ESSAY 39: Consequences of B(3) for Photon Mass.

When I first inferred B(3) on a snowy afternoon in November 1991 it seemed little more than common sense, always a dangerous thing to say in the dogma ridden world of theoretical physics. As I often did, I was working at home as a private scholar away from Cornell Theory Center, which I attended in the mornings, being linked in to two supercomputers from home. The first three papers on B(3) were published in Physica B and are available in the Omnia Opera section of www.aias.us. I was trying to rationalize the idea of the Piekara Kielich conjugate product in non linear optics. It seemed to me that this object existed in two dimensions and that its vector cross product should produce a magnetic flux density in the axis of propagation. Evidently, the referees of the first three Physica B papers had no objection. I wrote to Mansel Davies back in Criccieth about the idea, and he accepted it with great enthusiasm, immediately recommending it for a Nobel Prize by writing that he had never seen anything more worthy of the prize. For a hard headed sceptic that was unusual. I also discussed B(3) by letter with Stanislaw Kielich, who was very ill but who was my co editor of the first edition of AModern Nonlinear Optics@. He also accepted it with enthusiasm.

In January 1993 Jean Pierre Vigier became the fourth or fifth major scientist to accept the idea of B(3) enthusiastically and invited a paper on it to Physics Letters A. Taishi Kurata had also begun to work on its industrial applications but did not communicate until about the mid nineties. Among less well known scientists to accept the idea was Justin Huang, an expert in photon mass. The dogma of the time was that the photon must be massless because otherwise the lagrangian is not invariant under U(1) gauge transformation. The idea of photon mass, although proposed by Einstein in about 1906, did not agree with the fashionable theory of the time, gauge theory. Proca proposed an equation for the massive boson in the mid thirties, so the Proca equation is not U(1) gauge invariant, which is a big problem for standard physics, which still adheres to U(1) like glue.

In standard physics mass is defined by the first Casimir invariant of the Poincare group, which was developed by Wigner in 1939. The definition of the first Casimir invariant is the same as the Einstein energy equation. If the mass is zero, this equation becomes E = cp, where E is total relativistic energy and p the relativistic momentum. The dogma claims that light travels at c in a vacuum, so in special relativity the infinitesimal line element is zero. This is known as a null geodesic. There is no rest frame for the massless photon. The Lorentz transform runs into difficulties because the gamma factor of Lorentz is infinite for a photon travelling at c. This means that the mass must be zero. A photon of zero mass travels at c and can never be at rest, a very strange idea to anyone who stands outside the dogma of theoretical physics.

In special relativity the second Casimir invariant is spin, defined in terms of the Pauli Lubansky pseudovector. For a massless particle the second invariant is also zero, meaning that the energy momentum four vector must be proportional to the Pauli Lubansky pseudovector. The proportionality constant is the helicity. Why this should be integral or half integral is not known in the standard theory of the Poincare group.. The latter reverses sign with parity and from these properties the standard physics asserts that the massless photon has only two senses of polarization and that these must be transverse. So there is no B(3) field in standard physics, meaning that one axis (Z) of three dimensional space (X, Y, Z) is missing, an absurd dogma that runs into many difficulties. For example it implies the existence of a group E(2) that has no physical meaning, and demands the Aremoval@ of the timelike and longitudinal polarizations using the arbitrary Gupta Bleuler method. Canonical quantization of the electromagnetic field runs into severe difficulties.

If the photon mass is restored to physics, the electromagnetic field has four senses of polarization, timelike, two transverse and one longitudinal along the axis of propagation. So the B(3) field is allowed when the photon has mass, however tiny. Therefore the inverse Faraday effect caused by B(3) can be interpreted as definitive evidence for photon mass, in whose pursuit Vigier had spent a lifetime of distinguished work. The idea of U(1) gauge invariance comes from the structure of the Maxwell Heaviside theory, which must be replaced by Proca theory for a finite photon mass. The ECE wave equation gives the Proca equation in the limit of the free electromagnetic field and not the d=Alembert equation associated with a massless photon. The B(3) field in ECE theory is associated with the geometry that gives rise to the Proca equation.

The B(3) field has turned out to be the key to a unified field theory because it is defined in terms of the spin connection term in the first Cartan structure equation. Its inference also led to the abandonment of gauge theory in favour of general relativity and it is seen more and more as a major discovery of physics.