Viewing Guide for *The Four Forces of Nature*

This is a series produced by American musician and film maker Hank Green Jr., for his YouTube series *SciShow*.

Part 1a – The Strong Force

Hank Green does a great job overall, but he does overstate a bit when he says that the strong force holds atoms together. He quickly corrects that to saying that it holds the *nuclei* of atoms together.

1) Why would the protons in the nucleus want to bust apart, as he says? (If you don't know, wait until question 6.)

2) What other particles beside quarks are the basic constituents of the universe?

3) Physicists use the term color to denote a special kind of charge that quarks have. How is color charge different from ordinary electric charge?

4) What is the enormously powerful carrier of the color force called?

5) How does the strength of the color force change with distance?

Part 2a – The Strong Force

6) Again, why do protons want to get away from each other?

7) What does Hank Green mean that the nuclear for is a residual force?

8) The gluon carries the string force inside protons and neutrons. What other particle carries the force between protons and neutrons?

9) How is the pion like a team bus?

10) And the point of the helium balloon is… ?

Part 2 – The Weak Force

11) What's the first enormous benefit of the weak force in our lives?

12) The strong force changes what physicists call the color of quarks. What does the weak force change?

13) How do up and down quarks constitute protons and neutrons?

14) What are carriers of the weak force?

15) Why is the weak force called the weak force?

16) Through the weak force, a neutron can transform into a proton and an electron. Why does that produce a different element?

Part 3 - Gravitation

17) What kinds of phenomena are explained by gravitation?

18) To review a bit, how did Newton describe gravitation?

19) Again, Hank Green made a small slip: he said gravitation is useful for predicting the planet Uranus from the orbit of Neptune. It was the other way around. But moving on, how did Einstein explain gravitation?

20) What particle might be responsible for carrying gravitation? How is it quite different from the other force carriers?

Part 4a – Electromagnetism

21) What does electromagnetism do for atoms?

22) Ouch! He used magnets with electrical charges on them to talk about charges. Sigh! Anyway, what two ways can the electric force work?

23) What particle carries the electromagnetic force?

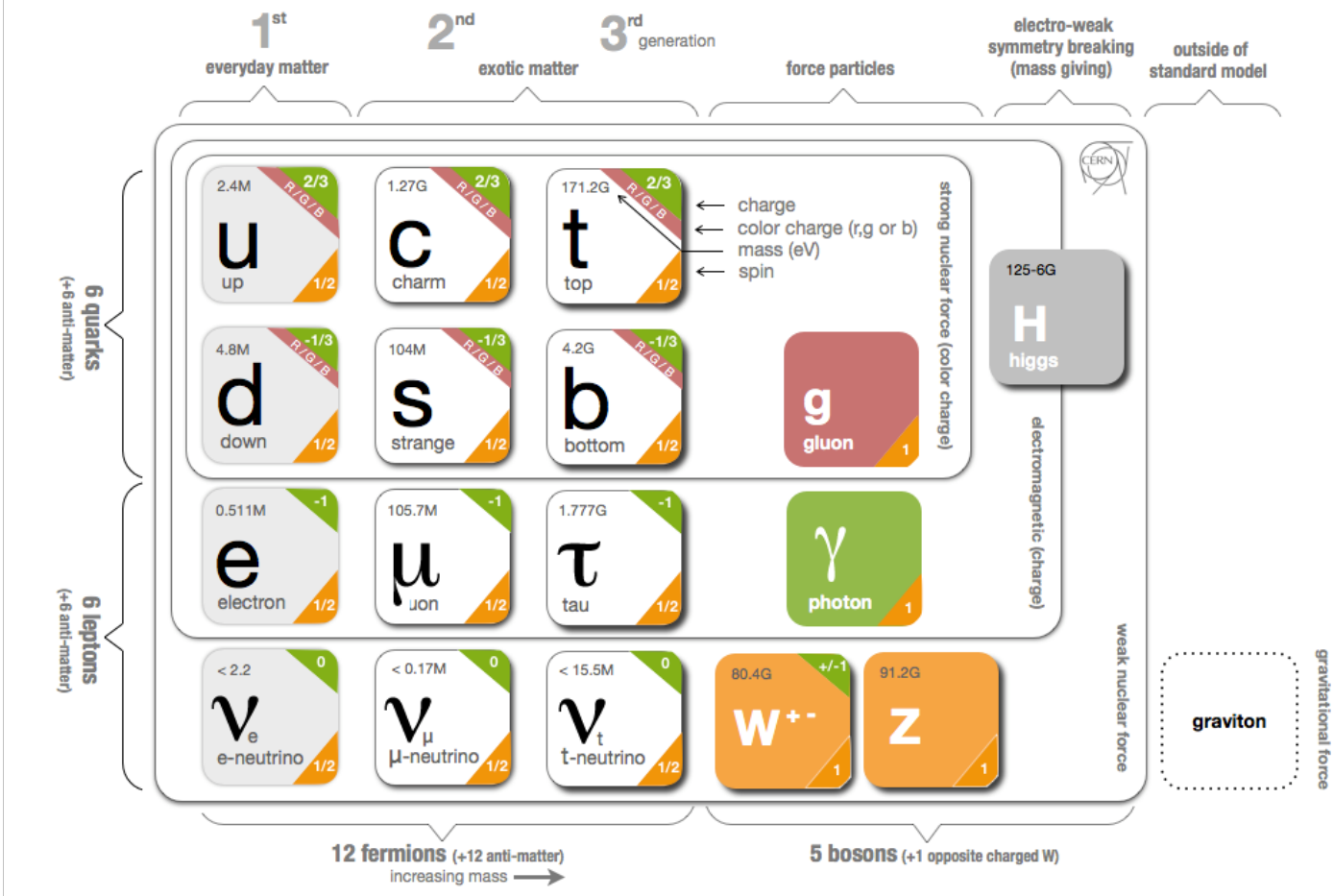
24) What is electricity?

25) What does a stream of moving electrons also create?

Part 4b – Electromagnetism

26) In what ways do we benefit from the earth's magnetic field?

27) How can a magnetic field generate electricity?



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