

Lessons From Our Solar System
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[home page \(page 1\)](#)

[home page \(page 2\)](#)

[E-Book](#)

Included in Carl Sagan's posthumous collection of essays: "*The Varieties of Scientific Experience: A Personal View of the Search for God*" (Penguin, 2007), is a beautiful satellite photo of Saturn, taken during one of NASA's missions to the planet. It is a stunning picture of perfect spherical symmetry, and as I admired the photo, the thought occurred to me that this was an image of gravity itself - the "bare" force, with nothing added. Had Newton seen this photo, he might immediately have deduced his namesake gravitational force law - the geometry is so obvious. While we have lost our dark skies and starry nights to the city lights of modern technology, we have in compensation gained photos like this - a museum-quality picture of the planet Saturn, as never before seen by humans.

Just taking the photo at face value, we notice two major features: 1) the superb spherical symmetry, and 2) the fact that all the particles composing this planet (and its magnificent rings) have been gathered together in one place, rather than (as is more likely) being strewn throughout space in a random/chaotic mist. In other words, this is a photo of the work of a "gathering" force, evidently a force acting between all the individual particles of the planet to bring them to a common location at the center of their mutually attractive forces. The force is spherically symmetric in its activity, of that there can be no doubt. The photo just tells us that there is a spherically symmetric "gathering force" ("gravity") at work here, nothing more. Newton has to help us lesser mortals with his inverse-square gravitational force law, the balancing angular momentum and "centrifugal" force laws of mechanics (for the rings), etc. , but post-Newton (and with the principal of energy conservation), all this is evident from the photograph.

The atomic nature of matter (and its variety) is not demonstrated in the Saturn photo, although the simple existence of a planet's worth of matter without a counter-balancing allotment of antimatter, is in fact a crucial ontogenetic issue which must be addressed during an earlier cosmological epoch ([primordial weak-force symmetry-breaking](#) between matter and antimatter during the "Big Bang"). So much for lovely Saturn and the simple symmetry of gravity - illustrating also the universal democracy of the attractive force of gravity: [only the mass - not the kind - of a particle is felt by gravity](#) (a democracy extending even to antimatter).

If Saturn illustrates the simplicity of Newtonian gravity for us, what forces does the Sun demonstrate? Our blazing star - so different from serene Saturn - shows what happens when gravity becomes strong enough to arouse the tremendous nuclear forces deep within atoms. The weak, strong, and electromagnetic forces - in addition to gravity - are all at work in our glorious star. In the center of the Sun, at tremendous pressure and temperature, the strong and weak nuclear forces work together to transform hydrogen (one proton) into helium (2 protons/2 neutrons), releasing in the process enormous amounts of energy ($E = mc^2$), which is carried by the electromagnetic force (as light) to outer space and planet Earth. It's of course more complicated than this, but this is the essential picture (electron neutrinos are also released).

The solar process is "spontaneous" of course, given the whip of gravity. Gravity is forcing the solar process because matter - in the absence of antimatter - has a [symmetry debt to repay](#), which can be accomplished by

the conversion of matter's mass to light. Light has the [greatest symmetry of any energy form](#), and during the "Big Bang" very high-energy light creates matter and antimatter in equal numbers of particle-antiparticle pairs. These pairs attract each other (via the opposite charges of the long-range electromagnetic force) and annihilate, returning to the symmetric light which formed them. However, the weak force also enters this creation process and slightly reduces ("breaks") the symmetry of the annihilating pairs, such that about one pair out of 10 billion (approximately) fails to annihilate, leaving a (tiny) residue of matter which decays to its ground state, forming our asymmetric matter-only universe, including us. This is "[primordial weak force symmetry-breaking](#)", and it is responsible for the production of the matter component of our universe. The photons released from the bulk of the (symmetric) annihilation reactions are seen today as the 2.7K cosmic background radiation. Meanwhile, the heavy leptoquark antineutrinos released during the primordial symmetry-breaking have become the mysterious "dark matter" of the Cosmos. The matter-only asymmetry of our Universe is its most significant single fact - the "original sin" of the Cosmos - the underlying explanation for all subsequent phenomena.

