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A model-independent likelihood function for the Belle II $B^+ \to K^+\nu\bar{\nu}$ analysis

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Rare decays like $B^+ \to K^+\nu\bar{\nu}$, searched for by the Belle II collaboration, are important in particle physics research as they offer a window into physics beyond the Standard Model. However, the experimental challenges induced by the two final state neutrinos require assumptions on the kinematic distribution of this decay. Consequently, the results feature a model dependency arising from both Standard Model assumptions and from the description of the pertinent hadronic matrix element, making reinterpretation complicated without reanalysing the underlying data.

In this work, we address this issue by deriving a model-independent likelihood function, parameterizing the theory space in terms of Wilson coefficients of the weak effective theory, and reweighting the signal template according to the predicted kinematic signal distribution.

By extending the pyhf fitting software and interfacing it with the EOS software for flavor physics phenomenology, we can perform a runtime update of the theoretical model, enabling us to derive exclusion limits in the space of Wilson coefficients.

Once public, the model-independent likelihood function will be a useful tool for the particle physics community to perform tests on existing theoretical models.

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