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Lattice determination of the pion mass difference $M_{\pi_+} - M_{\pi_0}$ at order $\mathcal{O}(\alpha_{em})$ and $\mathcal{O}((m_d - m_u)^2)$ including disconnected diagrams.

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We determine, with Twisted Mass Lattice QCD simulations and adopting the RM123 method, the charged/neutral pion mass difference $M_{\pi_+} - M_{\pi_0}$ at order $\mathcal{O}(\alpha_{em})$ in the QED interactions and present preliminary results for $M_{\pi_+} - M_{\pi_0}$ at order $\mathcal{O}\left((m_d - m_u)^2\right)$ in the strong isospin-breaking term. The latter contribution provides a determination of the SU(2) chiral perturbation theory low-energy constant ℓ_7, whose present estimate is affected by a rather large uncertainty. The disconnected contributions appearing in the diagrammatic expansion of $M_{\pi_+} - M_{\pi_0}$, being very noisy, are notoriously difficult to evaluate and have been neglected in previous calculations. We will show that making use of the recently proposed Rotated Twisted Mass (RTM) scheme, tailored to improve the signal on mesonic observables, it is possible to evaluate the disconnected diagrams with good precision. For the QED induced pion mass difference, we obtain, after performing the extrapolation towards the continuum and thermodynamic limit and at the physical point, a value that is in nice agreement with the experimental result. For $M_{\pi_+} - M_{\pi_0}$ at order $\mathcal{O}\left((m_d - m_u)^2\right)$, the results, which are so far limited to a single lattice spacing, are in agreement with phenomenological estimates.

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