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PHYSICS AND THE ARTISTIC IMAGINATION

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2018

ON TIME:

Peter Galison

Time is something that for us evokes ideas of mortality and our humanity at its most essential form, but that also stands absolutely central to the ideas of Newton and Einstein and more recent ideas about the nature of the physical universe. It's that cross-connection that fascinates me, that doubling up between our human, very visceral, immediate understanding of our lives and our place in the world and the larger structure of the universe.

As a small child, what really struck me was that my grandfather, whom I adored, had a collection of clocks – fantastic and beautiful clocks mostly from late-nineteenth-century Paris, but also from Vienna, Berlin, and other places. Every morning he or my grandmother would walk around the house and wind them as if they were watering plants. I remember looking at them, at the mercury, pendula, and some of the clocks, or hearing the way they clicked or chimed or opened. I found that absolutely fascinating.

I learned relativity before I learned proper Newtonian mechanics. I started out by thinking that it was normal for every observer to have his or her own time and own measures of space. [Einstein's Theory of Special Relativity, 1905, which is in opposition to Newton's idea that time is universal and constant.]

I thought that was completely the way things were done. In a sense, I've tried to compensate for that with my own students by really trying to have them understand what a shock it was to think that time was relative, that each observer in motion carried his or her own proper time. It's really amazing.

That doesn't upset people quite so much as the idea that time changes, because time is so strongly associated with our existence, the beats of our heart. The heart and the fact that a second is approximately the beat of a heart is very close to our life itself, and the amount of time that we're allotted on the earth is deeply ingrained in

us as something that is associated with what it is to be human. If you mess with this, if you say, actually, that if your twin went out to a faraway star at a fraction of the speed of light and then came back, then your twin could end up younger than you – that seems amazing, disturbing, unnerving even. It's also [scientifically] true.

We test that all the time at CERN or in any other accelerator in the world. We see particles that normally live for a tiny fraction of a second living much longer. We see cosmic rays as particles that come from deep in space that by all accounts should be decaying into other things, but they reach the surface of the earth. The reason is that their clocks run slow, so to speak, and so they live long enough to reach down to sea level.

We see this in a million ways ourselves. We see it with our telephones and watches when we use GPS. If relativity wasn't right, then our maps wouldn't work. We'd get lost in our cars. Our watches would no longer synchronize. We test relativity all the time in our daily life in this way and in others. We test it through the motion of Mercury around the sun, but all of these are relatively weak bendings of space and time. Around a black hole near the event horizon itself, time and space are curved; they're distorted in a much more extreme way. That is what [an experiment called] the Event Horizon Telescope will ultimately probe.

If you fly from Europe to the United States and back, then you are younger by some tiny amount than somebody who stays at home.

We know that you can travel into the future, and if you imagine, as you easily can, getting rockets to go faster and faster, then you could end up moving into the future and living beyond the time when everything and everyone you know has long ceased to exist. Whether that's a dream or a nightmare is another question, but the idea of traveling into the future by no means contradicts physics. It's completely in agreement with the physics that we've known about since Einstein sent in his paper in June 1905.

We have well over a century of thought about the way time can bend in this way; it's also the case that when you stand on the earth, that your head and your feet age at different rates because being in a gravitational field distorts time and the progress of time. You're time traveling even one part of your body relative to that of the other when you stand up or stand on your head. That is well accepted. The idea of traveling backward in time is much more disturbing, and it is much less clear that it's compatible with any kind of physics.

Look at the history of art: if you go back and you look at a Renaissance painting and you see a sundial or a sand clock, then it's always talking about mortality. It's always about life and death, the possibility of an afterlife, about these fundamental aspects of the human condition . . .

Clocks are never just clocks.

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