WHAT HAVE WE LEARNED FROM ANNIHILATIONS AT REST?  
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I was asked to present to this symposium a critical review on annihilations at rest. Meanwhile, I recently presented a review to the Boson Conference in Boston which gives a larger perspective on annihilations and I feel that it should be part of this symposium. This review was not presented to the Symposium but instead a recent test of charge independence was presented which is likely to "reopen" the study of annihilations at rest and low energy.

This work is a collaboration between Democritos (T. Filippas, G. Gramatikakis, Th. Papadopoulou, E. Simopoulos, and A. Vayaki) and Syracuse University (L. Gray, T. Kalogeropoulos, J. Roy, and G. Tzanakos). This work will be published soon and briefly the test and results are outlined here. Charge Independence implies that in \( \bar{p}d \) annihilations (see e.g. Lipkin and Peshkin, PRL 28, 862, 1972)

\[
\bar{E}_{\pi^\pm} = 2 \bar{E}_{\pi^0}
\]

(1)

Energy conservation implies for pionic annihilations

\[
\bar{E}_{\pi^\pm} + \bar{E}_{\pi^0} = \bar{E}_{\text{Tot}}
\]

(2)

From (1) and (2) we obtain

\[
\bar{E}_{\text{C.I.}} = \frac{2}{3} \bar{E}_{\text{Tot}}
\]

(3)

\( \bar{E}_{\text{C.I.}} = (1238 \pm 2) \text{ MeV} \).

We have measured \( \bar{E}_{\pi^\pm}^{OB} \) and found

\[
\bar{E}_{\pi^\pm}^{OB} = (1164 \pm 10) \text{ MeV}
\]

(4)

or

\[
\bar{E}_{\text{C.I.}} - \bar{E}_{\pi^\pm}^{OB} = (74 \pm 10) \text{ MeV}.
\]

(5)

We estimate that the effects of \( \pi, \omega \) electromagnetic decay modes account for \( \approx 8 \text{ MeV} \) and thus do not explain the difference (5). It is our opinion that the existence of many \( \bar{N}N \) s-channel narrow resonances are responsible for this violation and for which many evidences exist.

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