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C. Caso:

# B PHYSICS FROM DELPHI AT LEP

Invited talk given at the
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Ho Chi Minh City, Vietnam, October 21–28 1995

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# B PHYSICS FROM DELPHI AT LEP[1]

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**Abstract**

Some recent physics results obtained from the DELPHI Collaboration in the sector of $b$–physics are reported, with a special emphasis to lifetimes and spectroscopy of $b$–hadrons.

The mean $b$ lifetime has been measured to be $\tau_B = 1.600 \pm 0.010$ (stat) $\pm$ 0.028 (syst) ps investigating its decay length distribution. The lifetime of the $B_s^0$ meson has been determined using 4 independent and complementary methods and the combined result turns out to be $\tau_{B_s^0}$ = $1.54\ ^{+0.19}_{-0.15} \pm 0.06$ ps. The $\Xi_b$ baryon has been observed and its lifetime estimated: $\tau_{\Xi_b} = 1.5\ ^{+0.7}_{-0.4} \pm 0.3$ ps.

As for the spectroscopy, precise determinations of the $B^*$ production and decay properties are presented together with the observation of the orbitally excited meson states $B^{**}_{u,d}$, $B^{**}_s$ and of the baryon states $\Sigma_b$, $\Sigma_b^*$ and $\Xi_b$. For all these $b$–hadron states masses (or mass differences) together with production and decay parameters are reported.

[1] Invited talk given at the IInd Rencontres du Vietnam, Physics at the Frontiers of the Standard Model, Ho Chi Minh City, Vietnam, October 21–28, 1995. A condensed version will appear in the Proceedings.

# 1 INTRODUCTION

To prepare this talk I have decided to take the following attitude:

- give priority to original results, namely results where DELPHI has been either pioneering or "unique";
- give priority to results which have been made possible due to some "unique" DELPHI sub–detector (and RICH is certainly one of those);
- take into account my own personal taste too.

Following these guidelines I will then concentrate on the following subjects:

♠ lifetimes, with expectations and results on inclusive $\tau$, $\tau\ (B^0_s)$ and $\tau\ (\Xi_b)$;

♠ excited $b$–hadrons, with expectations and results on $B^*$, $B^{**}_{u,d}$, $B^{**}_s$, $\Sigma^{(*)}_b$ and $\Xi_b$.

# 2 HEAVY FLAVOR LIFETIMES

An accurate determination of the lifetimes of weakly decaying hadrons containing a heavy[2] quark is important for a variety of reasons. First of all the lifetime is a fundamental property in itself, like the mass; furthermore it allows to measure the CKM matrix element $\mid V_{cb} \mid$:

$$\Gamma(b \to cl\bar{\nu}_l) \ = \frac{B(b \to cl\bar{\nu}_l)}{\tau_b} = \frac{G_F^2 m_b^5}{192\pi^3} F(\frac{m_c}{m_b}) \mid V_{cb} \mid^2 \qquad (1)$$

Finally it is essential to understand non–perturbative hadron dynamics and to study time–dependent $B^0 \Leftrightarrow \bar{B}^0$ mixing and CP violation in the $b$–sector.

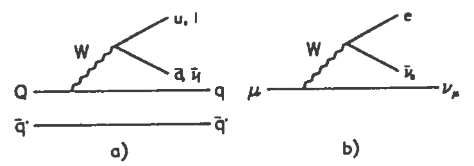


Figure 1: a) Spectator diagram for a semileptonic and hadronic decay of a meson containing a heavy quark Q; b) muon decay diagram.

Fig. 1(a) shows a sketch of the decay of a meson containing a heavy quark Q. This diagram is the so–called "spectator diagram" since only the heavy quark undergoes a decay, while its partner light quark acts as a spectator; this mechanism is considered to be the dominant decay diagram. Since the spectator diagrams are essentially the same for all particles containing a given heavy quark, one could expect that all these particles have the same lifetime.

This simple scheme of a pure light quark spectator model is in disagreement with the data in the c–sector, where we know that $\tau(D^\pm) \approx 2.5\ \tau(D^0)$, indicating significant non–spectator effects. Model dependent qualitative predictions for the c–sector are:

$$\tau(D^+) > \tau(D^0) \approx \tau(D^+_s) > \tau(\Lambda^+_c) \qquad (2)$$

which are well satisfied experimentally.

For the $b$–sector, since the spectator model is expected to be a much better approximation, one has a similar predicted hierarchy:

$$\tau(B^+) > \tau(B^0) \approx \tau(B^0_s) > \tau(\Lambda^0_b) \qquad (3)$$

[2] To quantify the term "heavy" one usually assumes $m_Q \gg \Lambda_{QCD}$. Since $\Lambda_{QCD} \approx 350$ MeV, the $b$–quark is certainly heavy and the c–quark is heavy to a lesser extent.

# References

[1] P. Aarnio et al., DELPHI Collaboration, *Nucl. Instr. and Meth.* **A303** (1991) 233; for the detector performances see DELPHI 95–112 PHYS 547.

[2] V. Chabaud et al., DELPHI Collaboration, CERN–PPE/95–86, submitted to *Nucl. Instr. and Meth. A.*

[3] DELPHI Collaboration, DELPHI 95–139 PHYS 564.

[4] T. Hessing, DELPHI Collaboration, DELPHI 95–94 PHYS 529.

[5] P. Abreu et al., DELPHI Collaboration, *Zeit. Phys.* **C63** (1994) 3.

[6] M. Canepa et al., DELPHI Collaboration, DELPHI 95–82 PHYS 517.

[7] M. Feindt, CERN–PPE/95–76, CERN–PPE/95–139.

[8] N. Isgur, M.B. Wise, Phys. Lett. B 232 (1989) 113;
M.B. Wise, Procs. XVI International Symposium on Lepton and Photon Interactions, Ithaca, New York, 1993, Ed. P. Drell, D. Rubin, p. 253.

[9] L. Montanet et al., Review of Particle Properties, *Phys. Rev.* **D50** (1994) 1173.

[10] E. J. Eichten et al., FERMILAB–CONF–94/118–T.

[11] P. Abreu et al., DELPHI Collaboration, *Zeit. Phys.* **C68** (1995) 353.

[12] D. Buskulic et al., ALEPH Collaboration, Phys. Lett. B **313** (1993) 535;
P. Abreu et al., DELPHI Collaboration, *Zeit. Phys.* **C65** (1995) 555.

[13] DELPHI Collaboration, CERN–PPE/95–53.

[14] D. Buskulic et al., ALEPH Collaboration, CERN–PPE/95–108.

[15] M. Acciarri et al., L3 Collaboration, *Phys. Lett.* **B345** (1995) 589.

[16] M. Feindt et al., DELPHI 95–105 PHYS 540.

[17] P. Abreu et al., DELPHI Collaboration, *Phys. Lett.* **B345** (1995) 598.

[18] R. Akers et al., OPAL Collaboration, *Zeit. Phys.* **C66** (1995) 19.

[19] M. Feindt et al., DELPHI 95–107 PHYS 542.

[20] R. Roncaglia et al., *Phys. Rev.* **D51** (1995) 1248.

[21] P. Abreu et al., DELPHI Collaboration, *Zeit. Phys.* **C68** (1995) 541.

[22] P. Avery et al., CLEO Collaboration, *Phys. Rev. Lett.* **71** (1993) 2391.

[23] J. I. Kroll, talk given at the 17th International Symposium on Lepton–Photon Interactions, 10–15 August 1995, Beijing, P. R. China.