THE HIGGS BOSON AND THE SPACETIME METRIC

(Revised June, 2016)

JOHN A. GOWAN

home page (page 1)
home page (page 2)
E-Book

(See also: "The Mysteries of Mass" by Gordon Kane, *Scientific American,* July 2005, pp. 41-48; and: "When Fields Collide" by David Kaiser, *Scientific American,* June 2007, pages 63 - 69.)

Table of Contents:

Abstract

Currently, there seems to be (at least) two interpretations of the activity of the Higgs boson: 1) the older, original interpretation of the Higgs as the scalar or gauge boson which determines the *rest masses* of the weak force Intermediate Vector Bosons (IVBs - the "W" and "Z"), and through the IVBS, of the elementary particles as well (an interpretation I can understand and endorse); 2) a newer (additional? alternative?) interpretation consisting of a "Higgs ether" which acts as the source of particle mass in the sense of *inertial resistance* to acceleration. In this latter interpretation, all elementary particles interact with a universal Higgs field in proportion to their mass, and it is this interaction or "Higgs ether drag" which causes the inertial resistance to acceleration we recognize as mass. It is this latter interpretation which I cannot understand or endorse, as it seems to have no ability to explain the inertial mass of composite particles (baryons), or Einstein's relativistic mass. However, replacing the "Higgs ether drag" hypothesis (but retaining the Higgs scalar role) with a "gravitational field drag" concept does allow us to understand the mechanism of relativistic variability in the metric and energetic parameters of mass, and crucially preserves the equivalence between gravitational, inertial, and rest mass, including that of composite particles.

Introduction

In terms of Newtonian or low-velocity mechanics, the inertial resistance of mass to acceleration is simply explained by the conservation of energy. Energy is obviously required to accomplish an acceleration, in direct proportion to an object's mass (F = ma). Intuitively, there is nothing particularly mysterious about mass or inertial resistance at low velocity. Classically, the concept of mass was no more unusual than the concepts of energy, space, or time; the equivalence between gravitational "weight" and inertial mass was its greatest mystery. Einstein explained that puzzle (accelerating spacetime) but introduced new ones: according to the high-velocity mechanics of Special Relativity, inertial mass increases with increasing velocity, and likewise "clocks run slow and meter sticks shrink", destroying the classical simplicity of metric symmetry and energy conservation. Energy conservation and causality nevertheless prevail, of course, but it requires a changed (or "warped"/"curved") metric to do so, and a new understanding of the relation between free and bound electromagnetic energy (E = mcc), as well as between gravitation, space, and time.

More recently still, a new question regarding the scalar origin of the mass of the elementary particles has been raised, a question answered by positing the "Higgs" mechanism (as originally suggested by Peter Higgs, among others). The Higgs boson acts as a mass scalar which determines the masses of the weak force IVBs (Intermediate Vector Bosons), and subsequently, acting through the IVBs, "gauges" the specific masses of the elementary particles (formalized in the mathematics of the electroweak unification of the "standard model" by Glashow, Weinberg, and Salam, 1979 Nobel Prize). We might put this more simply by saying the Higgs boson gauges the mass-energy of the electroweak unified-force symmetric energy state, elementary particles (quarks, leptons) and IVBs included.

CERN announced the discovery of a "Higgs-like" boson on 4 July, 2012, at approx. 125 GEV. (See: Science Vol. 337 13 July 2012 pp. 141-143) (see also www.sciencemag.org)

The Higgs Field vs the Spacetime Metric

In his book "Nothingness: The Science of Empty Space" by Henning Genz (English Translation 1999, Perseus Books Pub. L.L.C.), on pages 228-237, Genz provides an illuminating explanation of the "Higgs" field and particle, currently the "Holy Grail" of particle physics. As I read and reread this section, I was struck with the similarity between Genz's description of the interaction of the Higgs field with a particle, and my own notion of the interaction of the spacetime metric with a particle's gravitational field. In Genz's description of the Higgs mechanism, the interaction of a particle with the Higgs field provides the particle's attribute of inertial mass (resistance to acceleration); in my conception, a particle's inertial mass or resistance to acceleration is simply the consequence of the interaction of the particle's gravitational field with the metric field of spacetime (a notion bearing some similarity to Mach's ideas on the subject, since the metric of spacetime is influenced by the gravitational field of the entire universe).

I am here considering the distinction between Einstein's "rest mass" energy content (E = mcc) of an elementary particle (quarks, leptons), which is evidently scaled by the Higgs boson, and the inertial mass due to acceleration (or the gravitational mass or "weight") of the same particle. "m" is presumed to be the same quantity in all three cases, and must be, for energy conservation reasons, which is the rationale for this discussion. However, to attribute the inertial mass of acceleration to an interaction between the Higgs scalar and elementary particles (as a sort of modern-day "ether drag") is to lose the identity between rest mass and inertial mass in non-elementary particles, since in the latter case the binding energy component of rest mass (which is huge in composite particles such as baryons - as much as 99%) cannot be attributed to the Higgs interaction. Binding energy is not an elementary particle - how is the Higgs supposed to recognize it? However, we preserve this identity (necessary for energy conservation) by attributing a particle's inertial mass of acceleration to the interaction between the spacetime metric and a particle's gravitational field, as we know the gravitational field is an exact measure of the total bound energy content of a particle (Gm), whatever the source of that bound energy may be. (See also: "A Description of Gravitation"). Crucially, this formulation also preserves the identity between gravitational "weight" and inertial mass, as in Einstein's "Equivalence Principle".

