10.0: General Relativity Introduction

Video Transcript

> *Close your eyes, and imagine yourself in a comfortable room. Like a small recording studio, the room has no windows and is soundproofed so there is no way to see or hear the outside. There is an exit, however, and just before you are about to leave a voice over a loudspeaker says, "Be careful; watch your step. You are about to exit a moving vehicle."*
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> *How could you tell if you were in a moving vehicle, as opposed to in a building? You might wait to see if you feel yourself slow down, or if you feel the vehicle hitting potholes or going around curves in the road. But, if you are moving at a constant speed over a smooth, straight road, what could you do to determine if you were moving?*
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> *What if, instead of saying that you were in a moving vehicle, the voice over the loudspeaker said you were in a rocket in space accelerating at 1G? The acceleration due to the Earth's gravity is 1G as well. Are you really in space? How could you tell if the voice over the loudspeaker was telling the truth or not without leaving the room?*
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> *Albert Einstein had similar thoughts that led him to develop the general theory of relativity. But this theory doesn't just apply to hypothetical situations of windowless rooms on accelerating rockets; it is our most accurate theory of gravity and is important in our everyday existence.*
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> *If the general theory of relativity had not been developed our present-day world would be very different. For example, GPS systems rely on the results of general relativity. If GPS satellites used Newtonian gravity as the basis of their calculations, the positions produced by the satellites would be incorrect and they could not provide accurate directions. General relativity also provides a vital perspective for our understanding of objects like black holes and even the evolution of the Universe. Without it, our understanding of nature would be far less complete.*

Imagine you exist in a small room, about the size of an elevator. The room has no windows or any other way to see outside. Now imagine that this room is inside a rocket ship, far out in space and away from any massive objects. The rocket is accelerating at 1g, or 9.8 m/s^2. If you did not know beforehand, is there any way that you would be able to determine that you were on a rocket ship and not, say, sitting in a windowless room in a building on Earth? Is there any sort of experiment that you could do that would distinguish these two cases for you? The answer to that question might surprise you, and it will lead us to a remarkable new view of gravity, just as it did Albert Einstein more than 100 years ago.