Light (free electromagnetic energy) has the greatest symmetry of any known form of energy, whereas atomic matter (bound electromagnetic energy) is very asymmetric.

To this point, light is massless, carries no charge ([including no gravitational charge](#)), is non-local and timeless, traveling with intrinsic motion "c". Velocity "c" is a symmetry state of effectively "infinite" velocity defining/creating space (light's entropic conservation domain). In contrast, matter is massive, carries various charges ([including a gravitational "location" charge](#)), is local and temporal, has no intrinsic spatial motion, having instead an intrinsic temporal motion in history (matter's entropic conservation domain). *History is matter's entropic equivalent of light's entropic spatial domain.* Together, free and bound electromagnetic energy produce the compound entropic conservation domain of historic spacetime, [wherein both forms of electromagnetic \(EM\) energy can find their conservation needs satisfied](#) - beginning with their entropic ("intrinsic") motions in space and time. It is these "intrinsic" motions in space and time that cause the entropic expansions of space, time, and historic spacetime. When free EM energy is converted into bound EM energy (as during the "Big Bang"), a great deal of symmetry is lost; according to Noether's Theorem, this lost symmetry must somehow be conserved. Nature's way of conserving light's symmetry when massless light is converted into massive matter is via charge conservation - matter-antimatter annihilation providing the archetypal example. *The charges of matter are symmetry debts of light.* Charge conservation is symmetry conservation, and this rule applies also to matter's gravitational "location" charge, hence providing a conceptual unification of the "four forces of physics" under the mantle of [Noether's Theorem](#) as applied to their various charges.

The point of this discussion is that the "whip of gravity" is a symmetry debt of matter, specifically the [gravitational "location" charge of matter \(Gm\)](#), which codes for the lost symmetry of light's "non-locality" - symmetry lost when light was converted into matter during the "Big Bang" (or subsequently). Matter has "location" in spacetime, light does not. "Location" is a lower state of symmetry because the time dimension of matter is one-way, and because matter's definite spatial position is undistributed. Light's non-locality has "all-way" dimensional symmetry, as well as a symmetric spatial distribution (equitable everywhere) due to its "infinite" and "intrinsic" velocity "c", which is actually a state of dimensional symmetry, banishing time. Matter's gravitational symmetry debt (Gm) is active in terms of negative spatial entropy-energy, that is, gravity causes the contraction and heating of space, rather than spatial expansion and cooling. What gravity is actually doing is converting space to time, converting the positive spatial entropy domain of light (free EM energy) to the positive historical entropy domain of matter (bound EM energy), creating the compound entropy domain of historic spacetime. Recall that Einstein discovered that "space" is actually "spacetime". Gravity is simply extracting a metrically equivalent temporal component by collapsing space; one entropy

domain is seamlessly replaced by the other, both forming the necessary dimensional foundation for energy conservation of free or bound EM energy via "intrinsic" dimensional motions, whether spatial (light - velocity c) or historic (matter - time). People ask: "What is the Universe expanding into?", when told of Hubble's epic discovery; the Universe expands into the [compound entropic domain of historic spacetime](#). *Gravity is matter's memory it once was light.*

