Search for new physics in $B^0 \to K^* \gamma$ decays with the Belle II experiment

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The highest priority of the experimental particle physics community is to discover signs of physics processes beyond the Standard Model. One on-going approach consists in exploring the energy frontier at the LHC with hadron collisions. Another powerful and complementary way relies on the study of e^+e^- collisions at the intensity frontier. Such a system allows exploring in details quantum properties of particles, benefiting from the relatively simple final states resulting from these collisions. The SuperKEKB collider located at KEK in Japan offers this opportunity. From 2018, SuperKEKB will provide e^+e^- collisions at 10.6 GeV with the highest worldwide luminosity. The Belle II experiment will record these events for the study of the *B-Bbar* system with an unprecedented precision.

The radiative decay $B0 \to K^* \gamma$ features a sensitivity to physics processes beyond the Standard Model in various ways, which makes its study very attractive. First, the initial and final states are CP eigenstates so that this decay channel allows measuring CP-violation effect. Secondly, the elementary process between fermions involves $b \to s \gamma$ transition, which only proceeds through a second order diagram involving a weak boson in the Standard Model. New physics is expected to introduce new bosons and potentially significantly modify the expected small standard cross section for the process. Finally, the vector-axial coupling of the standard weak interaction constrains the polarization of the emitted photon. New physics does not necessarily follow the vector-axial scheme and could in that case change the photon polarization distribution expected from the Standard Model.

Experimentally, we propose to search for potential effects beyond the Standard Model through a measurement of the time dependant analysis of the asymmetry in the $K^*(\to K^0_s \pi^0)\gamma$ final state. Indeed, this asymmetry depends on CP-violation parameters sensitive to new physics effects mentioned previously. This is an ambitious measurement exploiting the full potential of the Belle II detector and various advanced data analysis techniques. Three decays have to be reconstructed, with charged particles for the K^0_s, with photons for the π^0 and finally the B^0. The efficiency to identify this decay chain relies on the the vertex detector, the tracker and the calorimeter. To build up an asymmetry, the particle or anti-particle type of the neutral *B* meson has to be identified through the partial reconstruction of the other *B* meson present in the event. Finally, the time reference requires the evaluation of the distance between the decays of the two *B* mesons.

The first year of the thesis will be devoted to the phenomelogical understanding of the measurement with respect to New Physics and the Standard Model as well as the preparation of the analysis tools. During the second year, the student will commission the analysis with the very first Belle II data, potentially using simpler *B* decay channels, while the full analysis with a statistics equivalent to the existing measurements (~1 ab^{-1} obtained with BaBar and Belle experiments) will be reached at the beginning of the final year.