# Higgs Boson

AU Science Club

Jack Yurasek

December 15, 2020, 10:30 AM

# What is the Higgs Boson?

https://youtu.be/L6AN6UwTTjU

# Particle at the End of the Universe

- In his talk , Carroll describes Particle Physics and Fields, as well as the construction of the Collider, where proton are smashed into one another at speeds approaching that of light. This involves a discussion of the Four Fundamental Forces, associated Fields, and Force Carriers. Some basic background material: The study of particle physics started with Democritus (a Greek who predated Aristotle), who suggested that all matter was made of tiny indivisible pieces called atoms.

- John Dalton in the 1800s used this terminology to define chemical elements, where the atom was indivisible. We now know that atoms are made up of orbiting Electrons and a nucleus core of Protons and Neutrons. The Protons and Neutrons are not indivisible–they are made up smaller pieces, called Quarks.

- Thomson developed a 'Plum pudding Model', containing positively charged protons and negatively charged electrons.

- Ernest Rutherford was studying atoms of elements by firing beams of alpha particles through them. He expected that they would pass directly through, but discovered that some were reflected. He thus developed the model of a central core of Protons (positively charged) in the middle, with negatively charged Electrons orbiting around the core, like planets.

- Niels Bohr noted that the new model contradicted classical physics, with questions about why the electrons did not deteriorate, and result in the disappearance of atoms. He used the ideas of Plank and Einstein to develop quantum physics.

# Particle at the End of the Universe

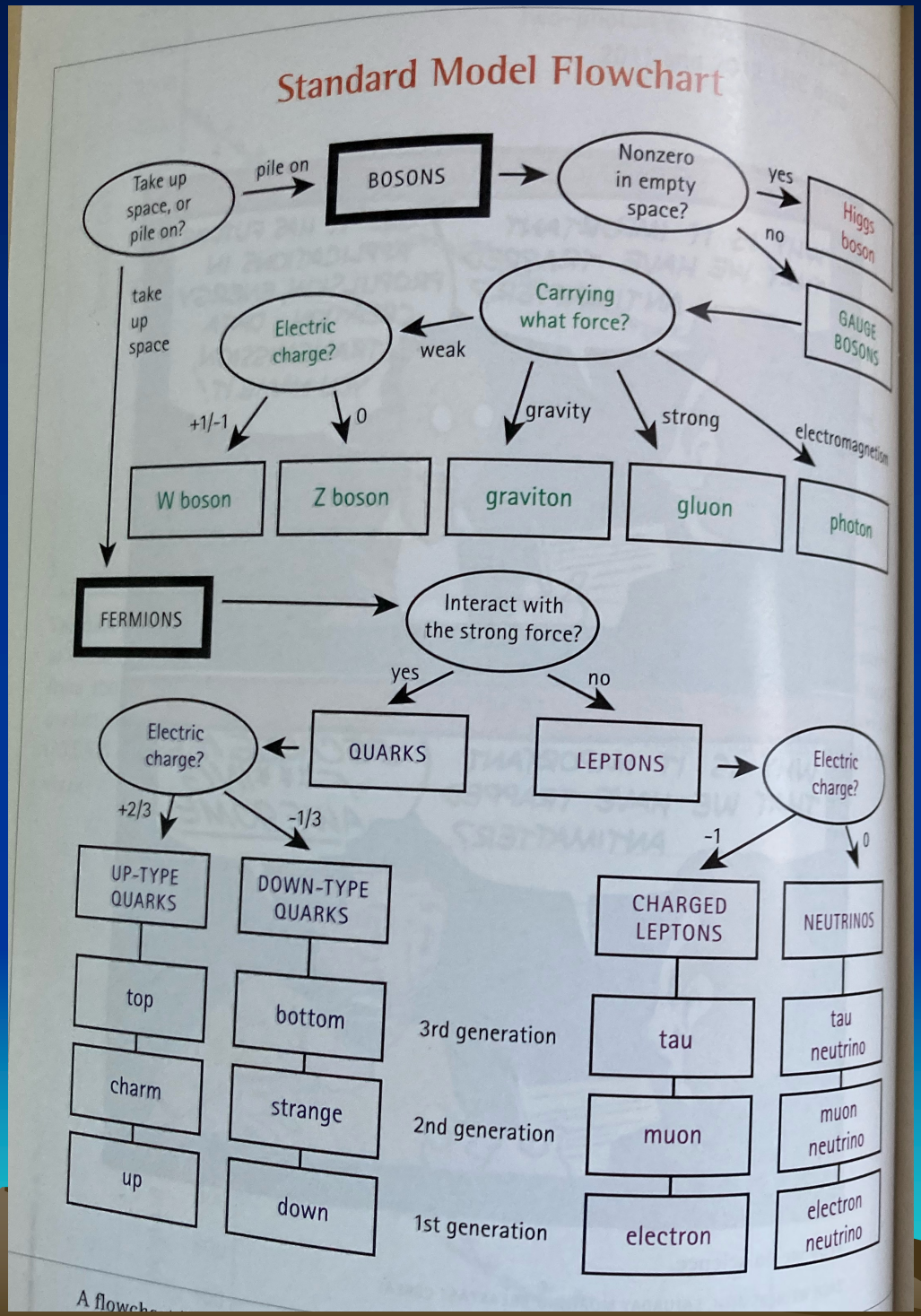
- Today, in the sense Democritus's 'atoms', the indivisible building blocks are quarks and electrons, and we refer them as 'Elementary Particles'. Two kinds of quarks (up and down) go into making the protons and neutrons of the atomic nucleus.

