The two solutions differ by about six times the uncertainty in either one. The ambiguity is expected to be resolved by future pionic x-ray measurements involving lighter atoms, where it is known with fair certainty that the K shell is almost empty during the pionic transition of interest. Such measurements on pionic oxygen and nitrogen at a pressure of a few bars have begun at the Paul Scherrer Institute [2]. We now give both Solutions A and B in the Listings below.

In the previous edition, we reported five $\pi^{\pm}$ mass measurements with uncertainties smaller than 0.005 MeV. These, together with the results from the new analysis, are shown in Fig. 1. Two of them, CARTER 76 and MARUSHENKO 77, have such large errors that there is no conflict with either A or B. JECKELMANN 86B was basically Solution A above, with a small difference (it was $0.8\,\sigma$ lower) because of the new analysis and revised wavelength calibration. DAUM 91 was based on technique (a), a measurement of the muon momentum from π^{+} decay at rest. Since their reported mass was obtained by assuming $m_{\nu_\mu} = 0$, it is really a lower limit. It is in good agreement with Solution B but disagrees with Solution A, as we discuss further below. LU 80 is compatible with Solution A but not with Solution B or with DAUM 91. A screening correction used by LU 80 came from a theoretical calculation based on a 1961 paper by Eisenberg and Kessler [3]. It would now appear that the new intensity-ratio measurements call into doubt some of the earlier input assumptions.

The DAUM 91 measurement of the muon momentum from π^{+} decay at rest has been further refined, and Assamagan *et al.* [4] report $p_\mu = 29.79207 \pm 0.00012$ MeV/c (this work has been submitted for publication). This result is close to their earlier value, but the error is much smaller. When this result is combined with Solution A, one obtains a value for $m^2_{\nu_\mu}$ that is negative by six standard deviations. By contrast, with Solution B, $m^2_{\nu_\mu}$ is negative by only about one standard deviation. (See the parallel discussion and graph in the m_{ν_μ} section of these Full Listings.)

On the grounds that $m^2_{\nu_\mu}$ ought to be nonnegative, we choose Solution B of JECKELMANN 94 as the $\pi^{\pm}$ mass. We do not average this with any other results, given the uncertainties. Obviously, however, the DAUM 91 (or Ref. 4) result determines our choice. Thus from the 1992 edition to this one, the mass has changed from 139.5679 ± 0.0007 MeV to 139.56995 ± 0.00035 MeV, a shift upwards of 0.00205 MeV, or three of the old standard deviations.

Since the π^0 mass comes from measurements of the $\pi^{\pm}$-π^0 mass difference, it too jumps upward.

Notes and References

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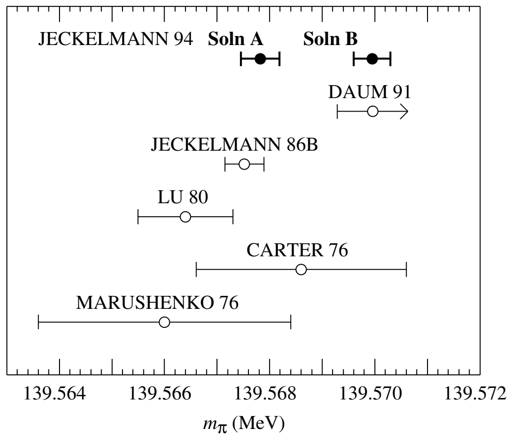

Figure 1: Published $\pi^{\pm}$ mass measurements with uncertainties less than 0.005 MeV.