

Paper(s) 4: Width of the Z boson – Particle Physics – Summer 2016

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hand in: Mo 27.6. (in the lecture)

Reference: *Determination of the number of light neutrino species*, D. Decamp *et al.*, Phys. Lett. B **231**, 519 (1989).

Prerequisites

The Z boson propagator:

$$\frac{1}{q^2 - m_Z^2 + im_Z\Gamma_Z}$$

The $e^+e^- \rightarrow Z \rightarrow f\bar{f}$ (f any fermion) cross section near the Z boson resonance is of the form

$$\sigma(e^+e^- \rightarrow Z \rightarrow f\bar{f}) \sim \frac{1}{(s - m_Z^2)^2 + m_Z^2\Gamma_Z^2}$$

The cross section at the peak of the resonance to two fermion is related to the $\sigma(e^+e^- \rightarrow Z \rightarrow e^+e^-)$ cross section by

$$\sigma_{f\bar{f}} = \frac{12\pi}{m_Z^2} \frac{\Gamma_{e^+e^-} \Gamma_{f\bar{f}}}{\Gamma_Z^2}$$

More details can be found in chapter 16 in the book of Thompson and will be covered later in this course. However, a deep understanding of the the Z boson, its decay, and its production is not necessary to understand this paper.

4.1 Why are the muon detector located on the outside?

4.2 What is the Z boson?

4.3 Draw the Feynman diagram for a 2 photon event.

4.4 What are the other 3 experiments running at LEP.

4.5 Have a look at Fig. 4 and Fig. 5 in *Phys. Lett. B* 235, 399 (1990). What has changed?

4.6 How was the efficiency of the event selection quantified?

4.7 Something from the paper I do not understand:

Note: Bring the paper/your notes with you to the discussion session, which should be seen as a *Journal Club*.