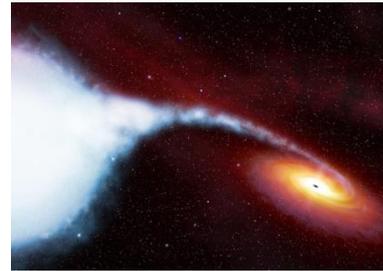


Stephen Lucas - *Effective Communications - Letter to a non-scientific friend- Entropy and direction of time*

Hey,

Do you remember that time we knocked over your mum's crystal vase? Have you not ever wondered why we can break the vase, but the shards never jump back and reassemble themselves?

Ludwig Boltzmann, an Austrian Physicist, had an idea as to why most bodies, provided they are made up of lots of little parts, prefer disorder, i.e. a mess, rather than order, i.e. an intact vase. The glass vase we smashed could have broken into two fragments, six or maybe even fifty! Of course, there was also the hoped possibility that it did not break. Boltzmann's insight is that each of these outcomes is as equally as likely as each other. However, since there are so many different ways in which the vase could break, creating disorder, compared to the likelihood it would not, it is far more likely that when we dropped it, it would smash into tiny irregular fragments.



This idea about disorder is known as 'entropy', and really just means how likely something is to become disordered. Since the disordered possibilities outnumber the ordered possibilities, bodies usually go from order to disorder. A good example is my bedroom, a once spacious place you could swing a leopard in, which is now hidden beneath clothes. The direction of time is also associated with the direction of disorder.

Everything around us is made of lots of little parts – atoms, which as you probably know are the tiny little 'Lego bricks' that make up all things. The fact is, every time we produce heat, we are creating disorder. Heat is essentially the random jiggling of these very 'Lego bricks'. So in every process we create order, i.e. the formation of cells in a baby's brain, we create disorder, i.e. heat produced from metabolising its mother's breast milk.

If all processes in the universe increase disorder, surely there is a disorder limit? Take a star for example, a hot, fiery, burning ball of gas, sputtering out light and heat. Eventually the star will become cooler and nearby space will become warmer until the temperature difference is ironed out. As the star gives out heat, disorder increases, but at a constant temperature, none of this disorder is usable. This phenomenon is known as 'heat death'. Theoretically, the heat produced from the creation of the Universe should mean our Universe is suffering from heat death. How so is it then that time and activity still exist? Disorder can only still exist if at one point, the Universe was more ordered. It's thought that when the Universe was 380,000 years old, it was sufficiently cool enough to allow atoms to form, and so gravity could take hold and shape the Universe. This changed the Universe from a disordered to ordered state.

So next time you destroy one of your mother's beloved treasures, remind her, you've just shown her why the arrow of time points forward, why shattered glasses do not reform and why our Universe must have begun with an enormous explosion.

500 words (**References:** We need to talk about Kelvin – Marcus Chown – Chapter 9, **Images:** Uppermost image - <http://dsc.discovery.com/space/top-10/gallery/black-hole-625x450.jpg>, Image beneath that - <http://vanpay.files.wordpress.com/2008/04/broken-vase.jpg>)

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