On the Decay Process of Positive and Negative Mesons

M. Conversi, E. Pancini, and O. Piccioni
Instituto di Fisica della R. Università di Roma Centro di Fisica nucleare del C.N.R., Rome, Italy
October 15, 1945

SOME years ago Tomonaga and Araki[1] pointed out that on account of the electrostatic interaction with nuclei, the capture probability should be for negative mesons in dense material much greater than the decay probability; while for positive mesons the decay probability should prevail on the capture probability.

In 1941 in a direct measurement of the mean-life of mesons stopped in Al-absorber, Rasetti[2] obtained for the ratio η between decay-processes and stopped mesons the value $\eta=0.42\pm0.15$. Successively Auger, Maze, and Chaminade[3] found no essential lack from unity for η. Further experiments by Rossi and Nereson[4] (Al absorber), and by ourselves[5] (Fe absorber) gave, respectively, $\eta=0.4$ and $\eta=0.49\pm0.07$.

From the above mentioned works it seems reasonable to conclude that η is about 0.5. However, some doubt can be raised against the precision of such a value of η, considering that it is deduced from the comparison between its evaluated value and the rate of the actually registered decay-electrons, which represent only a small fraction of all the decay-processes occurring in the absorber.

Among other sources of error affecting the evaluation of η, one ought to consider the determination of the minimum delay of the registered electrons which depends on the size and shape of the counter-pulses. In order to avoid such a difficulty, in our previous work[5] we counted the delayed coincidences with little and slightly different delays and obtained from the plotted results the point "zero" of the time-scale. In order to obtain an independent determination of η and to check at the same time whether, according to Tomanaga and Araki prediction, negative mesons do not undergo the decay-process in dense materials, we performed an experiment based on the possibility of concentrating positive and negative mesons by means of magnetized iron cores.

The registering set—whose circuit has been already described in a previous paper[6]—consisted of three-fold (III) delayed-coincidences and of an anticoincidences unit. (This unit was really a four-fold (IV) coincidences unit.) It registered the decay-electrons, due to mesons stopped in a Fe absorber 3 cm thick. By means of convenient magnetized iron cores we could concentrate on this absorber alternatively positive or negative mesons. The energy of such mesons was well defined as that corresponding to the range interval between 20 cm of iron (magnetized iron cores) and 20+3 cm (absorber). We took care that the value of the magnetic induction B inside the magnetized iron cores was high enough ($B\approx15{,}000$ gauss) to concentrate on or bend away from the absorber all mesons of such an energy.

With a fixed delay we found the following results:

Concentrating positive mesons:

$$(\text{III–IV})_+=58/177^h\,16'=0.33\pm0.04,$$

Concentrating negative mesons:

$$(\text{III–IV})_-=13/168^h\,06'=0.077\pm0.02.$$

Regarding the actual result only as a qualitative one, we have not taken into account the small lack of efficiency of the four-fold coincidences.

These results point out the greatly different behavior of negative and positive mesons, so that the prediction of Tomonaga and Araki seems to be confirmed experimentally. We have not yet checked whether the small rate (III–IV)$_-$ is caused by some instrumental effect, or not. Further experiments are now in progress.

[1] S. Tomonaga and G. Araki, Phys. Rev. **58**, 90 (1940).
[2] F. Rasetti, Phys. Rev. **60**, 198 (1941).
[3] Auger, Maze, and Chaminade, Comptes rendus **213**, 381 (1941).
[4] B. Rossi and N. Nereson, Phys. Rev. **62**, 417 (1942).
[5] M. Conversi and O. Piccioni, Nuovo Cimento II, 71 (1944); Phys. Rev. (submitted for publication).
[6] M. Conversi and O. Piccioni, Nuovo Cimento II, 40 (1944).

On a Type of Kinematical "Red-Shift"

E. L. Hill
University of Minnesota, Minneapolis, Minnesota
September 29, 1945

THE work of Page and Milne on the introduction of accelerated coordinate systems in relativity theory has recently been put on a more definite basis by the explicit reduction of the transformations involved to the 4-dimensional conformal group.[1] One of the important points thus introduced is the necessary use of a 15-parameter group of transformations, whereas the corresponding classical group requires but thirteen. The purpose of this note is to indicate an interpretation of one of these new parameters which leads to a type of "red-shift" phenomenon. We use the notation of reference 1 and leave aside transformations based on X_{15}, since these do not lead directly to velocity changes. If we consider an observer situated at the origin of coordinates, but having neither velocity nor acceleration, we can still modify his coordinate system by the 1-parameter subgroup of transformations based on X_{14}. To first orders this yields the equations

$$\mathbf{r}'=(1-\alpha_{14}t)\mathbf{r},\quad t'=t-\alpha_{14}\cdot\tfrac{1}{2}(t^2+r^2/c^2),$$

which, in turn, lead to the velocity formula

$$\begin{aligned}\mathbf{v}'&=\mathbf{v}-\alpha_{14}[\mathbf{r}-\mathbf{v}(\mathbf{r}\cdot\mathbf{v})/c^2]\\&=\mathbf{v}-\alpha_{14}\mathbf{r},\ \text{to terms in } v^2/c^2.\end{aligned}$$

To this order of approximation the added term is a simple radial velocity with magnitude proportional to the distance from the observer. The sign of the velocity may be either positive or negative, and to obtain formal agreement with the observed red-shift we take $\alpha_{14}=-1.8\times10^{-17}$ sec.$^{-1}$. At very great distances, at which the radial velocity approaches that of light, the term in v^2/c^2 acts to limit the speed, but its effect is too small to be observable at present, since it amounts to only about 0.01 km/sec. at a distance of 2×10^6 parsec., at which the red-shift gives a radial speed of around 1000 km/sec. In any event the first-order approximation which has been used here would become invalid, and the calculation would need to be carried out more exactly.