Phenomenology of Particle Physics II

Exercise Sheet 8

ETH Eidgenössische Technische Hochschule Zürich Swiss Federal Institute of Technology Zurich

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www.itp.phys.ethz.ch/education/lectures_fs12/PPPII

Please read the article from CERN Courier dedicated to the discovery of the NC
http://cerncourier.com/cws/article/cern/29168
and the first paper recommended there:
http://www.sciencedirect.com/science/article/pii/0370269373904942

Exercise 13 [*Discovery of the NC (neutral current)* $\bar{\nu_\mu} + e^- \to \bar{\nu_\mu} + e^-$*:*]

(i) Why did one look for NC events in neutrino and antineutrino beams and not with other particle beams?
Hint: consider the level of background

(ii) How does one produce neutrino and antineutrino beams?

(iii) Why is it easier to search for NC events with a beam of muon neutrinos compared to electron neutrinos?
Hint: Compare $Br(\pi(K) \to \mu + \nu_\mu)$ *with* $Br(\pi(K) \to e + \nu_e)$

(iv) What is the advantage of antineutrino over neutrinos when looking for NC current events in purely leptonic final states?

(v) What are background sources mentioned in the paper? How could one suppress and control them?

Exercise 14 [*Question 2: Z, W decays*]

(i) Describe how you would separate the production of W and Z bosons in a $p\bar{p}$ collider experiment from backgrounds

(ii) G. Wolf, the spokesperson of the DESY TASSO experiment in 1983, said spontaneously when the discovery of the Z was announced: "Now we know that we do not have very large number of lepton families with light neutrinos." Please explain his reasoning when not only a handful of Z events were observed by UA1 and UA2. Can you find any explanation why the experimental result for the number of neutrinos is measured to be slightly below 3 ($= 2.984 \pm 0.008$).

Exercise 15 [*The precision of the leptonic W branching ratio measurements at LEP II*]

(i) Estimate the expected leptonic branching ratio of the W into a charged lepton and the corresponding neutrino. The measured BR's from the four LEP experiments are: 10.59 ± 0.17, 10.55 ± 0.16 and 11.20 ± 0.22 for decays to electron, muon and tau leptons (plus the neutrino) respectively. What is your explanation that nobody seems to be worried about the "apparent" lepton universality violation in W boson decays?

Hint: The average leptonic branching ration seems to be in perfect agreement with the theoretical expectation of about 10.8%.

(ii) Why (it hopefull is(!)) is the theoretical result a little smaller than your above estimate?

Informations relative to the exercises

Testat condition : 60% of the exercise sheets worked out and solve one exercise at the blackboard.

Exercises may be solved in groups of up to 3 people.

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