

Proposition de sujet de stage M2 / M2-Internship Proposal

2023-2024

A new approach to measuring $B \rightarrow K \nu \bar{\nu}$

Description :

The rare decay $B \rightarrow K \nu \bar{\nu}$ is a process generated by an underlying $b \rightarrow s$ quark current. This is a so-called flavour-changing neutral current (FCNC), in SM suppressed because of its specific symmetry structure. As a result, FCNC processes like $B \rightarrow K \nu \bar{\nu}$ are sensitive probes of new dynamics, because the SM “noise” is structurally small. $B \rightarrow K \nu \bar{\nu}$ actually represents a **milestone** of the Belle-II program. The challenge is to identify a single track (the K) produced from B that decays nearly at rest. To meet the challenge, one relies on a recoiling system, represented by another B (known as the “tag B”), whose decay is fully reconstructed.

We advocate the use of **new kinematic variables** that allow to drop the requirement that the tag-B decay be fully reconstructed. These variables were introduced to search for supersymmetry-like events, namely pair-produced heavy particles decaying semi-invisibly. These variables are varieties in the space of the event momenta, and by construction they extremize over the un-known momenta of the undetected particles. The extremization can be performed with a number of additional constraints, which give large room for maneuver in the definition of these variables.

Importantly, **the application to our problem** – of pair-produced meson decays – **is entirely novel** and could lead to a breakthrough in the identification of high-level variables for signal/background separation.

The thesis will be jointly:

- theoretical – on the design of the kinematic variables in the context of a scalable library, and
- experimental – on a full-fledged application to $B \rightarrow K \nu \bar{\nu}$, potentially leading to a standalone measurement.

The thesis will be in co-supervision EXP/TH. The student will be **based at IPHC Strasbourg**, and will perform at least a 6-month visit to **LAPTh Annecy**. Close interaction with an external collaborator from South Korea is anticipated. We are thus seeking an ambitious and talented candidate for a PhD subject concurrently theoretical and experimental, and willing to embark on a highly competitive measurement.

Ouverture vers un sujet de thèse : OUI

Mots-clefs : kinematic variables for collider events ; Belle II ; rare B decays

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