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Topic: Uniform Field Theory

Setting: Cortland High School Astronomy class

Objective:

The purpose of the presentation is to encourage high school students on the cusp of graduation to consider studying the space sciences (and the physical and life sciences in general) in their undergraduate and graduate years of academic study.

Too often science is presented to students as a discipline of cut and dry facts meshed with complex jargon and difficult theory. It is depicted as a “boring and tough” subject and offers little motivation for students to pursue it. However, the very nature of science recoils at this cold definition. In truth science is the study of the unknown, and its devices of study often straddle the line between genius and insanity. It is a field where little is known and much is left to be discovered. If anything, science is the antithesis of a cut and dry jargon loaded subject. To illustrate this truth about the nature of science high school students were provided a brief introduction to one of the most glaring problems in modern science: the lack of a uniform field theory bridging Quantum Mechanics and General Relativity.

Material Needed:

- Spandex Universe
(A space-time model that belongs to the CRSR Education & Outreach program, made of a large circular pvc pipe frame and a piece of spandex that is stretched taught like a trampoline. A heavy lead ball, ball bearings, and beads are used to simulate the curvature of space-time. A smaller model can be made from a large quilting hoop and spandex fabric)
- Your intellect

Presentation Structure:

I started my lecture questioning whether anyone had given any thought to time travel. I let the students muse about the subject and then I stated that relativity theory predicts forward time travel but not backwards time travel. I then proceeded to give a brief synopsis of Einstein’s Relativity theory and how objects that travel at extreme velocities experience slower time. I used the classical example of two twins in explaining this concept. Once I had established the idea of earth lines I then described how a person could time travel if they were caught at the Swartzchild radius of a super massive black hole.

I then moved the students over to the spandex universe model and demonstrated how General Relativity predicts warped space and time flow. I showed this by rolling marbles (stars) across the spandex universe and showing the students how the space around the marbles was warped (I also made them think about how this could cause orbits). I then went

underneath the spandex universe and pinched it downward to show the students what a black hole (or wormhole) is in terms of space-time warps. I expounded the fact that black holes act according to the principles of General Relativity at their radius.

Finally, I told the students one of the paradoxes of time travel that goes back to classical mechanics and relativity theory: matter cannot be two places at once (time travel into the future and meet yourself--> impossible and a paradox). I then transitioned to Quantum Mechanics and gave a brief overview of what it was. I paid particular attention to the fact that matter does not exist in a set point in space until it is observed. Before the object is observed however, it can exist in multiple places at once. I then asked the students if this contrasted with the idea proposed in General Relativity (mainly matter cannot be in two places at once). I then explained to the students that although General Relativity and Quantum Mechanics are at odds with each other in many ways (paradoxes contradict each other and solutions to a problem are different) they have both been validated by every single experiment devised to disprove them. In short I told the students that both theories are "true" despite their conflicts with another. I further told them that not only are both theories "true" but that both theories also exist harmoniously in black holes. I already mentioned the radius of a black hole acts according to General Relativity laws, but the center of a black hole is a singularity and it acts Quantum Mechanically. I then asked the students what this meant. I let them muse and then revealed to them that ultimately what this tells us is that there is a still larger theory out there that has yet to be discovered by scientists regarding the unification of General Relativity and Quantum Mechanics. This theory is that of the uniform field. I then told the students that the only way that this theory would be uncovered was if young people like them went into science and investigated these problems first hand.

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4-H group using the Spandex Universe