

SpiritPlants Radio
<http://www.spiritplantsradio.com>
Science Report
Weekend of 6.02-03.2012

Impossible: Physics Beyond the Edge
with Dr. Benjamin Schumacher

http://www.teach12.com/tgc/courses/course_detail.aspx?cid=1299

Physicists spend a lot of time thinking about impossible things, since probing the constantly shifting bounds between the possible and impossible is one of the best ways to discover unexpected phenomena and new laws of nature. And for nonscientists, exploring this extraordinary realm is one of the best introductions to the immensely rich subject of physics.

Dr. Benjamin Schumacher is Professor of Physics at Kenyon College, where he has taught for 20 years. He earned his B.A. from Hendrix College and his Ph.D. in Theoretical Physics from The University of Texas at Austin.

Episode 23: Symmetry, Information, & Probability

Survey the landscape of the impossible by focusing on three recurring themes in the course: One, symmetries are among the deepest principles in physics; two, the idea of information is pervasive; three, many phenomena that appear to be impossible are only statistical impossibilities.

Episode 24: The Future of the Impossible

Professor Schumacher concludes the course with his million-dollar list—those things he would be willing to bet a million dollars will remain impossible even in the face of future discoveries. But first he challenges you to draw on your newly acquired knowledge of physics to propose your own list.

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Weekend of 5.05-06.2012

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Episode 21: Entanglement and Quantum Cloning

Delve into the weirdest of all quantum phenomena: entanglement, which causes a pair of quantum particles to behave as if they are telepathically connected. By cloning quantum particles, this effect could, in theory, allow faster-than-light signals, but there are fundamental reasons this is impossible.

Episode 22: Geometry and Conservation

Where do conservation laws come from? How does nature "enforce" them? Investigate these questions by performing a remarkable thought experiment: See how Maxwell's laws of electromagnetism and the geometry of space together imply the conservation of electric charge, even in a theoretical "electromagnetic-free" zone.

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Weekend of 3.17-18.2012

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Episode 19: Quantum Tunneling

Discover how phenomena deemed impossible in classical physics are a regular feature of the quantum world—notably quantum tunneling, which is the ability of a subatomic particle to surmount a seemingly impassable energy barrier. One result of this effect: Black holes emit a slow trickle of energy known as Hawking radiation.

Episode 20: Whatever Is Not Forbidden Is Compulsory

Explore a startling rule in quantum mechanics: Anything that can possibly happen, will happen. This means that whatever does not happen, whatever is truly impossible among the elementary particles, provides a clue to the fundamental laws of nature.

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Weekend of 1.21-22.2012

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Episode 17: Curious Quantum World

With the discovery of quantum mechanics in the early 20th century, the accepted boundary between the possible and the impossible was changed in radical ways. Begin a series of lectures on the quantum realm with a look at three of its key features.

Episode 18: Impossible Exactness

In Newtonian physics, the position and velocity of a particle can both be specified to any level of precision. Not so in quantum mechanics, where these are limited by Heisenberg's famous uncertainty principle. Investigate the consequences of this fundamental restriction on what it's possible to know.

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Weekend of 11.26-27.2011

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Episode 15: Mirror Worlds

Inspect the universe through three special mirrors. One is an ordinary mirror that reflects left and right. Another mirror exchanges matter and antimatter. The third switches the future and the past. Is it possible to tell these mirror-worlds from our own? What does that imply about the laws of nature?

Episode 16: Invasion of the Giant Insects

Test a favorite plot device of science-fiction movies by examining whether supersize gorillas, insects as big as trucks, and other ordinary creatures enlarged to gigantic size can really exist. Is there a physical reason such monsters are in fact impossible?

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Weekend of 09.24-25.2011

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Episode 13: A Spinning Universe, Wormholes, and Such

Delve deeper into Einstein's theories to uncover some startling implications: The entire cosmos could be rotating on its axis, giving rise to several supposedly impossible phenomena, already dismissed. Weigh the evidence for and against "exotic" matter, wormholes, and other hypothetical features of space-time.

