Question 13

CDF M_W *vs* m_{top}

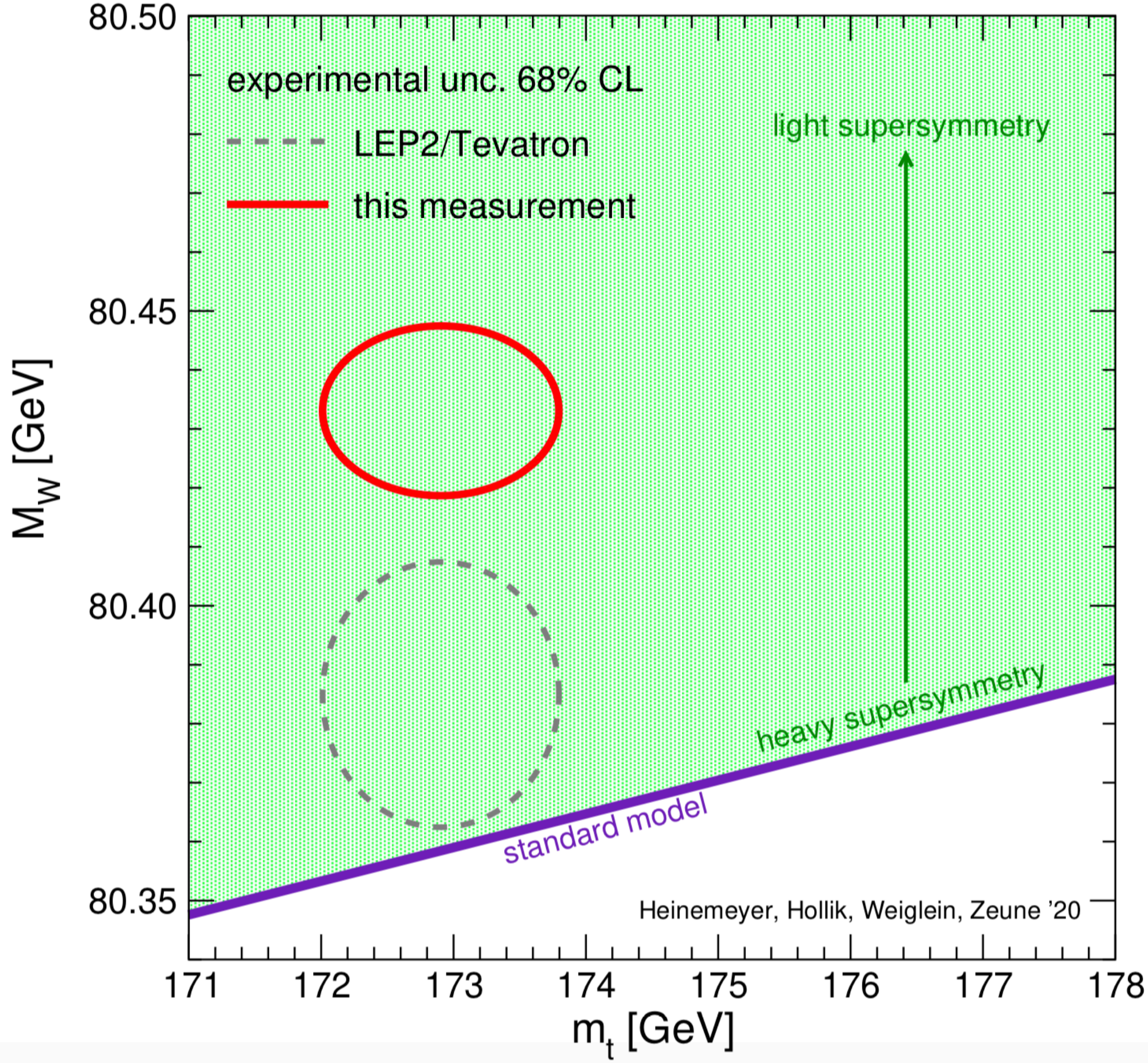


Fig. 1
from paper

7 σ (sigma) difference from Standard Model theory

(exceeds 5 sigma scientific threshold for discovery)

Synopsis

- The *W* boson mass is sensitive to new laws of nature through quantum fluctuations

