Introduction

One of the most important scientific quests of our time is the search for the theory of everything. This is the currently unknown theory that explains everything from atoms to the whole universe. Many scientists believe that this theory will soon be found—an exciting prospect, especially for the discoverer, who will be immortalized in history.

The present view of physics is that everything reduces to twelve particles interacting through four forces. Six particles are called quarks and six are called leptons, while the four forces are gravity, electromagnetism, and the weak and strong nuclear forces. The forces combine these particles into the atomic elements whose behavior is the subject of physics and chemistry.

Most matter around us is made up of only the two lightest quarks and one lepton, the electron. The strong force glues these two quarks together into protons and neutrons, which themselves combine into atomic nuclei. Electromagnetism attracts the electrons to these nuclei, which they orbit, to make up atoms. The weak force causes the radioactive decay of some nuclei. Meanwhile, the other force, gravity, works on the size of people and planets, and makes any mass attract another. Hence apples fall and the Earth orbits the sun.

The above view of everything seems simple, but scientists believe it is not the whole story. Most think there is a simpler theory that that underlies it all. This theory is currently not known, although it is expected to be mathematically elegant—perhaps one simple equation. Yet the best minds of several generations have tried to find this theory and failed. One major problem is that there are two very successful theories for the forces and particles, general relativity and the standard model, but they do not seem to join into one theory.

General relativity describes space, time, gravity and the universe, and was discovered by Albert Einstein in 1915. It models gravity as a bending of space and time—for example, a satellite travels in a straight line, but because space is bent it looks as if it orbits the earth. The standard model describes particle physics, and was pieced together gradually up to about 1970 by scientists such as Richard Feynman, Sheldon Glashow, and others. It uses quantum physics to describe the twelve particles and the three forces other than gravity. Quantum physics describes how matter can be both particle-like and wave-like and was discovered in the 1920s by scientists such as Erwin Schrödinger, Werner Heisenberg, and Wolfgang Pauli. Physicists have tried to apply quantum physics to general relativity, but mainly get nonsensical answers.

Many scientists believe that the theory of everything is string theory, a theory that describes all forces, particles, and gravity as the vibrations of line-like objects moving in ten-dimensional space. String theory was originally proposed as a model of protons and neutrons in the 1960s, but was disproved by the more successful quark model. In the 1980s the American physicist Edward Witten revived string theory as a theory of everything. Since then, Witten’s calculations have become the most influential work in theoretical physics. If string theory is the theory of everything, it would overthrow ideas about particles and force that date back to Sir Isaac Newton in the 17th century. This would be the most revolutionary scientific discovery ever.

String theory is not without its critics though. Opponents say that string theory makes virtually no experiment predictions. It thus does not even qualify as a scientific theory because it cannot be proved wrong. Further, string theory has recently taken most research funding, which prevents scientists from pursuing other ideas. Critics also argue that string theory has been actively researched by the best minds for over twenty years, yet scientists are still unsure whether the theory is right or even self-consistent.

On the other hand, supporters of string theory argue that it is mathematically beautiful and is the best candidate for a theory of everything. String theory also contains general relativity in a way that seems compatible with quantum physics. It thus gives a simple picture for the elementary particles and all fundamental forces. Supporters point out there is currently no believable alternative to string theory, and so it is ‘the only game in town.’

The two following articles could not take more opposing views about the merits of string theory for finding a theory of everything. Michio Kaku, in the first article, is a well-known popularizer of string theory. In his view, string theory is a beautiful idea that could hold the key to the theory of everything. Peter Woit, however, strongly disagrees. He views string theory as unscientific, over hyped, and ultimately wrong.

Summary

The debate on whether string theory is the theory of everything is probably the most contentious issue in physics today. The following two authors could not have more opposing views about this important question.

Michio Kaku, the author of the ‘yes’ article, argues that string theory is a beautiful idea that can combine general relativity with quantum physics. This is a previously unsolved problem that had defeated physicists for years. Thus, in a remarkably simple picture, string theory could explain everything from atoms to the creation of the universe. Although string theory is not yet understood, this is because it is part of 21st century physics that fell by chance into the 20th century. It is simply waiting for someone to finish it off.

Peter Woit, the author of the ‘no’ article, argues that the only part of string theory that scientists understand is mathematically inconsistent. He says that string theory makes virtually no experimental predictions and is thus not even wrong because it cannot be tested. The only prediction it does make gives the most incorrect answer in the history of science. Woit concludes by stating that string theory is dangerously over hyped, which has damaged physics by stopping people from inventing promising alternatives.

Key points

Science: Is string theory a scientific theory?
Yes: String theory combines quantum physics and general relativity, and has the potential to be a theory of everything.
No: String theory makes virtually no experimental predictions, and thus cannot even be shown to be wrong.

Alternatives: Is string theory the only choice for a theory of everything?
Yes: String theory is the only game in town.
No: The large amount of hype over string theory has diverted funding from finding alternatives.

Correctness: Will string theory be the theory of everything?
Yes: String theory is just waiting for someone to finish it off. Then it will describe everything in one simple theory.
No: String theory is mathematically inconsistent. Scientists have worked on it for two decades and still not made it work.