Questions and answers - Pedro Machado Lecture 2

The following questions were submitted through Zoom Q&A. Some / all may have been answered in the Q&A session already. Nevertheless, we request our lecturers to provide written answers here for the benefit of those who could not attend that session. Thank you!

(1) What are the advantages/disadvantages of using a gauge symmetry vs a global symmetry when building models? Gauge symmetries are nice because they relate to dynamics, while global symmetries are more like rules/textures for your Lagrangian. But overall, the goal is to figure out nature, so we should explore as much as possible.

(2) In the Lagrangian why is there no coupling analogous to n_L for n_R? Ie, n_R^ c n_R? There is! It is just not important for what I presented, but I have added that to the notes. Good catch!

(3) The term “kinetic mixing” has come up in several lectures. What does it mean? See the notes. The thing is that if you have two U(1) gauge symmetries, because the field strength tensor F_munu is gauge invariant, nothing forbids you to write the kinetic mixing term. That term induces lots of interesting phenomenology.

(4) What does “upscattering” mean? It is just a fancy word to say you are scattering to a heavier state. Some people also use down-scattering.

(5) Follow up on kinetic mixing, is the mixing term in lagrangian from just being allowed? Why are no interaction terms allowed? Does it have anything to do with loops? Do we get diagonal because the A-\epsilon z' or we get this A because of diagonalizing first? how do we know millicharge is milli? You can't start with writing e.g. ebar.gamma^mu.e Z'_mu because that violates gauge symmetry. All interactions with gauge fields come from the gauge symmetry itself (when you take your derivative and make it into a covariant derivative). The term "millicharged" is a bit of an abuse of language: it is just smaller than usual charge due to experimental constraints.