- New measurement is twice as precise as previous measurements

  - M_W = 80433.5 ± 9.4 MeV

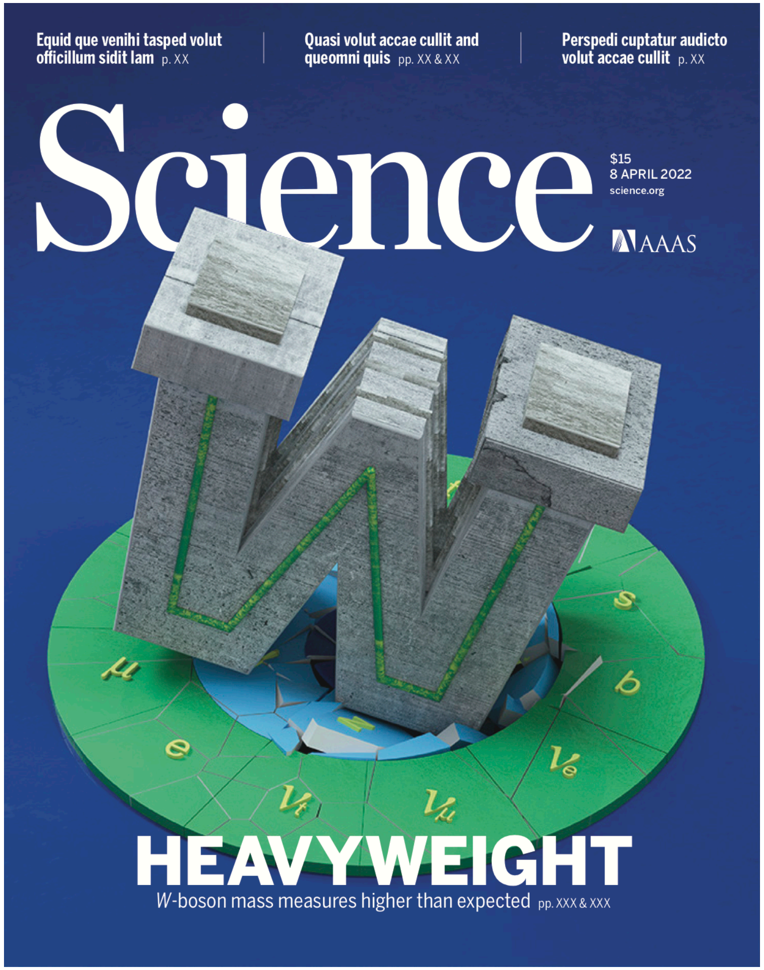
- Significant difference from Standard Model calculation of M_W = 80,357 ± 6 MeV

  - significance of 7.0σ (>5σ is considered scientific discovery)
  - The Higgs boson is not the end of the story

