

SHORT HW 6: Z Bump

COURSE: Physics 165, *Introduction to Particle Physics* (2018)

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DUE BY: **Thursday**, February 15

Note that this short assignment is due in class on Thursday. You have only *two days* to do it. This should be quick, I recommend doing it right after class on Tuesday.

The **propagator** for a particle with four-momentum p^μ and mass M is proportional to

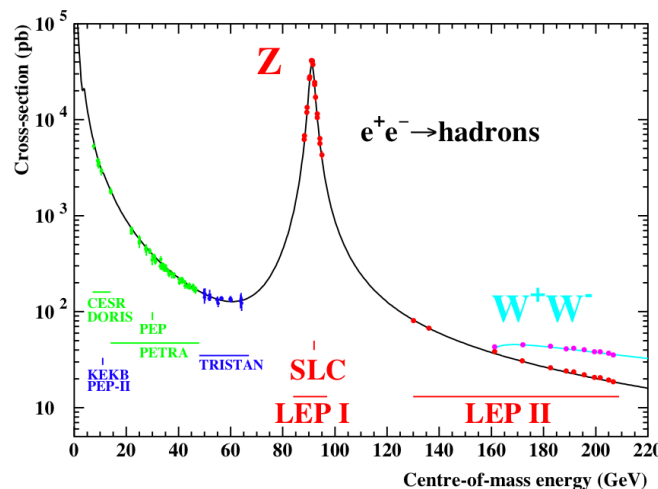
$$\frac{1}{p^2 - M^2 + iM\Gamma} . \quad (.1)$$

This means that any time you have a diagram with an internal line, the amplitude for that diagram is proportional to the above factor. The imaginary part is proportional to Γ , the **decay width** of the particle.

[Flip: 2/14: clarified part 2, added hint.]

[Flip: 3/12: I totally screwed up this problem. Parts 2 and 4 are wrong. You will only be graded on parts 1 and 3. Apologies.]

Consider the following plot that combines data from the Stanford Linear Collider and the Large Electron-Positron Collider¹:



1. What is the mass of the Z boson?
2. What is the order of magnitude of $\sqrt{M\Gamma}$? (HINT: the rate for a process goes like the amplitude times its complex conjugate.) [Flip: not counted]
3. What is the value of the Z decay width in the PDG? (Full width.)
4. The decay width directly encodes the information of the Z boson's lifetime. Based on your above answers and dimensional analysis, estimate the lifetime of the Z boson. Answer in GeV to some power. [Flip: not counted]

¹<https://arxiv.org/abs/hep-ex/0509008>