Internship proposal : Study of charmless b-hadron decays with the LHCb spectrometer.

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The **LHCb experiment** , operating at the Large Hadron Collider at **CERN**, has successfully recorded proton collisions since the LHC Run I at center-of mass energies of 7 TeV (2011) to the end of Run II at an energy of 13.5 TeV (2018). Thanks to a robust and flexible trigger system, the integrated luminosity reached the level of $9\,\mathrm{fb}^{-1}$. The Physics objectives of the LHCb experiment consists in the high **precision studies of rare decays and** CP **violation phenomena** in the heavy flavours (b, c, and τ) sector.

The charged current quark flavour transitions are described in the **Standard Model (SM)** by the **Cabibbo-Kobayashi-Maskawa (CKM) matrix**, which relates the quark mass eigenstates to the electroweak eigenstates. This is **intimately linked to the spontaneous symmetry breaking** of the electroweak symmetry. The existence of a non vanishing phase in that matrix is the unique source of CP violation in the SM and most of what we can learn experimentally on this quantity is brought by the observables belonging to the b-hadron decays and mixing phenomena.

The LHCb experiment started at the moment when the B-factories experiments (BaBar and Belle) completed their Physics program. The science produced at these facilities is simply impressive. The **KM paradigm** is actually established as the **main source of** CP **violation at the electroweak scale**. Yet, there are strong indications (mostly driven by cosmological observations) that **new sources of** CP **violation must exist**. The LHCb experiment is expected to **improve the precision on CKM parameters** in particular (it already did in some respects) and constrain further if not unravel these new CP violation sources. The Physics analyses developed in our group belong to this framework.

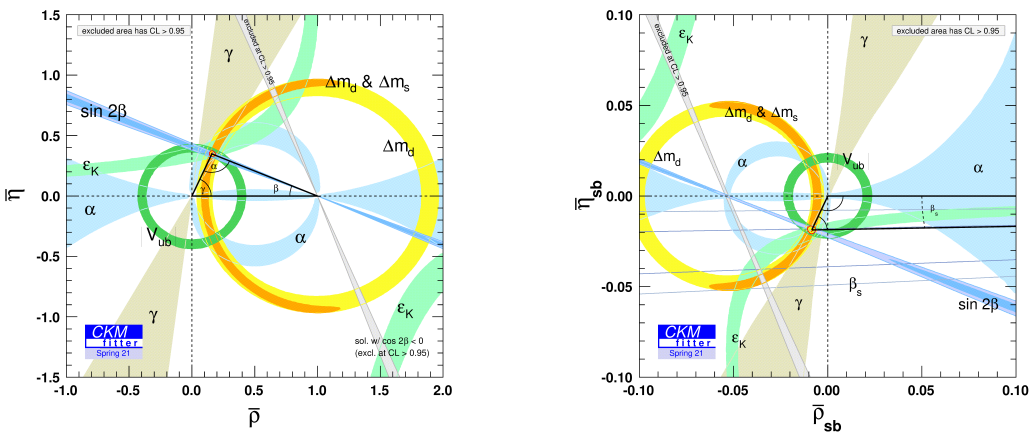

FIGURE 1 – Unitarity triangles related to β (left) and β_s (right).

Our team aims at measuring the weak phases which govern the amplitudes of the B_d^0 and B_s^0 mixing phenomena, which can be identified in the SM with the CKM angles β and β_s (Figure 1). This can be realized by means of **Dalitz plane analyses of the charmless 3-body decays** of these mesons, including a K_S^0 in the final state. These measurements are requiring advanced techniques of the **decay amplitudes determination** as well as **decay proper time reconstruction**. The internship subject will consist in installing the latter technique in the current framework we've developped, relying on the last developments reported on the last theses defended in our group.

The internship's subject can be **prolonged towards a PhD. program**.

Keywords : LHCb, LHC, ElectroWeak Standard Model, CP violation, B Mesons Mixing.