units that possess many properties; verbal definitions of them must be connotative. This appears to be recognized by Professor Compton. The use he makes of the definition is therefore invalid. In order to establish his thesis, he must show, by other than an appeal to verbal definitions, that radiation is indeed a unit of the group denoted by the word matter, that it satisfies the connotative demands.

In the first paragraph of the letter we find the expressions "conservation of matter," "conservation of mass" and "mass or inertia." The terms matter, mass, inertia appear to be regarded as synonymous. Certainly the concepts designated by "matter" and by "inertia" are quite distinct. The terms matter and material, as commonly used, refer to aggregations of what we are pleased to call atoms. Such aggregations have been found to possess both weight and inertia. It is the first of these, the one that determines the value of m in the gravitational equation, that has been found experimentally to be conserved. The second term, inertia, determines the work that is required to give the aggregation a specified velocity. The two concepts are quite different and should not be confounded. Experiments indicate that the ratio of the weight of such an aggregation to its inertia is a universal constant, the same for all such aggregations; but it should not be forgotten that this truly surprising relation has been established solely for aggregations of atoms. I know of nothing that will justify the conclusion that the possession of inertia universally implies the possession of weight. When these different concepts are kept clearly distinct, the difficulty of establishing the proposed thesis is increased. In truth, the thesis in general appears untenable.

If the words "matter" and "inertia" are redefined as identical concepts denoting a single property the quantity of which differs from energy by only a universal constant, then, and probably only then, can the thesis in general be maintained.

Redefinitions appear to be essential to the relativity theory, but they are in general unavowed and unrecognized by the expositors of that theory. Terms so redefined do *not* denote the same concepts as they did before, and much of the utter nonsense that has been written about relativity is attributable to a failure to recognize the differences so introduced. Is it superoptimistic to hope that in the near future expositors of relativity will consider carefully and inform their readers of the actual significance of the terms they use? Care in this respect, combined wih the elimination of inconclusive and invalid arguments, will be of great service to both the physicist and the layman. Incidentally, it will reduce the volume of relativity literature that one has to read; but that need not be considered here.

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RIGHT AND LEFT HANDED SPEAKERS

THE subject of right and left handedness periodically has evoked interesting discussion in the columns of SCIENCE, but I do not recall mention of a fact which I frequently have verified by observation, namely, that there are right and left handed speakers. Given an audience hall of oblong dimensions where the