Question 14

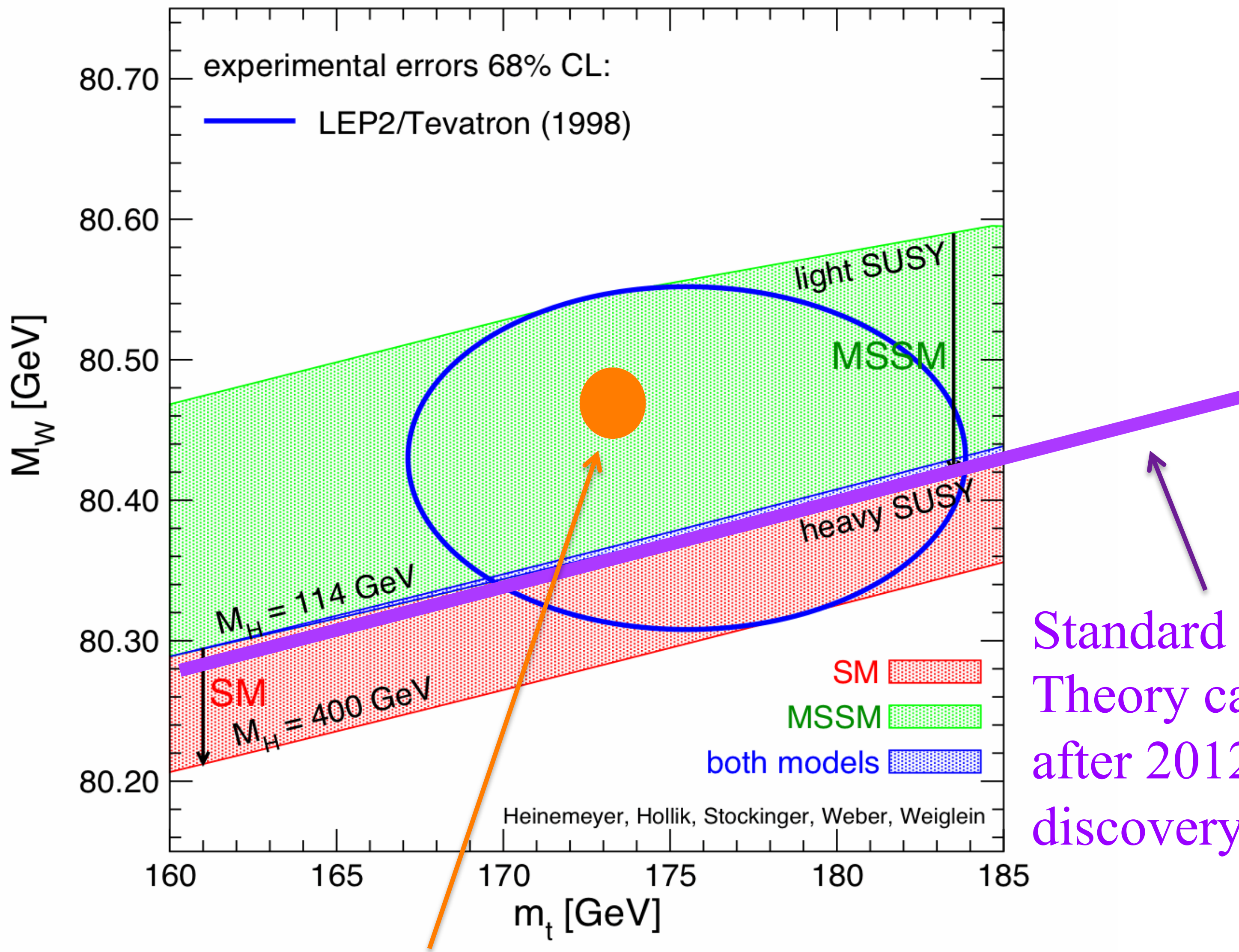
The Higgs is Not Enough

Verdict from the Heavyweight W boson



Ashutosh Kotwal
Duke University

2022 Status of M_W *vs* M_{top}



Standard Model Theory calculation after 2012 Higgs discovery

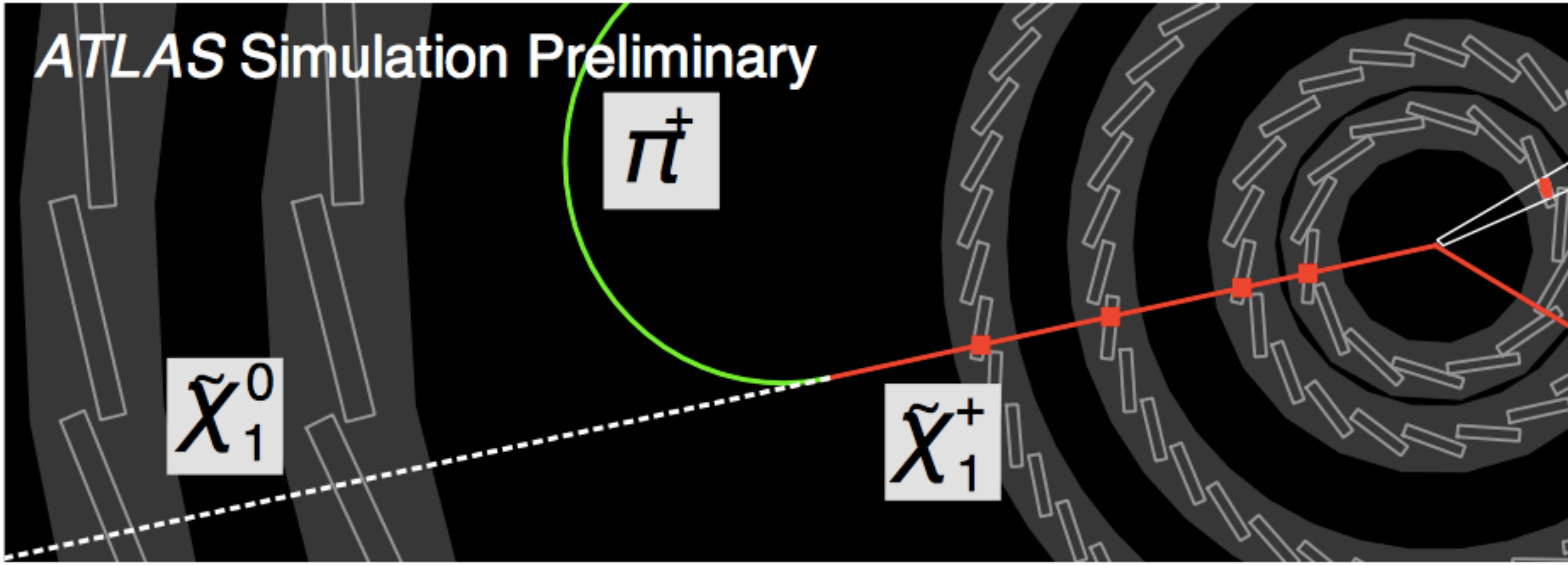
Science **376**, 170 (April 7, 2022); DOI: 10.1126/science.abk1781

