

THE RISE AND FALL OF EVOLUTION

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ABSTRACT

Jeremy England proposed in his “Statistical physics of self-replication”¹ that energy dispersion drives evolution. Such is the explanatory power of his theory that we build on it to rethink the relationship between life and entropy as handed to us by Schrodinger, to find a place for the origin and evolution of life within the cosmos, to explain the Cambrian Explosion and the Mass Extinctions from an entropic perspective, hence the title, and finally, to find a way out of the gloom and doom of global warming.

Physicists often write that life increases entropy, which is the dispersion of energy. I find this hard to grasp, as entropy is a statistical rather than physical quantity, so life increasing entropy makes entropy sound tangible, as if it exists and increases. In fact, it is energy that is dispersing more and more, and increased entropy is nothing more than a name, as observed by the following rephrasing of the second law of thermodynamics: Energy spontaneously disperses from being localized to becoming spread out if it is not hindered from doing so².

If we substitute in the definition, we have life disperses energy. However, it is in fact energy that is flowing through life, powering the reactions that comprise life, and dispersing in the process. It is energy that is active, and life passive. Similarly, in this video (<http://y2u.be/uI-KrtV0PJA>)³, it is the flow that is spinning the vortices, not the vortices spinning to disperse the flow so entropy can increase, as if the vortices somehow have a mind of their own, and the good sense to obey the second law of thermodynamics.

Now, we use the concept of energy rather than entropy to explain why the descension from laminar to turbulent flow in the video is an analogy for evolution on earth. The laminar flow, a steady flow of kinetic energy, is like the sun, a steady flow of heat energy. Once the laminar flow is disrupted, its energy disperses into forming the myriad vortices, just as once the flow of heat from the sun is disrupted by the earth, the heat disperses through either conduction or the powering of the photosynthetic reactions of most of flora on earth. The energy in the vortices themselves further disperses by forming small flows or smaller vortices nearby through shear, just as photosynthesis disperses heat while the energy in the glucose produced by photosynthesis further disperses by powering the cellular respiration in the flora-eating fauna on earth. The bigger picture is that the energy in the laminar flow disperses by flowing into turbulence or the first vortices, whose energy further disperses by flowing into turbulence or the nearby vortices, so on and so forth. This is akin to the energy from the sun dispersing by mere conduction or flowing into flora, whose energy further dispersing by mere heat emission or flowing into fauna, and so on and so forth up the food chain.

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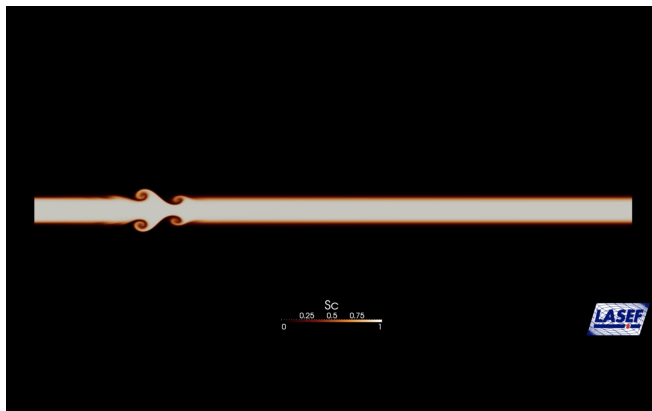


Figure 1. The disruption of laminar flow at the third second.

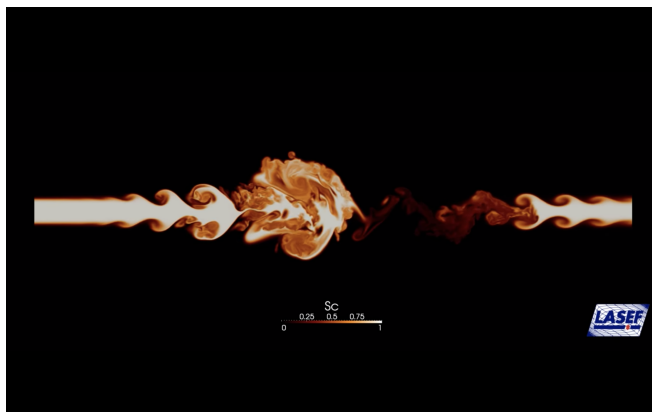


Figure 2. The exponential vortex growth at the fifteenth second.