When gravity causes the conversion of mass (bound EM energy) to light (free EM energy) in our Sun, the gravitational mass of the Sun is reduced, as is the Sun's "location" symmetry debt, in equivalent amount (hence "paying down" the "principal" of the "location" symmetry debt, not just paying the "interest" as in weaker planetary fields). If this process could go to completion, the Sun's mass would be completely converted to the light which originally created the atoms of the Sun, and the Sun (and its gravity) would disappear - all symmetry debts paid in full. However, due to the conservation of "baryon number", this process can only go to completion in a "Black Hole", via Hawking's "quantum radiance" (this is the conservation function of black holes - paying the symmetry debt of "baryon number" in satisfaction of Noether's Theorem). On planets like Earth or Saturn, where the gravitational force is too weak to engage nuclear energies, gravity simply "pays the interest" on the "location" symmetry debt represented by the planet's gravitational mass, converting space to time and hence creating the time dimension of the planet, providing the planet with a (very necessary) historical entropy domain. In the Sun, both "interest and principal" of matter's "location" or gravitational symmetry debt are simultaneously paid by the conversion of mass to light.

Our Sun (and stars generally) is simultaneously performing two important services for the Universe: 1) paying the "location" symmetry debt of the Sun's gravitational mass, both "interest and principal", by the gravitational conversion of bound to free EM energy; 2) taking the first step along the ["Information Pathway"](#) toward the Periodic Table of the Elements and the creation of life, by converting hydrogen into helium. Indeed, the solar effulgence may be seen as a celestial celebration of this double accomplishment. The strong and weak nuclear forces, roused to action by gravity, are involved in both processes. But it is the gravitational charge-energy (Gm) which collects the particles and provides the necessary push and "spontaneous" (charge driven) character of these transformations. Larger stars than our Sun will complete the Periodic Table via greater temperatures and pressures and eventually via supernova explosions.

Let us look now at planet Earth, and ask what this may tell us of fundamental processes. Whereas Saturn illustrated gravitational forces paying the "interest" on the "location" symmetry debt of planetary mass, calmly converting space to time/history, the Sun also illustrated the paying of the "principal" of the "location" symmetry debt associated with the Sun's mass (Gm), via the violent action of the weak and strong forces converting hydrogen to helium, thereby climbing the first rung of the "Information Ladder" leading to the full Periodic Table of the Elements. On Planet Earth we finish this journey from the Periodic Table to life: *life is the crowning glory of the Information Pathway and Information domain, and the rationale for the very existence of the Universe*. On planet Earth, humanity is the top rung of the ["Information Ladder"](#); however, we have no idea what might have been achieved elsewhere within the Information Domain of our Universe. The significance of planet Earth is the story of life, of the gentle intersection of the Information Domain with the electron shell of atoms and molecules, especially carbon atoms and water molecules. Seen from a distance, our planet is a curious sight, surrounded by a swarm of artificial satellites, occasionally shooting probes (both robotic and manned) to our moon and other planets, even out of the solar system altogether. It also produces a multitude of radio and TV transmissions; at night the lights of cities can be seen. No other planet does anything like this. Clearly the special feature of our planet is life, and technologically advanced life at that. But what a curious thing life is! We who have life

tend to become accustomed to the miracle we are experiencing - we are the atoms of the Earth raised to self-aware consciousness; we in fact embody the [information pathway](#) by which the universe achieves consciousness and self-awareness, looks around, and sees itself and its creations "from the inside". "[The human experience](#)", in all its facets - the drama, the love, the pain, the courage, the accomplishment, the understanding, the appreciation, the awe, the beauty, the inventions, the science, the art, the creativity - all these things and many more are available to the Universe only through the physical form of human life (so far as we know). Mighty and vast as it is, the Universe must stoop to our level to experience anything more complex than mere existence - human love, for example, or human creativity and discovery in the arts and sciences, even the pure drama, pomp and circumstance of our small human life. These all belong to the universe only through us, only through the information pathway of the Periodic Table, atomic electron shells, and the evolutionary phenomenon of *Homo sapiens*.