Episode 14: What is Symmetry?

Something is symmetric if it is impossible to tell whether a particular transformation has been applied. Explore this fascinating boundary between the possible and impossible, which includes some of the deepest principles of physics—among them, the surprising connection between symmetry and conservation laws discovered by mathematician Emmy Noether.

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Weekend of 08.27-28.2011

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Episode 11: Faster Than Light

Nothing can travel faster than light. Is there a way around this prohibition? Learn that it all depends on what is meant by a "thing." By considering various thought experiments, discover that this ultimate speed limit applies fundamentally to information, which means it is impossible to send a message into the past.

Episode 12: Black Holes & Curved Space-Time

Nothing can travel faster than light. Is there a way around this prohibition? Learn that it all depends on what is meant by a "thing." By considering various thought experiments, discover that this ultimate speed limit applies fundamentally to information, which means it is impossible to send a message into the past.

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Weekend of 07.09-10.2011

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Episode 9: Visiting the Past

Explore the paradoxes of time travel. These are so fundamental that most physicists regard time travel as a near-absolute impossibility, yet science-fiction writers—and a few imaginative physicists—have proposed ways to avoid these difficulties. Look into some of their intriguing ideas.

Episode 10: Thinking in Space-Time

Is the passage of time merely "a stubborn illusion," as Einstein believed? Investigate the revolutionary concept of space-time that emerges from his theory of relativity, which involved a major redrawing of the boundary between the possible and the impossible in physics.

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Weekend of 05.28-29.2011

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Episode 7: Absolute Zero

Learn how absolute zero (0 K or -273.15 degrees Celsius) is unattainable due to the third law of thermodynamics. Nonetheless, remarkable things happen on the way toward this impossible goal. For example, electrical resistance and viscosity drop to zero in certain substances, and weird quantum mechanical effects occur.

Episode 8: Predicting the Future

Consider a new kind of impossible thing: predicting the future in the presence of chaos. Even the slightest imprecision in present knowledge makes the long-term future unknowable. This is the phenomenon of dynamical chaos, also known as the "butterfly effect"—from the ability of a single flapping butterfly to radically affect future weather.

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Weekend of 05.07-08.2011

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Episode 5: Reflections on the Motive Power of Fire

Learn how the 19th-century French engineer Nicolas Carnot showed that only a temperature difference can be used to generate work, and that some waste heat must always be lost—ideas that led to the second law of thermodynamics and the important concept of entropy.

Episode 6: Maxwell's Demon

Entropy always increases in a system in which work is being done. Investigate James Clerk Maxwell's famous "demon"—an imaginary being that, in principle, appears to violate the entropy law. See how the demon paradox was resolved by interpreting entropy as information.

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Episode 3: Perpetual Motion

Probe one of the most enduring of all impossible quests: the search for a perpetual motion machine. Learn how the futility of such a pursuit was explained four centuries ago by the Flemish mathematician Simon Stevin, whose work eventually led to the law of conservation of energy.

Episode 4: On Sunshine and Invisible Particles

Investigate two challenges to the law of conservation of energy, also known as the first law of thermodynamics. In the 19th century, the source of the sun's energy seemed inexplicable, until the discovery of radioactivity. Then, in the 20th century, a type of radioactive decay appeared to violate energy conservation, until the discovery of an invisible elementary particle.

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Weekend of 03.26-27.2011

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Episode 1: From Principles to Paradoxes and Back Again

Prepare to explore the thrilling frontier that separates the possible from the impossible by first looking at what scientists mean by these two terms, and how the boundaries can shift. Professor Schumacher notes that by pondering the impossible, scientists gain amazing insights into the nature of physical laws.

Episode 2: Almost Impossible

Many technological and scientific breakthroughs were thought to be impossible before they were achieved. Examine several famous cases in which foremost experts were proved wrong—about heavier-than-air flight, space travel, the chemical composition of stars, and the existence of life forms at ultrahigh temperatures.