Question 17

My Next Research Project

Detect Dark Matter Production at Large Hadron Collider (LHC)

Dark Matter Production at Large Hadron Collider (LHC)



Explains Dark Matter production by the Big Bang in the Universe

I have designed a silicon chip that uses Artificial Intelligence to identify this process at the LHC

Published in Nature Scientific Reports 11, 18543 (2021)

Operates 100 times faster than latest computers

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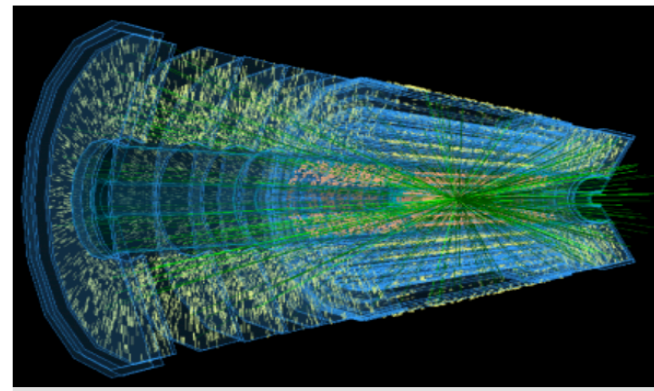
Capturing secrets of the Universe on a silicon chip

September 27, 2021

Imagine taking a snapshot of the Big Bang with a computer chip. Ashutosh Kotwal, Fritz London Professor of Physics at Duke University, thinks we may have a first step in that direction.

In a paper published last week in the journal Nature Scientific Reports, Kotwal melds two fascinating ideas from technology and physics - the use of artificial intelligence and machine learning for image recognition and the search for dark matter, the mysterious stuff that makes up 84% of the total amount of matter in the universe.



Rendering of a collision of particle beams at the LHC (Credit: ATLAS Experiment © 2021 CERN)

As a particle physicist, Kotwal is pursuing the hypothesis that dark matter is made up of exotic particles – particles that are poorly understood or that don't behave according to the known physics laws. Just like electrons, protons, neutrons and neutrinos, such stable dark matter particles would have been produced in a fraction of a second after the Big Bang, in those early moments when the universe was extremely hot.

The Large Hadron Collider (LHC) at the CERN Laboratory in Switzerland, the world's highest energy proton-proton collider, helps physicists study and understand how exotic particles are produced. Could some of the processes active at the time of the Big Bang also occur at the LHC, leading to dark matter production? And if so, how can we catch these processes in action?

The catch is that dark matter by its very nature interacts very weakly with ordinary matter. In fact, all we know about dark matter is that it obeys the law of gravity. Its gravitational effects in and around the galaxies of the cosmos have been observed. However, the gravitational force is far too weak

https://physics.duke.edu/news/capturing-secrets-universe-silicon-chip