- Carroll explains that 'boiling' the world down three particles –the up and down quarks and electrons is great, but there are actually 12 different kinds of matter particles: 6 quarks that interact strongly and are confined inside larger collections like proton and neutrons, and 6 leptons that can travel individually through space.

- We also have 'force-carrying' particles that hold the particles together. Without force particles , individual particles would travel through space in straight lines, and never interact-no atoms, no chemistry , no life!

- The particles (Quarks, Leptons and Force) are summarized nicely in The Standard Model ZOO, and very well understood. The Higgs Boson is somewhat different –it is technically a force carrying particle. It gives mass to all other particles. Finding it was necessary to complete the understanding of the universe.

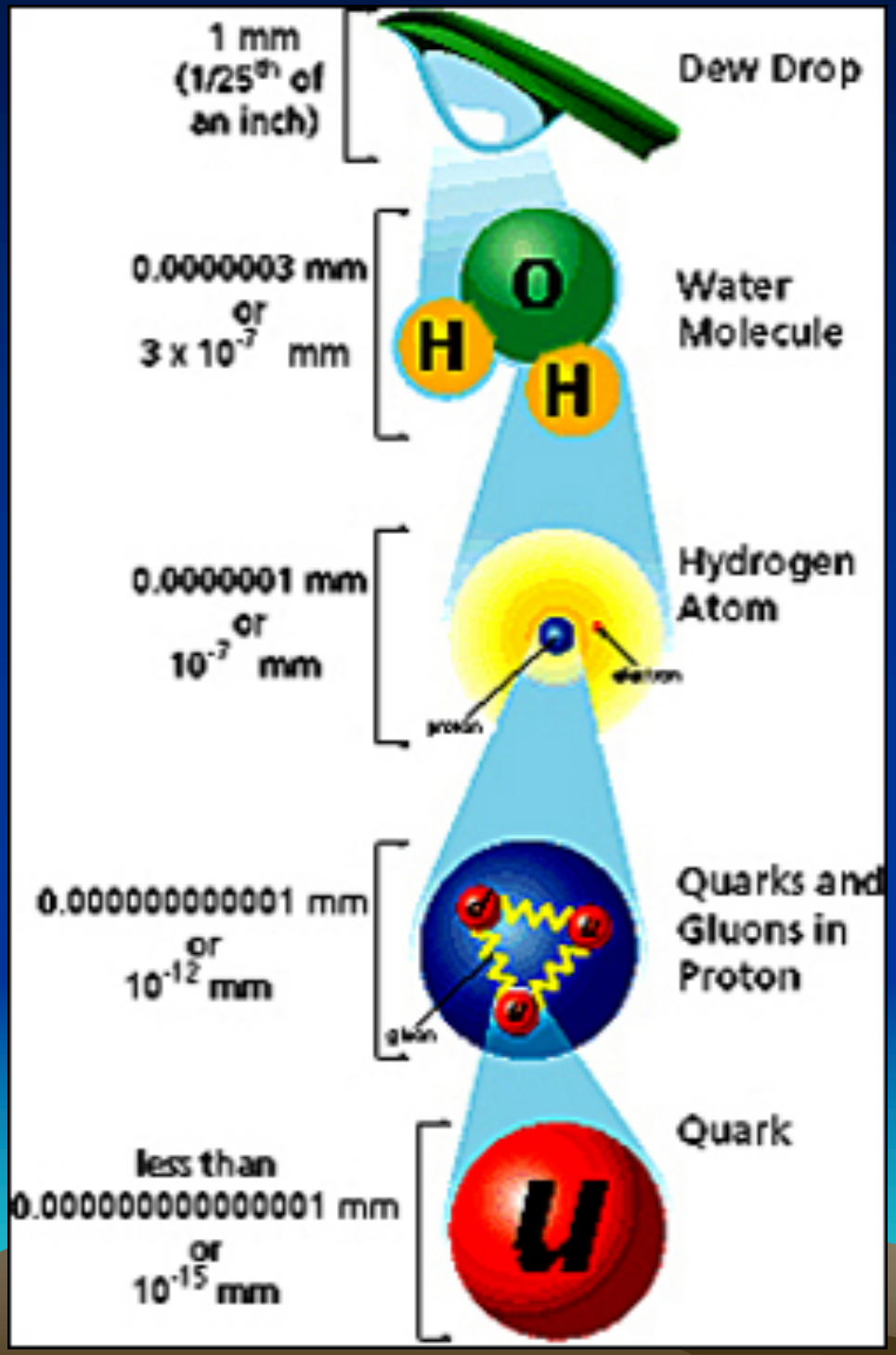
# Particle Zoo



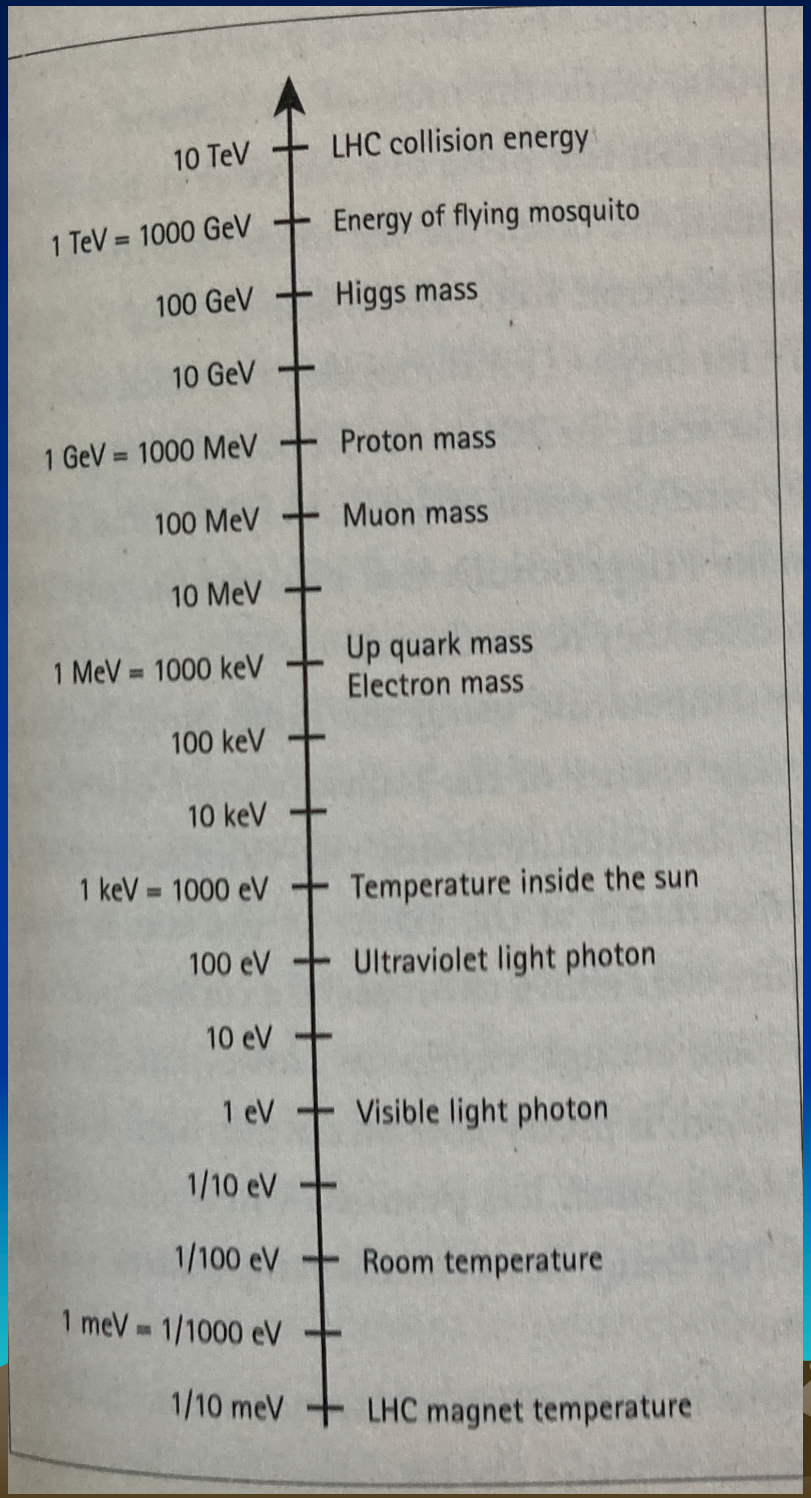
# Cern


An aerial view of CERN and the Large Hadron Collider, with major experiments

