

**MARKUS**

Welcome back to [INAUDIBLE], special relativity. So moving from special relativity to general relativity, we relax the requirement that reference frames can only have a constant relative velocity to each other. So we are looking at what happens now if you have accelerating reference frame, and the first example is that of rotational time dilation. So I mentioned you have a device which has two clocks.

**KLUTE:**

And so the first block sends its ticks up in terms of light beams, beams with some specific frequency. So there is a transmission going on, and there is a receiver on the other side. And the clock, the upper clock, u clock, submits the same things. They both have the same frequency, let's say 10 pulses per tick. We also assume now that we don't have to consider special relativity effects, yes, so the velocity of the thing is very small. OK so relativistic effects are small.

But when I now accelerate this device, there is an interesting effect. The lower clock will receive more than 10 pulses per tick, so it is perceived as running slow from the upper clock, right. So the lower clock is expecting 10 ticks, but it's seeing 12, so you think that your clock is running slow. Similarly you can discuss the upper clock, which because it's accelerating upwards, it only receives 8 pulses per tick.

So it's expecting 10, so it's perceived to be faster. Now, this acceleration as in this example, as I've discussed previously, is equivalent to being in a gravitational field. So we have a time dilation effect on us. We already discussed the consequence in the discussion of GPS systems. Here is a summary of this plot, and just showing you the effect of changing gravitational fields as a function of the distance of the center of the Earth.

And you see that the rotational speed-up,  $\Omega$  on the Earth's surface, becomes rather large the further away you get from Earth, while if you consider that the object, a satellite, in an orbital motion, the speed of this object is kind of compensating partially. But there is this net effect, as we discussed earlier, on the GPS system.