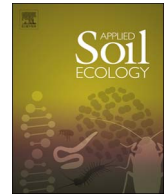




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Short communication

## Humans, humus, and universe

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## ABSTRACT

By inverting the movement of the galaxies, which are constantly moving (except the ones forming local clusters) away from each other and thanks to a system of complex equations, astrophysicists have found that all matter detected in a 13.799 billion light-year radius was originally contained in a volume  $10^{24}$  times smaller than an atom. In the same spirit, a relationship between the processes of biodegradation and the general evolution of the entire universe is suggested in this short communication. This reflexion aims at answering questions related to humus systems from a biological perspective: Why is life always the result of recycling of previously formed structures? Why do organisms get old and die? The cyclic succession of life and death can be puzzling and may go beyond a scientific discussion into a more existential realm relating matter, life essences, and even philosophical or religious considerations. To read in moderation.

## 1. Light and internal energy

Not visible to the naked eye, billions of bacterial cells are living in each cubic meter of air we breathe, millions are growing on each squared cm of our skin, billions inside our body (microbiome) and billions develop in each gram of productive soil. What about invisible light photons?

It is well known that light has a double-sided existence: an “inertial essence” of matter particles behaving like minuscule bullets and an “electromagnetic essence” acting like waves. Both are running through the space at 299 792 458 m/s. Nothing can go faster than light. To go as fast as light, matter *has to become* light. It has to transform into something we still do not yet understand.

Matter bathes in a sea of light, always and everywhere. This flux of electromagnetic waves puts matter particles in communication and keeps them in equilibrium at a shared “energetic level”

The concept of internal energy may help in understanding what matter is and how a dynamic exchange of energy might be related to an exciting concept of life. Internal energy can be explained considering three of its components: a) kinetic energy, due to the microscopic motion of the composing particles (translations, rotations, vibrations of molecules or atoms); b) potential energy, related to the forces between the particles (attraction, repulsion, chemical bonds); c) mass energy: in case of thermonuclear reactions – we have to use Einstein’s formula ( $E = mc^2$ ) – accounting for consistent gains or losses of mass. More

simply, a change in internal energy is registered following changes in temperature (kinetic energy), and/or heat (potential energy), and/or mass (matter).

In this article, admitting a certain inaccuracy, the word “light” is used as synonym of “electromagnetic waves” and the word “temperature” as an estimation of the “internal energy level” of a given mass of matter. If the first approximation is only a question of the domain of the same variable, the second might be wrong if taken without precautions. Interdepending kinetic, potential, and mass energies may change in opposing directions.

In an attempt to avoid confusion, in the following text we will use “temperature” as a synonym of “internal energy” for purely conceptual and practical purposes. We consider that temperature and internal energy are positively correlated, meaning that they operate in the same manner and are intrinsically intertwined and inseparable.

Light can transfer energy from more energetic to less excited particles, until reaching a temperature of equilibrium (Fig. 1). The transfer of energy caused by light is literally “magic”: a part of a particle matter becomes light through lose of its inertial mass and thus is transformed into a wave form. When this light particle reaches another particle under the form of electromagnetic waves it becomes inertial mass again, the receiving particle becoming heavier.

Usually matter cannot stop irradiating its internal energy. As if it were obliged to lose light in order to feed colder matter around it, as a star in dark cold space. In doing so, the light passes through the matter

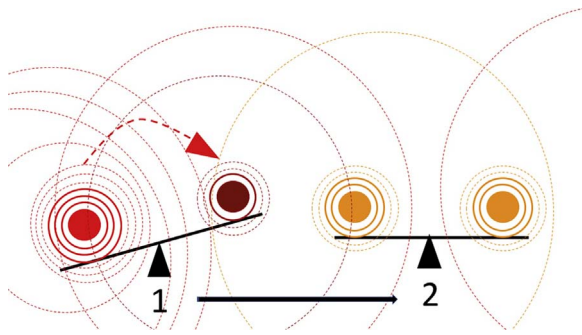
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<sup>1</sup> Music while reading? Naragonia – Lilac/Dave The Watchman: <https://www.youtube.com/watch?v=PKiprmZJ43M>.

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**Fig. 1.** Matter particles exchanging energy/matter thanks to electromagnetic waves. 1) The particle on the left is more excited (at higher temperature) than the same particle on the right at lower temperature. For this reason, the particle on the left of the scale is heavier than the same particle in the right; 2) particles in electromagnetic equilibrium, the one on the left yielding part of its internal energy to the one on the right thanks to an electromagnetic exchange.

like water in a mill wheel, which turns and conserves as long as possible its inertial newly received energy (Fig. 2). This phenomenon is similar to the one that links life and death. Dying, organisms disappear and become source of nutriment for new organisms. Living organisms are continuously enriched by material coming from decomposing organisms, microorganisms and DNA fragments (Ascher et al., 2012; Carteni et al., 2016; Lal et al., 2015; Nagler et al., 2016).

**2. What's natural evolution?**

Why can we not stop growing older? There are physical joining biological reasons. None is exhaustive. The journey among them may be amusing.

