Testing the Standard Model with the LHCb experiment

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Recent experiments have established that CP violation in the quark sector of the Standard Model (SM) can be accommodated by the Cabibbo-Kobayashi-Maskawa (CKM) mechanism. These results led to the recent award of the 2008 Nobel Prize in Physics to Kobayashi and Maskawa. However, the measurements also confirm that the level of CP violation in the SM is too small to explain the matter-antimatter asymmetry of the Universe. Therefore, there must be other sources from physics beyond the SM.

An exciting possibility is that these new sources of CP violation are related to the as-yet-unobserved particles that are predicted to be discovered at the CERN Large Hadron Collider (LHC) in models (such as supersymmetry) that attempt to address some of the theoretical shortcomings of the Standard Model. In order to experimentally test these possible mechanisms of physics beyond the SM, it is vitally important to make precise measurements of CP-violating phases in as many different processes, governed by as many different quark-level transitions, as possible.

In any case, if new sources of CP violation exist in nature, as they must, they should produce effects that can be seen in measurements as deviations from the Standard Model prediction for the pattern of CP violation effects. Among existing and approved experiments, the LHCb experiment is uniquely capable of reaching the high precision that is needed to resolve the situation. Over the timescale of this project, results from LHCb could dramatically redefine the direction of research in the field of particle physics, either by observing new physics (NP) effects, or by setting strong constraints on their possible contributions.

The project will involve (at least) two aspects. The first part is to take a prominent role in the data quality assurance of the LHCb experiment, or to develop software to enhance the physics capabilities of the experiment and maximise the sensitivity to interesting physics signals. The second part will be to carry out measurements of (one or more) observables sensitive to NP effects. Both aspects will be achieved using modern computing techniques. Courses in these techniques are included as a part of the elementary particle physics group's graduate training curriculum. The project will require some international travel, including visits to CERN.

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