IL NUOVO CIMENTO Vol. 34 C, N. 6 Novembre-Dicembre 2011
DOI 10.1393/ncc/i2011-11043-4

Colloquia: IFAE 2011

Sensibility study for $B \rightarrow Invisible(+\gamma)$ decay with the BaBar detector

A. Rossi on behalf of the BaBar Collaboration

Università di Perugia and INFN, Sezione di Perugia - Perugia, Italy

(ricevuto il 29 Luglio 2011; pubblicato online il 4 Novembre 2011)

Summary. — We show prospects for research of invisible decays of B meson in a sample of about 470 millions $B\bar{B}$ pairs recorded with the *BABAR* detector at the SLAC PEP-II B factory. The Standard Model predictions for a B decay with completely invisible final products (or with a single photon as detectable particle) are far from the current experimental sensitivities but several New Physics Models predict significant enhancements on the branching ratio of these decays. The analysis technique consists in the reconstruction of a semileptonic B decay on one side and in the search of missing energy or missing energy plus one photon in the recoil. We will describe the search techniques and provide the expected sensitivities for these decays.

PACS 13.20.-v – Leptonic, semileptonic, and radiative decays of mesons.
PACS 13.20.He – Decays of bottom meson.

1. – Introduction

In the Standard Model (SM), a weak decay such as $B^0 \rightarrow$ invisible $(+\gamma)$ can only occur through second-order diagrams like those shown in fig. 1.

All these processes are highly suppressed within the SM. Like all purely leptonic B decays, they contain a $b \rightarrow u$ transition plus an internal quark annihilation, that further suppresses the amplitude with respect to rare semileptonic decays. In addition, helicity suppression factors proportional to m_ν^2 make the $\nu\bar{\nu}$ channel completely undetectable in the SM scenario. For the $\nu\bar{\nu}\gamma$ channel the latter factor is not present resulting in a SM branching fraction expectations at the 10^{-10} level [1]. Several new physics models predict enhancements of these branching ratios up to values close to the experimental detection: a phenomenological model motivated by the observation of an anomalous number of dimuon events by the NuTeV experiment where the Lightest Supersymmetric Particle (LSP) has large couplings with b quarks as well as models with a large number of extra dimensions are explained in [2] and referenced therein.

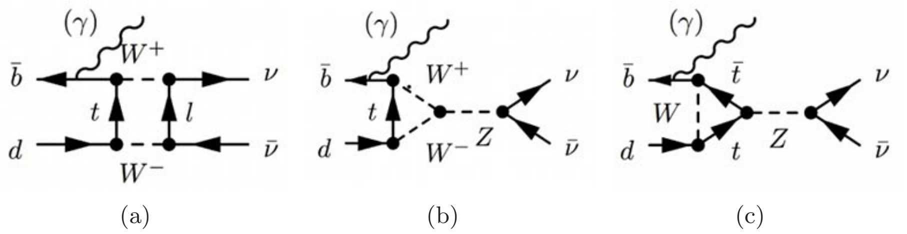

Fig. 1. – The lowest-order SM Feynman graphs for $B^0 \to$ invisible $(+\gamma)$ decays: (a) box diagram, (b) and (c) weak annihilation diagrams.

2. – Sensibility study

The search for invisible and invisible $+\ \gamma$ B^0 decays is perform in the recoil of a semileptonic B decay ($B^0 \to D^{(*)-}l\nu$ and charge coniugates), this kind of search have been previously performed in *BABAR* [2], using about one sixth of the final statistics collected by the experiment during the data-taking period. Upper limits were set of 2.2×10^{-4} on $\mathrm{BR}(B^0 \to Invisible)$ and 4.7×10^{-5} on $\mathrm{BR}(B^0 \to Invisible + \gamma)$ at 90% of confidence level.

At this time an update of this analysis is in progress and the main difference with the previous are:

- Full *BABAR* dataset: $430\,\mathrm{fb}^{-1}$
- Improved particles identification selectors
- Data-driven background estimation to reduce dependencies on data–Monte-Carlo disagreement
- Multivariate analysis method for both tag and signal side selection

With respect to the previous analysis this search is expected to have about the same signal efficiency but much lower background contamination thanks to the improved particles identification selectors and the higher rejection power achieved with a Neural Network technique. The main background sources are represented by combinatoric reconstructions of kaons and pions which result in misreconstructed B decays for the $B^0 \to D^{*-}l\nu$ tag and by $e^+e^- \to c\bar{c}$ events for the $B^0 \to D^-l\nu$ tag. In this last case a real D meson is reconstructed and with an electron (or muon) could mimic the signal, in the $B^0 \to D^{*-}l\nu$ tag this kind of background is lower due to the fact that it is less likely to reconstruct a D^* since a very soft pion or photon is needed.

Preliminary studies, with a cut-and-count approach and considering only statistical uncertainties, shows that the results can be improved down to $\sim 4\times10^{-5}$ on $\mathrm{BR}(B^0 \to Invisible)$ and $\sim 8\times10^{-6}$ on $\mathrm{BR}(B^0 \to Invisible + \gamma)$.

REFERENCES

[1] Adler S. *et al.* (BNL-787 Collaboration), *Phys. Rev. Lett.*, **84** (2007) 3768.
[2] Aubert B. *et al.* (*BABAR* Collaboration), *Phys. Rev. Lett.*, **93** (2004) 091802.