Our planet has an atmosphere that is about 20% oxygen, which is a highly reactive gas (fire, rust) that informs us of the presence of living plants and photosynthesis. Life has changed ("terraformed") planet Earth in many ways to suit itself (as in the "Gaia" hypothesis), filling the "biosphere" of Earth (essentially the entire surface of the planet) with millions of species of extant/extinct life forms. Life is a weedy "take-over" force, reproducing itself until it fills all available and suitable space, even if that space is the size of a planet. Life is not a small or timid force; life arises from the confluence of information and electromagnetism in the electron shells of atoms, molecules, and chemical systems (electricity supplies the force, information supplies the diversity, evolution supplies the function). Life is curious and expansive, exploring the available space for suitable habitat. Above all, life is creative, not only reproducing itself, but evolving new forms with new capacities, enabling survival in new habitats. That is what those "artificial" satellites are about: life finally evolved a space-faring species of rocket scientists that can propel her to entirely new worlds, as well as protect her home planet (from large meteor strikes, for example). As for humans created in the "image and likeness" of God, in a functional and fractal sense this is true on a micro-scale, in the sense that we are creative, we make new species of animals and plants, we even make new elements, we understand and harness the forces of nature, we terraform the Earth, and we model our social systems on what we presume to be "divinely ordained" laws and principles, taking "karmic law/justice" into our own hands ("on Earth as it is in Heaven"). We are indeed little gods, and what we do now on a daily basis would seem utterly miraculous to people of biblical times.

Earth tells us that life is one of the fundamental forces, that life manifests where conditions permit, and that it is characteristic of life to create, invent, explore, and spread. We can expect that what is happening in our solar system is also happening (or has/will happen) in similar systems throughout our own galaxy and in the other galaxies of the Cosmos. The life force is apparently a chemical sub-system of electromagnetism. Likewise, "Information" is a universal characteristic of atomic systems, resident in the atomic nucleus, electron shell, the chemical elements of the Periodic Table, and all elaborated chemical systems. [There is magic in the atoms, and it is called "life"](#). The fundamental ingredients of life (electromagnetism/Information) being ubiquitous throughout the material universe, [we expect life to arise wherever conditions permit](#). The only question is what form it takes in its various manifestations and evolutionary pathways. Of particular interest is how common is technological civilization? This is an especially knotty problem, as even on Earth today we have stone-age cultures subsisting simultaneously with rocket scientists and super-computers. Apparently, even when all other conditions are suitable, a science-based technological civilization may fail to evolve. And even if it does, it may self-destruct, leaving no progeny behind. Nevertheless, the fact that we have no alien visitors is only a testament to the insuperable distances separating astronomical systems, and the validity of Einstein's theories regarding the intractable problems of extensive travel in spacetime, especially for living creatures. We should be grateful for this

isolation, however, as it protects us from predatory invaders from elsewhere in our galaxy - think of the "Borg" in the TV series "Star Trek". It seems very likely that we will always have the Earth to ourselves, to do with as we like, for better or worse. As for the other - apparently lifeless - planets of our solar system, they are defining the limits of habitable celestial real estate: too hot, too cold, too large, too small, improperly constituted, etc. Of course some of these may surprise us yet, but there is much to learn even from the sterile failures.

What is the magic that infuses atoms and the [information pathway](#) with life? Is it anything more than the ability of DNA to replicate itself within a competitive, difficult environment? All our art, science, religion and philosophy testify that there is (at least potentially) more to life than merely animal functions: eating, breeding, etc.; that beyond the animal, humans have opened, and are expanding into, a new [abstract realm of knowledge](#), experience, and accomplishment, an intellectual, abstract information domain even larger and more various than that explored by molecular DNA before us, a domain that is pulling us into unknown territory. Finally, life lifts the Universe above a bare mineral existence, giving it self-conscious awareness, a purpose, and a significance. As Tolstoy understood, the meaning of life is found in the experience of life, both for the Universe and for the individual. "God is life, and to love life is to love God." Thou Shalt Grow! Reproduce! Explore! Create! Experience! Celebrate!

[home page \(page 1\)](#)

[home page \(page 2\)](#)

[E-Book](#)