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Using Gradient Flow to renormalise Matrix Elements for B Meson Mixing and Lifetimes

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Neutral B meson mixing and B meson lifetimes are theory-side parametrised in terms of $\Delta B = 2$ and 0 four-quark operators which can be determined by calculating weak decay matrix elements using lattice QCD. While calculations of $\Delta B = 2$ mixing matrix elements are standard, matrix elements with $\Delta B = 0$ for extracting lifetimes suffer from complications in standard renormalisation procedures.
Here dimension-6 four-quark operators mix with operators of lower mass dimension using standard renormalisation procedures and, moreover, quark-line disconnected diagrams contribute.

We present work detailing the idea to use fermionic gradient flow to non-perturbatively renormalise $\Delta B = 0, 2$ matrix elements, later to be combined with perturbative input in order to develop renormalisation+matching-to-$\overline{\text{MS}}$ procedures for these operators.
The well-studied $\Delta B = 2$ matrix elements governing B mixing are first considered to test and validate the method before turning the focus to the quark-line connected $\Delta B = 0$ matrix elements.

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