

THE SYMMETRY GROUPS OF LIGHT

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In the mathematical terms of Evariste Galois' "Group Theory", the ["Tetrahedron Model"](#) is a description of the *symmetry group of light*, including its destruction by [asymmetric weak force decays](#) (producing our matter-only Cosmos), and its on-going restoration in obedience to [Noether's Theorem of symmetry conservation](#) (as in the conversion of bound to free energy in stars).

The usual symmetry group identified with light is that of local phase transformations, and it is designated as either $SO(2)$ or $U(1)$. However, I am suggesting here that light contains a very much larger (and more interesting) symmetry group associated with its transformation into particle-antiparticle pairs (and back again into light). I don't know what the formal designation of this group might be.

For an expert's explanation of the formal aspects of symmetry and group theory, See: Keith Devlin *The Language of Mathematics* Chapt. 5 "The Mathematics of Beauty", 1998 W. H. Freeman & Co. (Holt Paperbacks); see also: Ian Stewart *Why Beauty is Truth* Chapt. 13 "The Five Dimensional Man", Basic Books 2007.

A symmetry group consists (for one example) of a collection of figures that can be transformed into one another without changing the original. The symmetry group of an equilateral triangle (say) consists of all the triangles that can be created from an original by means of rotation, translation, reflection, etc. - provided the transformed articles are indistinguishable from the original. How do we apply this notion to the case of light? In what sense is there a symmetry group associated with (consisting of) transformations of light (free electromagnetic radiation)?

Beyond the simple phase transformations of the electromagnetic field, the examples of interest here are the particle-antiparticle pairs of the Dirac/Heisenberg "vacuum" of spacetime. These particle-antiparticle pairs are constantly produced from borrowed energy and instantaneously annihilate each other in an endless cycle of creation and destruction alternating between light and virtual particles, a cycle which has been ongoing throughout spacetime since its beginning in the "Big Bang". Since they are "virtual" rather than "real" particles we do not notice them even though they are everywhere around us. Essentially, we do not notice them because their symmetry is so complete. We only notice the asymmetries which surround (and comprise) us.

These virtual particle-antiparticle pairs consist of all known (and unknown) species of elementary particles, and their creation and annihilation cycles form (along with the phase transformations) the primordial symmetry group of light or free electromagnetic energy. During the "Big Bang", the symmetry of light and its virtual particle pairs was broken by [asymmetric high-energy weak force decays](#) which resulted in the creation of our matter-only universe. Our Cosmos consists of one-half of light's original symmetry group, the matter half. The antimatter half was annihilated along with most of the original matter. Hence the universe around us (including ourselves) is light's symmetry group revealed in its asymmetric, matter-only form; put it together with its antimatter counterpart and you get back the original light. What we are seeing in the physical objects around us (plants, animals, planets, stars) is the long-term evolutionary consequence of the energy and information contained in the original light and its particle-antiparticle symmetry group, exposed to our view only because its original symmetry was broken (in half), unleashing powerful and inexorable forces which forever seek to restore the original whole symmetry. Evolution is ultimately driven by matter's eternal search for antimatter - seen most directly and commonly in the electron-proton pairing - the primordial, powerful, and eternal attraction between positive and negative electric charges.

The periodic table of the elements is a basic (and astounding) example of the information potential contained

in (one half of) light's symmetry group. But atoms and elements are already compounded objects. At a deeper level we discover this information content is fractal - beyond the U, D (up, down) quarks of the proton and neutron lies another (heavier) level of C, S (charm, strange) quarks, and beyond them, a still heavier family of T, B (top, bottom) quarks. The three quark families are likewise accompanied by three successively heavier levels of leptonic families, the electron, muon, tau and their respective neutrinos. (Leptons, neutrinos, and mesons serve as alternative charge carriers for the quarks and for each other - replacing the original antimatter charge carriers.) The symmetry group of light turns out to be complex indeed, a complexity revealed only when its symmetric form is cut in half - like exposing the seeds, cells, nuclei, and DNA of a cantaloupe when we slice it open. (See: ["The Particle Table"](#).)

Nor is this all. Single particle transformations within these symmetry groups are (must be) precisely controlled by the weak force IVB (Intermediate Vector Boson) mechanism, such that every electron or other elementary particle created today is exactly the same as those created in the "Big Bang". Going back to the equilateral triangle analogy, the triangle can rotate only through 60 degree "quantum" steps; these fixed points correspond to the fixed mass, spin, and charge of the various elementary particles and particle-antiparticle pairs. The creation of single particles (rather than particle-antiparticle pairs) is especially difficult, and is the sole purview of the weak force and the reason for its elaborate and massive mechanism. (See: ["The W IVB and the Weak Force Mechanism"](#).)

And there is more. At the high energy levels of the early "Big Bang", the particle species lose their individuality and group together in ever more inclusive categories - analogously to the biological classification hierarchy of species, genus, family, and order. These particle classes come together as the forces unite - first the electric and weak forces combine, the electroweak unification bringing together all the lepton species and (separately) all the quark species into a lepton "genus" and a hadron "genus". At the electroweak unification energy level all leptons can freely transform one into another, and likewise all quarks can freely transform among themselves - having given up their individual identities for a more inclusive "generic" identity. Hence this is a higher energy and symmetry state of force unification, another category of light's symmetry groups (the "electroweak" symmetry group). These force unity states are also fractal, like the three quark and lepton energy levels before them. There are three of these unity states as well, second being the GUT (Grand Unified Theory) unification level of the combined electroweak and strong force, unifying all the leptons with all the quarks (the "family" group of fermions). Third and finally, the TOE (Theory of Everything) unification comprising all four forces, including gravity, uniting the bosons (field vectors) and fermions (particles) in a grand electromagnetic energy "order". (See: ["The Higgs Boson and the Weak Force IVBs"](#).) In this final state of ultra-high energy and symmetry (seen only at the beginning of the "Creation Event"), free electromagnetic energy is transformed into bound electromagnetic energy, and vice versa, setting the stage for weak force symmetry-breaking and the emergence of the matter-only universe of light's information content. This is the Cosmos we occupy, light's symmetry group revealed in its asymmetric, bound, and temporal form as massive atomic matter, charge, and information.

All the conservation laws and forces of the Cosmos work continuously to maintain, conserve, and restore its original symmetric energy state, even as the information content of matter evolves (in the biological realm) toward a fractal iteration of its Creator. (See: ["Symmetry Principles of the Unified Field Theory"](#).)

Returning the material system to symmetry in the absence of antimatter is the central problem of the Universe, requiring the creation (by gravity) of a new (alternative) entropy-carrying dimension: time. The historical maintenance of charge invariance in a world of relative rather than absolute motion, compounded of both light and matter, space and time, is a challenge met by the field vectors of the four forces, which are themselves compounded expressly for this purpose. (See: ["Global vs Local Gauge Symmetry in the Tetrahedron Model"](#).)

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References

Pierre Teilhard de Chardin : *The Phenomenon of Man*. French: Editions du Seuil, Paris, 1955. English: Harper and Row, New York, 1959.

Go to [Trance, Art, Creativity](#) (book by Prof. J. C. Gowan, Privately Printed, 1975).

Keith Devlin *The Language of Mathematics* Chapt. 5 "The Mathematics of Beauty", 1998 W. H. Freeman & Co. (Holt Paperbacks).

Ian Stewart *Why Beauty is Truth* Chapt. 13 "The Five Dimensional Man", Basic Books 2007.