Entropy in the Universe: A Story of Order and Disorder

The laws of physics do not distinguish between the past and the future, which allows us to assume that if an event can unfold in one direction, the reverse can also happen. As an example, consider an egg that has fallen from a high counter in your kitchen and splattered on the floor. The laws of physics allow for the egg to completely reconstruct itself, with all of the yolk and broken shells coalescing into a complete egg at the top of the counter. Seeing this in real life would be like watching a video of the egg falling off of the counter in reverse. The idea is undeniably absurd to think about because you would never expect a broken egg to reverse a process we see regularly. This brings us to an important question: why do we never see this happen in real life if it’s possible? The answer lies in topic of entropy.

At the root, entropy asserts that the outcome that has the most ways of occurring has the greatest likelihood of happening. Another aspect of entropy is that the more possible paths to get to a certain outcome, or arrangements, the greater the disorder, and the higher the entropy. The inverse is also true. The fewer arrangements the greater the order, and the lower the entropy. To see this in effect, think of opening a bottle of soda. When you open the bottle of soda for the first time, you release Carbon Dioxide particles into the room. As you might expect, these particles will most likely spread evenly throughout the room rather than forming into a tight cube in the corner of the room. The reason this is true is because there are far more ways the particles can spread throughout the room than there are to arrange the particles in a tight cube. The dispersion of the particles is an example of high entropy, while the cube is an example of having low entropy. When the particles are in the bottle, they have low entropy. Generally, low entropy deteriorates to high entropy, considering there are more arrangements for high entropy, which makes the likelihood of a system going from low to high entropy much higher than going from high to low entropy (or low entropy to low entropy). This truth explains why the egg cracks and doesn’t uncrack. There are more ways to crack an egg than there are to uncrack an egg. In fact, the likelihood that the egg would reverse its motion and reconstruct itself is so incredibly low that if you were to tell me you experienced this I would tell you to get your eyes checked before accepting that you witnessed this universal rarity.

This theme of going from low entropy to high entropy also holds true at a universal scale as well. The entropy of the entire universe is consistently growing. We can deduce that the universe started with very low entropy (this conclusion follows our observation better than the universe starting with high entropy, and it follow the model of deterioration of entropy) and is therefore in the process of deteriorating to high entropy. So, all complex structures with low entropy, such as stars, planets, humans, and trees, come from the remaining low entropy from the early universe. We see pockets of low entropy in the universe, surrounded by a universal growth in entropy.

This understanding of entropy is how we are able to understand the past and future of the universe. Entropy gives us insight about the Big Bang and the origins of the universe, as well as an idea of how the universe may look far into the future (and how it may end). Entropy also gives us a better idea of how we are physically able to exist as complex structures in a deteriorating universe.