**2.1. Charles Darwin (1809–1882)**

In a section of The Origin of Species by Means of natural Selection,

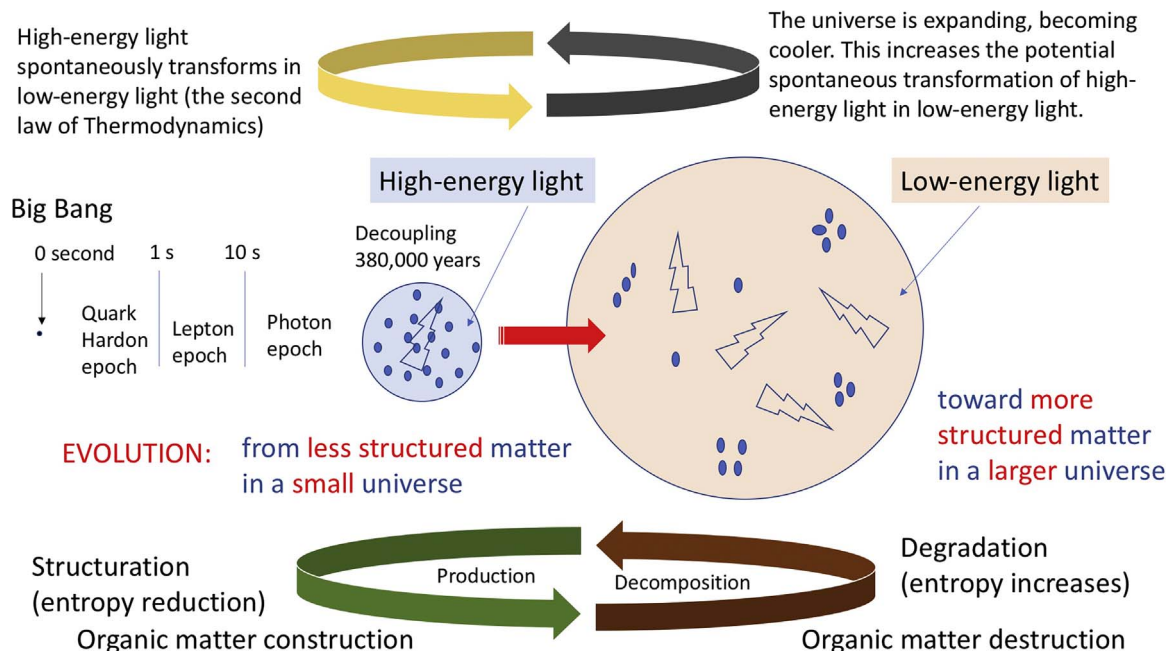
Darwin (1859) compares the human eye and telescope evolutions, the former led by the Creator and the second by man. We will see that a younger Schrödinger, who knew of the existence of the DNA, proposed a different explanation observing the evolution of similar human inventions.

Four steps resume the Darwinian theory:

- 1) Through a process of reproduction, a genetic character (today we say “genetic”, Darwin was not aware of this notion) can express itself in a larger number of individuals, each one with singular and slightly different morphological and functional characteristics;
- 2) these functional differences (example: a more performing insectivore beak on a bird) are selected by the environment, because they are more adapted for exploiting a given habitat (a beak catching insects hidden in small holes, for instance) in a precise historical moment (because these insects are numerous);
- 3) at each reproductive cycle the environmental conditions may change and will obviously act as feedback on the selection process operating on performing individuals;
- 4) a long-time period of reproduction/selection involving a great number of individuals generates the observed renovation of the species.

**2.2. Erwin Schrödinger (1887–1961)**

Considering evolution as a means of transport, Schrödinger (1967) gave an “as if Lamarck were right” interpretation of the evolution. Jean-Baptiste Lamarck (1744–1829) believed that an organism changes during its life in order to adapt to environmental changes and that this same organism can pass on this changes to its offspring. As a matter of fact, recent experiments reopened this question, (Chen et al. (2016), Heard and Martienssen (2014), Rechavi et al. (2011)). Schrödinger stated that “the true parallel of the evolutionary development of organisms could be illustrated, for example, by a historical exhibition of bicycles, showing how this machine gradually changed from year to year, from decade to decade, or, in the same way, of railway-engines, motor-cars, acroplanes, typewriters, etc. [...] We must, of course, not think that ‘behaviour’ after all gradually intrudes into the chromosome structure (or what not) and acquires ‘loci’ there. It is the new organs



**Fig. 2.** Representation of the relationship between the second law of thermodynamics and the processes of matter structuration and decomposition: a) General evolution of a confined system of gas molecules (or other “clusters of matter”). The represented moving matter tends to occupy a larger volume and respecting the second law of thermodynamics, the less probable system on the left evolves towards the more probable system illustrated on the right; b) an expanding universe works like a system evolving from left to right of the figure, because the place in which the matter may diffuse is increasing and temperature lowering. This allows the formation of “local clusters” respecting the second law of the thermodynamics, which imposes a general increase of the entropy in the long run. Notice that even light may “evolve”, from a relatively low number of high-energy photons in a “small universe” to a larger number of low-energy photons in a larger universe.

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