

Exercises:

ICTS: Future Flavours: Prospects for Beauty, Charm and Tau Physics

April 2022

1- How long a Λ_b baryon produced in proton-proton collisions at LHC will be travelling in the detectors before decaying? ($\beta\gamma \sim 100$)

2- The charm mesons D were discovered by the MARK I experiment of the SLAC accelerator in California in 1976 and have a mass around $1870 \text{ MeV}/c^2$. In the BES experiment in Beijing (China) electrons and positrons are colliding at a c.m. energy of 4.03 GeV, creating D and D* mesons. D** mesons decay into a D⁰ and a pion. Which is the maximum momenta of the D⁰ and the pion? D*⁰ mesons are also produced, and excited state of the D⁰ with the same quark composition but with J=1. It is observed that the D*⁰ decays into a D⁰ and a π^0 , but not into a D⁺ and a π^- . Why? (Note: use PDG for the meson properties).

3- Which is the maximum momentum of the pion in the $B \rightarrow \pi \ell \nu$ decay in the lab. frame in Belle II at (SuperKEK) and LHCb (at LHC) experiments?

4- How well is satisfied unitarity from the measured CKM elements?

Note: check the individual values from the PDG:

<https://pdg.lbl.gov/2021/web/viewer.html?file=../reviews/rpp2021-rev-ckm-matrix.pdf>

5- The PEP-II accelerator at SLAC was colliding e^+e^- asymmetric beams of energies of 3.1 GeV and 9 GeV to create $Y(4S)$ states. Which was the boost of the B mesons produced in the decay of the $Y(4S)$? Was it possible to reconstruct the decay vertex of the B mesons in the BaBar vertex detector?

(the first layer of the SVT was at $r=3\text{cm}$).

6- Which was the instantaneous luminosity of the B factories KEKB and PEP-II, assuming 1585 (1722) bunches in KEKB (PEP-II) and a transversal beam size of $\sigma_x, \sigma_y [\mu\text{m}] = 77,2 (150,5)$ in KEKB (PEP-II)? Each bunch had 2×10^{10} particles and the length of the accelerator was 3Km (2.2Km). How these luminosities compare with the present SuperKEK collider?