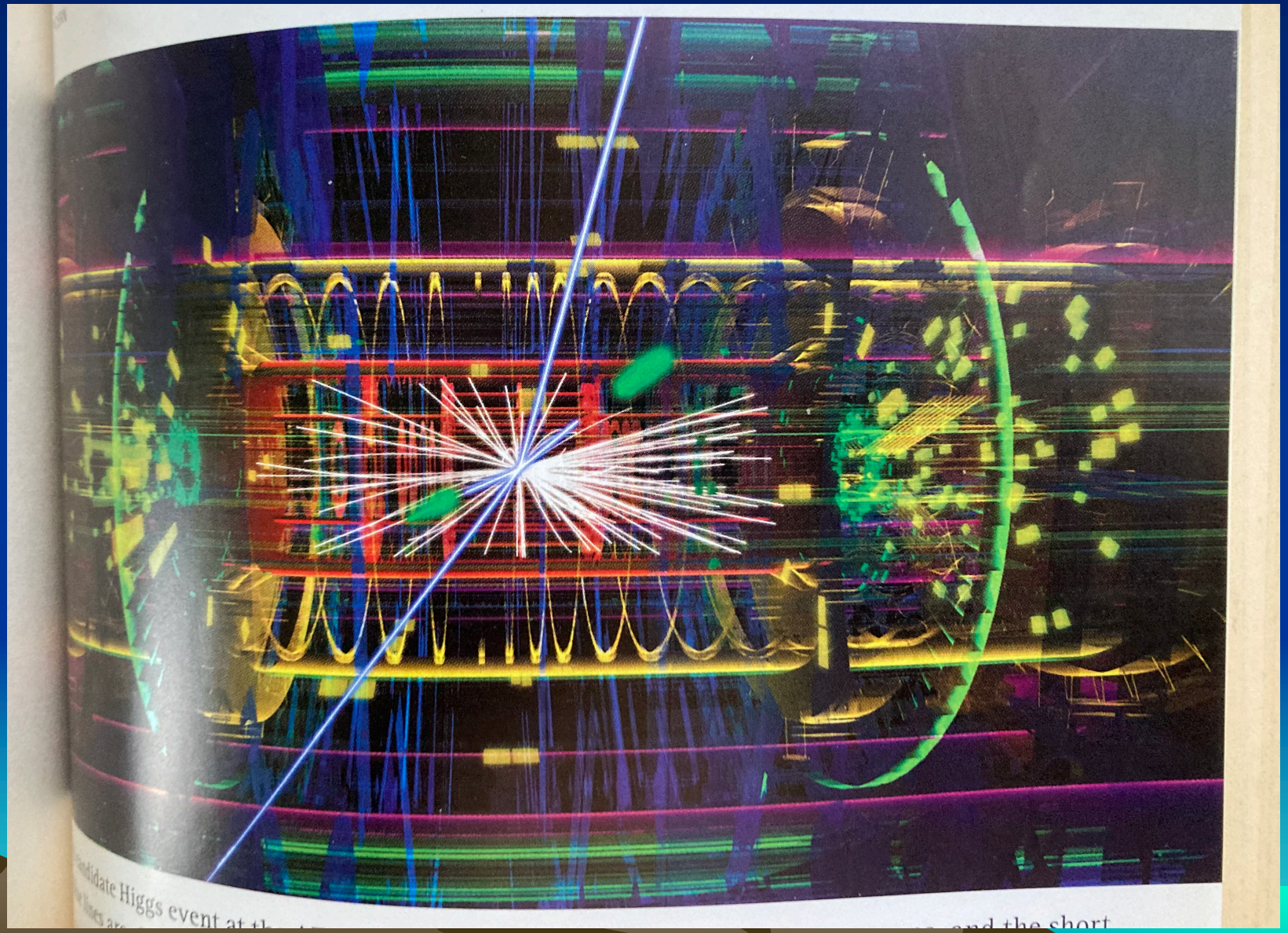
# Elemental Particles



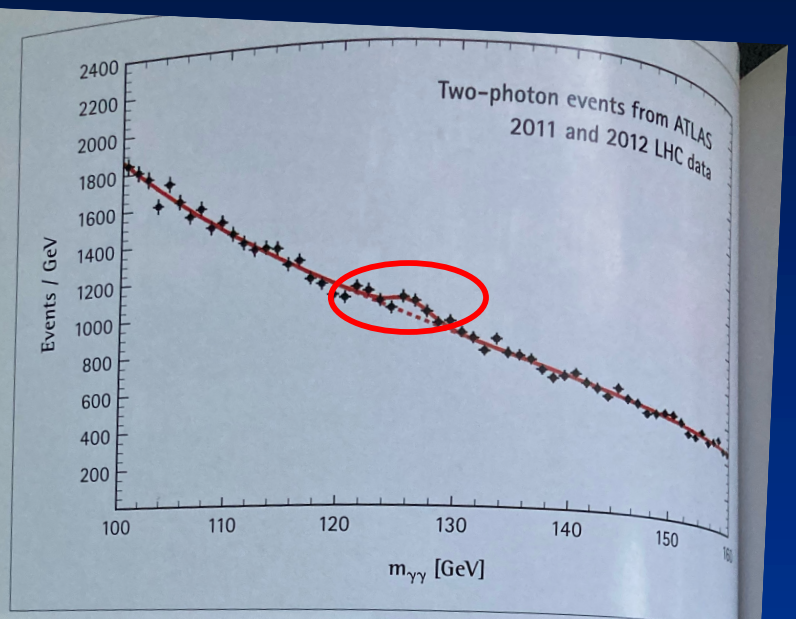
# Energy (Electron Volts)



# Particles from a Collision



# Higgs (Atlas, CMS)




The data produced and analyzed in the LHC's search for the Higgs. These plots show the numb
of events that produce two high-energy photons, where the total energy of the photons ran
from 100 to 160 GeV, in the 2011–2012 data from ATLAS and CMS. The dotted lines show t