Now, we elucidate the connection between the evolution of the turbulent flow and that of life on earth. At the third second, as shown in Figure 1, the laminar flow is first disrupted, and its energy disperses into forming the first vortices. This is akin to the heat from either earth’s core or the sun dispersing by powering the self-replication of ribozymes once the components are present. Prior to the thirtieth second, as shown in Figure 2, the vortices multiply exponentially as they form smaller and smaller vortices in between and at the fringes. This is akin to the Cambrian explosion, when the energy in one specie incentivizes the evolution of another that consumes it, exponentially increasing the number of niches. This exponential population growth of the vortices, if you will,

occurs until energy is too dispersed to form any more, and the carrying capacity of the laminar flow is reached. In other words, at such an equilibrium, the number of vortices remain the same because they collectively disperse as much energy as supplied by the laminar flow, as shown in Figure 3. This is akin to the exponential growth of the niches finally reaching an upper bound, and species only evolving in and out of a fixed number of niches. Finally, consider a sudden reduction of the laminar flow. The reduction in energy would result in a reduction of the the vortices closest to the laminar flow, and an inevitable cascade of vortex deaths. This is akin to the fallout of either asteroids or volcanic eruptions blocking the flow of heat from the sun to the earth, with dinosaurs at the end of the cascade of extinction. Moreover, falling sea-levels, an indication of global cooling, associated with all five previous mass extinctions, may be the effect of such a reduction in the energy supply from the sun one way or another. In fact, any drastic environmental change that reduces or halts any energy supply would cause a cascade of extinction, as is the case of the ongoing sixth mass extinction.

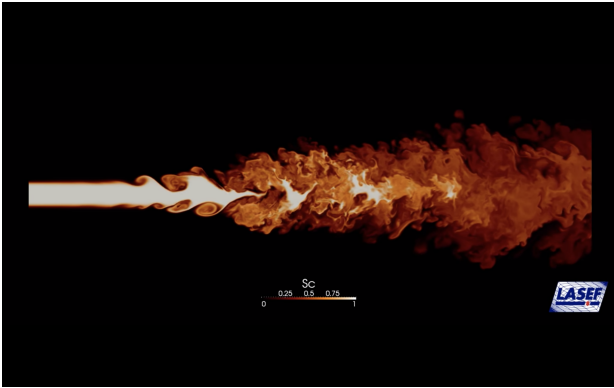


Figure 3. The number of vortices stabilize at the thirtieth second.

Humans are like a huge vortex hogging the laminar flow, causing the poor vortices behind it to die off in cascades before new ones can form. The analogy is imperfect here unless this vortex can suffer from the cascade of deaths behind it. Anyhow, among other problems, we are combusting too much carbon too fast for the evolution of some CO_2 -eating specie that can coexist with humans in cities. I am conjecturing boldly here. I believe that we can mechanically or genetically engineer substitutes for the species vacating the niches that keep our environment in equilibrium. For example, we can deforest, but only if we simultaneously install solar panels that mimic plants in photosynthesizing carbon dioxide and water into some carbon-based fuel and oxygen. In addition, we can pump sulfur-dioxide into the air, but only if we simultaneously factory farm some sulfur-eating bacteria genetically modified for efficiency. Anyhow, we need to mechanically or genetically engineer a substitute for whatever it is in the environment that is out of balance, and tune the ensemble of substitutes to create the right equilibrium. If we can achieve this, it would not matter if we heat up the earth by more than two degrees as we can terraform it back to normal. Then, we are effectively substituting the ensemble of species evolutionarily optimized for energy dispersion with an engineered ensemble, and achieving sustainability without other species.

In all cases, the evolution of life on earth is an optimization of the dispersion of energy from the sun. More generally, the evolution of the universe through time is an optimization of the dispersion of energy from the Big Bang.

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