BORN IN THE HIGG'S FIELD :
OUR UNIVERSE OF MATTER
AND ITS ANTIMATTER TWIN

John Bruce Davies, Ph.D.

Email: DaviesResearch@yahoo.com

Dept. of Physics (retd),

University of Colorado, Boulder, CO

Essay written for the Gravity Research Foundation 2020 Awards for Essays on Gravitation

Submitted 16 March 2020

Abstract

For the earliest Universe, a constant Planck energy density inflow with expansion at the speed of light is the only model that attains the finite mass of the observable Universe when the Higg's Field interacts. The conservation laws, as in Feynman's Diagrams, demand that the Higg's Field produce equal and opposite charged quark-gluon and antiquark-gluon balls of plasma moving in opposite directions. Regge calculus confirms this duality formation. Einsteins Field/wave equation for gravitational potential only has solutions with two equal and opposite propagating waves. The initial expansion of the Universe is a flow wherein, at the critical Reynold's Number, two equal and opposite vortices will form. That all these well-proven models of physical reality result in equal and opposite entities gives much credibility to the Higg's Field birthing our Universe of matter and its antimatter twin.

FLRW Universe

First we examine the FLRW equations for a continuum Universe that is usually assumed to govern the expansion of the scale-factor R(t) of the Universe from Planck time to the present are:

(1) $R_t^2 = 8\pi G/3.\rho R^2 + \Lambda/3.R^2$

where G is the Gravitational Constant, ρ is the energy density of the Universe, Λ is Einstein's hypothesized cosmological parameter which we do not restrict to be constant and we assume a flat Universe.

The second fundamental equation for this standard model governs the acceleration of the scale-factor:

(2) $R_{tt} = -4\pi G/3.(\rho+3P)R + \Lambda/3.R$

where P is the pressure.

Einstein obtained this equation relating Scale Factor acceleration with energy density based on the assumption of conservation of energy. This assumption forced Einstein to invent a hypothetical parameter which was labeled the Cosmological Constant. Einstein and subsequent researchers made the fundamental assumption that this universe was a closed system without sources or sinks of energy. We shall show that it is necessary to loosen that restriction for the earliest Universe with the cosmological term representing energy sources or sinks in the more general open Universe.

For the case of no sources or sinks, i.e. a closed system having Λ equal to zero, then, differentiating (1), dividing by R_t and equating with acceleration in (2), yields the equation relating pressure to density, its gradient and Universe expansion:

(3) $P = -\rho - \rho_t.(R/3R_t)$

Thus, in this FLRW Universe, the pressure depends not only on density but also on the rate of Universe expansion and the rate of energy density lost or gained, ρ_t. This is the equation of state of a nonlinear material and is similar to the viscous equation of fluid flow.

The acceleration is obtained by substituting pressure P from equation (3) into (2), i.e.

(4) $R_{tt} = 4\pi G/3.(2\rho + R\rho_t /R_t).R$

We can use this relationship to examine how the density and Scale Factor behave in time in this closed system that has neither source or sink.

Universe Constraints

The physical Universe is usually considered, from quantum arguments, to have an earliest possible start at the Planck time of about $5x10^{-44}$ seconds. Similarly, the starting energy density is also taken as the Planck density of 10^{96} kg/m^3 , which is considered from quantum arguments to be the largest possible energy density.

The largest total energy as the expansion progresses from the Planck time is the simplest solution of a constant Planck energy density that starts and continues with the maximum velocity, that of pure energy, light. This initial pure energy expansion ends at the time of the phase change that results in the constituents attaining mass. The observable universe mass is about 10^{54} kg and assuming the maximum possible radius of about $(ct)^3$, the time of this phase change is determined simply as $(10^{54} / c^3 10^{96})^{1/3}$ which is approximately 10^{-22} to 10^{-23} secs. This time is also the mean lifetime of the Higgs boson, which is considered to be the mediator of the Higgs Field that thus gives mass to the particle constituents of the Universe, Davies (2015).