prediction without any Higgs boson; the solid curve includes a Higgs with a mass of 126.5 Ge
(ATLAS) or 125.3 GeV (CMS).

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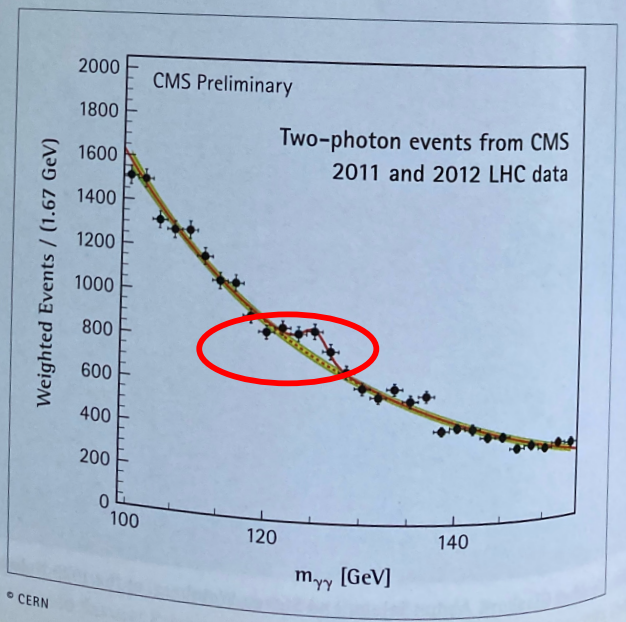


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# Particle at the End of the Universe

https://www.youtube.com/watch?v=RwdY7Eqyguo

# Discussion, Questions

# Future Planning

- Presentation Volunteers
- Guest Presenters
- Topics to Explore

- Next Zoom Meeting: January 19, 2021, 10:30 AM