The gravitational field of a massive particle is produced by the intrinsic (entropic) motion of the particle's time dimension, exiting space at right angles to all three spatial dimensions, and dragging space along with it (see: "The Conversion of Space to Time"). The spatial dimensions self-annihilate at the gravitational center of mass, leaving behind an uncancelled (because it is "one-way") metrically equivalent temporal residue, which in turn moves on down the time line into history, pulling more space with it, repeating the self-feeding entropic cycle forever. *A gravitational field is the spatial consequence of the intrinsic motion of time*. Time is the primordial entropy drive of bound energy, producing matter's entropic conservation domain (history), the analog of space in the case of free energy (light). Time is produced by the gravitational annihilation of a metrically equivalent quantity of space. The converse interaction occurs via the gravitational conversion of mass into light (as in stars). Hence the three dimensional intrinsic motions of light, time, and gravity are connected in an energy and symmetry-conserving triangle. (See: "Entropy, Gravitation, and Thermodynamics").

Gravity

Even though the Higgs may be an attribute of the spacetime metric (acting as the weak force mass scalar), setting the energy scale for the IVBs and by extension for the rest masses of the elementary particles via the IVBs, this is a one-time electroweak interaction regulating the production of *single* elementary particles; the Higgs field does not continue to interact with particles (as a sort of "ether drag") to produce their inertial resistance to acceleration. Instead, this latter role is played by the spacetime metric, interacting with a particle's gravitational field, an interaction which produces a particle's inertial resistance to acceleration, and precisely in proportion to its total mass (Gm), whatever the source of that mass may be. It also seems highly unsatisfactory to attribute part of a composite particle's *inertial* mass of acceleration to the interaction of its elementary components with the Higgs boson, and another part (binding energy, for example) to some other, non-Higgs type of inertial interaction: "inertial mass" should arise from a single source to retain its identity with "rest mass" and "gravitational weight". The "Higgs field" may be necessary to gauge the energy scale and regulate the specific *rest mass* or quantized bound energy content of the weak force IVBs and the various elementary particle species (quarks and leptons) the IVBs subsequently produce, but has nothing further to do with their mass as observed in inertial resistance to acceleration (or gravitational "weight"). The quantization of the Higgs and IVBs is necessary to ensure the invariance of the *single* elementary particles they produce. (See: "The Higgs Boson and the Weak Force IVBs".) Even though the Higgs may be viewed as a scaling property arising from the metric itself (a "metric" particle), and as establishing through the IVBs the rest masses of particles, this is not the specific attribute of the metric which creates inertial mass as defined by resistance to acceleration. Energy conservation, as well as Einstein's "Equivalence Principle", requires that the "m" in "rest mass" (E = mcc), inertial mass (resistance to acceleration: F = ma), and gravitational "weight" ("gm" in an equivalent local field), are all equal, whatever their source.

Mass, Energy, Time

Let us take note at this juncture of the relationship between mass, energy, and time, which we find not only in the non-obvious notion that gravitation, which is exactly proportional to and produced by mass (Gm), creates time and the temporal entropy drive of bound energy (through the annihilation of space and the extraction of a metrically equivalent temporal residue); but also in the famous set of equations relating "frequency" and energy: E = h*v* (Einstein-Planck); E = mcc (Einstein); h*v* = mcc (de Broglie) (the time component is implicit in *frequency)*. This subtle relationship emerges again in the notion of the increase of a particle's mass with relativistic motion in Einstein's Special Relativity, an otherwise puzzling result which is explained through the concept that a particle's inertial mass (resistance to acceleration) is entirely due to the interaction of its gravitational field with the metric field of spacetime.

The "mass" or inertial resistance to acceleration offered by a particle is due to the interaction and interference of the particle's gravitational field with the metric field of spacetime. The forced interaction between these two metric fields, one asymmetric and the other symmetric (or at least different), also produces the anomalous results of relativistic motion in the spatial, temporal, and mass parameters of the moving or accelerated system, as discovered by Einstein (slowing of clocks, shrinking of meter sticks, increasing particle mass). Because (in this view) the inertial mass of the system is from the outset attributed to the interaction of its gravitational field with the metric field of spacetime, the relativistic increase of mass with accelerated motion is seen as a natural outcome of the interaction, interference, and especially the feedback between the temporal (or "frequency") components of these two metric fields, and the connection (mentioned above) between frequency, time, energy, and mass (including the covariance of space with time). Recall that although the gravitational field of an individual particle may seem to be weak, it extends throughout the Universe. A gravitational field distorts spacetime and its metric (as per Einstein); forcing this distorting influence through the (universal) metric field of spacetime (as in accelerated motion) requires energy, which is the source of the particle's resistance - and in exact proportion to the particle's mass (Gm).

The equivalence of gravitational and inertial mass ("weight" vs resistance to acceleration - leading to Einstein's "Equivalence Principle") is due not only to the reciprocal character of the spacetime accelerations of gravity vs (for example) rocket engines (spacetime accelerating through the rocket vs the rocket accelerating through spacetime), but to the interaction in both cases of a particle's gravitational field with the metric component of (identically but reciprocally) accelerating spacetime (the spacetime metric accelerating through our gravitational field vs our gravitational field accelerating through the spacetime metric). Likewise, the vanishing of "g" forces in orbit or free-fall corresponds to the vanishing of the forced (accelerated) interaction between these two metric fields. Time is a common feature of gravity, acceleration, and even mass (as we saw above, through "frequency": $h\nu = mcc$). In contrast to immobile, massive matter, note in this connection that light, whose "inertial" state is "intrinsic" motion in space with "velocity c", has neither mass, a time dimension, nor a gravitational field, and consequently and significantly, *has no inertial resistance to acceleration* (as in reflecting between two mirrors). (See: "Does Light Produce a Gravitational Field?")

See: Postscript to this Paper

home page (page 1)
home page (page 2)
E-Book