As the initial Planck time is about 10^{-43} secs then the ratio to the Higg's time is about 10^{-20}. The particle plasma produced at the Higg's Field is considered to be about the size of a nucleon, i.e. 10^{-15} m, which compares with that of the initial Planck length, of about 10^{-35} m. Thus we get approximately the same expansion ratio for the scale factor, i.e. proportional to time and thus confirming the relation R=ct during the initial expansion.

But such a result is inconsistent with the equation (4) for the closed system, which for constant energy density demands an exponential time dependence of the Scale Factor. Similarly, it is inconsistent for an expansion in which the Scale Factor increases uniformly with time, as equation (4) will not allow a corresponding solution with constant Planck energy density. Thus the system must be open to sources which input the Planck energy and thereby produce a flow that, when the Higg's Field interacts therewith, is given mass.

Matter/Antimatter Twin Universes

The Higgs boson energy and half-life was measured at CERN through the reaction of quark/gluon/antiquark interacting with the Higg's Field producing signature photons emitted and thereby measured. This is a reversible process and so when the Planck energy interacts with the Higg's Field a quark/gluon/antiquark plasma is produced. At this time the physical processes of the Universe, as always, must obey the conservation laws of energy, momentum, charge etc. Conservation of energy and linear momentum demands the splitting of this q-g-aq composite resulting in the quark-gluon unit expanding away from an equal and opposite charged antiquark-gluon composite. Feynman used the conservation laws to produce the rules that govern the process and associated diagrams for pair production from energy. In all cases, a matter-antimatter pair are produced that both move forward in time but apart in space.

Regge calculus, that describes a self-consistent discrete space-time, where curvature rests on a triangular or smaller simplex, also demands conservation laws be applicable, c.f. MTW (1973). These result in mass/curvature creation from energy having equal and opposite discrete simplex components. Davies (1997) used Regge calculus to explain the 1/3 and -1/3 charges of quarks by quantizing this discrete simplex through measuring its curvature/area in units of Planck's Constant 'h'.

Einsteins fundamental equation is a wave equation that governs the gravitational potential produced by a density of mass/energy. Davies (2010) analyzed this equation in terms of the co-moving coordinates of the observer and concluded that the Universe could be expanding as a nonlinear Breather. In any wave equation of this type there are, for radially symmetric system, both forward traveling wave (r-ct) and backward traveling wave (r+ct) solutions, Whitham (1974). We can readily recognize these wave solutions as equivalent to Feynman's argument that antimatter propagating forward in time appears as matter propagating backward in time to an observer in the matter universe.

This initial intrinsic expansion is an energy flow governed by the laws of fluid dynamics which says that all flows have a source. Such flows are subject to changing their characteristics from laminar at low velocities to more complex flows depending on the value of the Reynold's Number, Re. This is given by the product of density, velocity and typical length divided by the viscosity. In his classic lecture series, Feynman (1964), shows that as the length of the flow from the source increases the first instability will produce two vortices with equal but opposite rotational directions.

Conclusion

For the earliest Universe, a constant Planck energy density inflow with expansion at the speed of light is the only model that attains the finite mass of the observable Universe when the Higg's Field interacts. The observational evidence shows that no antimatter galaxies have been seen back to the earliest moments after the decoupling of the CMBR. That the above four established and well-proven models of physical reality give the same result of the production of equal and opposite entities gives much credibility to the Higg's Field birthing our Universe of matter along with its antimatter twin.

References

Davies, J.B., 2015: "Intrinsic Initial Inflation Defines the Finite Mass Universe", Honorable Mention, Gravity Research Foundation Essay Competition.

Davies, J.B., 2010: "Co-Moving Coordinate Systems and the Breather Universe", Honorable Mention, Gravity Research Foundation Essay Competition.

Davies, J.B., 1997: "The Regge Calculus of the Fundamental Particles", Honorable Mention, Gravity Research Foundation Essay Competition.

Davies, J.B., 1991: "Nonlinear Clumping in the Early Universe", Honorable Mention, Gravity Research Foundation Essay Competition.

Feynmann, R.P., 1964, "Feynmann lectures on Physics", Vol II, Addison-Wesley Press.

Misner, C.W., K.S. Thorne & J.A. Wheeler, 1973, 'Gravitation', Freeman Press, New York.

Whitham, G.B., 1974, ‘Linear and Non-Linear Waves’, Wiley Press.