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Causality, time, and entropy

Causality would seem to be intimately connected with the direction of time (from the past via the present to the future). But while time certainly enters most physical equations as a variable, its direction (or sign) does not. Contrary to experience, then, physical equations indicate that processes could go either way. The arrow of time is introduced into physics through an inequality, the second law of thermodynamics, saying that entropy (or popularly expressed, degree of disorder) always increase in a closed system.

Indeed we can see this happening in observable approximations to closed systems. A broken sheet of glass does not spontaneously assemble itself and become whole again, and a movie showing this is immediately revealed as being “played backwards”. But according to the laws of physics, this could in fact happen. It is just extremely unlikely. Why? Simply because there are so many more kinds of mess than of order. Thus, the arrow of time would seem to be an “emergent property” in a fundamentally time-less world.

However, this brings more new questions than answers to old ones. What exactly is “order”, anyway? Life in general, and human culture, including science, in particular, seem to be “swimming upstreams”, increasing order, at least locally. The conventional answer to this objection is that such processes “export” entropy to the surroundings. Now, if we have a big closed system, some smaller subsystems might be able to dissipate some of their entropy to other parts of the closed system. But in this process, the entropy of the whole is inevitably increased, and sooner or later chaos will strike back at the small islands of order with a vengeance. This is exactly what is predicted by astrophysics, the universe will die a death of total regularity, and time itself will cease because nothing will happen. Fortunately, we should have ample time for a beer or two before this sad end of all.

But are there really any closed systems? Well, the universe is supposed to be all there is, so at least the whole universe must be a closed system, must it not? Maybe, but what if the universe is infinite, or infinitely expanding? Could not the islands of order also be expanding indefinitely? If so, would we have two arrows of time or only one, pointing in both directions at once, like Janus’ face? (Oh, the old Greeks knew a thing or two.) And what about the quantum fluctuations of the vacuum energy, even at zero absolute temperature?

I confess to being a heretic, in risk of being burnt at the stake. Oh, I’ll take the physics, with all of its gimmicks – but with a grain of salt...