Contribution ID: **25** Type: **not specified**

Flavour Physics on the Lattice

Wednesday, 25 March 2026 13:00 (35 minutes)

Flavour physics is an important area of phenomenology for performing tests of the Standard Model and searching for new physics using the rich category of decays available. These pursuits require high-precision theoretical predictions to compare to experiment, where lattice QCD has been instrumental in driving the precision of many processes. I will first give a short overview of the contributions of lattice QCD to the broader flavour physics programme, before focusing on an area of phenomenology that has as of yet received little attention from the lattice community: the lifetimes of heavy mesons.

The Heavy Quark Expansion is the framework through which such predictions can be made, describing an operator product expansion of $\Delta Q = 0$ operators of increasing mass dimension. The dimension-six $\Delta Q = 0$ four-quark operators are particularly interesting as they contribute the leading uncertainties to lifetime ratios such as $\tau(B_s)/\tau(B^0)$ and are rather similar to the $\Delta Q = 2$ four-quark operators describing neutral meson mixing which are well established on the lattice. However, the $\Delta Q = 0$ operators introduce power-divergent operator mixing under renormalisation and thus new techniques are required. I will introduce the gradient flow and its short-flow-time expansion as a renormalisation and matching strategy for $\Delta Q = 0$ four-quark operators, and show results for the operator matrix elements contributing to the lifetime ratio $\tau(D_s)/\tau(D^0)$ as an important first towards better predictions for B mesons.

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Session Classification: Session 1