Chapter 3

Resonant Initial Event in ECE Cosmology

by

Myron W. Evans[1] and **H. Eckardt**[2]

Alpha Institute for Advanced Study (AIAS)
(www.aias.us, www.atomicprecision.com)

Abstract

The resonant initial event in ECE cosmology is defined by spin connection resonance in a Bernoulli Euler type differential equation. A very small amount of oscillatory mass density in a driving force may cause resonance in potential energy. The equations governing the initial event are generally covariant and based on the Cartan Bianchi identity and Cartan Evans dual identity. This mechanism is the simplest possible mechanism that can result in a resonant initial event and so is developed on the basis of relativity theory and Ockham's Razor. In a galaxy for example such a resonant initial event may dissipate itself and form the observed logarithmic spirals of stars on the basis of generally covariant space-time dynamics.

Keywords: ECE theory, angular momentum theory, integration of a hypersurface.Einstein Cartan Evans (ECE) field theory, spin connection resonance, resonant initial event, Bernoulli Euler resonance.

[1]e-mail: emyrone@aol.com
[2]e-mail: horsteck@aol.com

3.1 Introduction

It is well known that the metrics of the big bang view of a single initial cosmological event are incorrect because of the neglect of spacetime torsion [1] - [10]. Big bang theory has effectively been discarded and replaced by the Einstein Cartan Evans (ECE) unified field theory, currently the leading unified field theory. Cosmological initial events appear to be a plausible idea, but in the course of evolution there is no reason to assume as in big bang theory that only one such event occurred. In Section 2 a plausible mechanism is proposed for an initial event that is a resonant initial condition of a Bernoulli Euler type equation derived from ECE theory's concept of spin connection resonance (SCR). The latter concept has been shown experimentally to be the key to industrial descaling technology, and so the concept has been proven on an industrial scale [11]. It has several other applications in the search for new energy sources [1] - [10] and in the development of counter gravitational technologies [12]. The cosmological resonant initial event can be caused theoretically by a very small amount of mass density that plays the role of an oscillatory driving force in the simplest type of Bernoulli Euler resonant equation [13], a well known aspect of classical mechanics that conserves energy/momentum. It is shown in section 2 that at resonance, a large amount of potential energy may be created by the small amount of oscillatory mass density. This process is a Bernoulli Euler resonant process of classical dynamics, known since the eighteenth century.

In Section 3 the general theory is applied to the evolution of a whirlpool galaxy [14], in which the resonant initial event is a resonant initial condition of a differential equation. The potential energy and angular momentum of such a system may dissipate until equilibrium is reached. The point of equilibrium may be exemplified on the simplest conceptual level by constant spacetime angular momentum, which may be shown to produce logarithmic spirals of stars as observed in a whirlpool galaxy. It seems plausible that there were N such initial events during cosmological evolution, N going to infinity. The universe appears to have no beginning and no end, (these are anthropomorphic concepts) and the obsolete big bang model was hopelessly simplistic and mathematically self inconsistent.

3.2 Spin Connection Resonance as an Initial Condition

As an introduction to the concept of spin connection resonance in cosmology consider the orbital problem. In the received opinion the orbit is the result of balance between a negative valued, central and attractive force law, and positive valued, repulsive centripetal force. The potential energy of attraction depends only on the distance of an object from the force centre, defined by the reduced mass:

$$\mu = \frac{m_1 m_2}{m_1 + m_2} \tag{3.1}$$

In a planar orbit, angular momentum is conserved [13] and rotation of the system about any fixed axis through the centre of force cannot affect the equation of motion. Conservation of angular momentum $\boldsymbol{L}$ means that:

$$\frac{\partial \boldsymbol{L}}{\partial t} = \boldsymbol{0} \tag{3.2}$$

where the angular momentum is defined by:

$$\boldsymbol{L} = \boldsymbol{r} \times \boldsymbol{p}. \tag{3.3}$$

However, in general:

$$\boldsymbol{\nabla} \cdot \boldsymbol{L} \neq 0. \tag{3.4}$$

In recent work [1] - [10] the conserved angular momentum has been considered to be the angular momentum of spacetime itself, derived from spacetime torsion [1] - [10]. Time independent or conserved torsion produces a potential energy that is a function only of r. It has been shown [15] that this type of torsion produces a positive valued potential energy that is $1/r$ dependent. When used in combination with the Newtonian inverse square law of attraction, the result is a logarithmic spiral of stars as observed in a whirlpool galaxy. Orbital theory of any kind is due to spacetime angular momentum, a generally covariant view based on ECE theory. The orbital force is defined as:

$$F = -\frac{\partial \mu}{\partial r} \tag{3.5}$$

and the potential energy may be in general:

$$U(r) = -\left(\frac{k_1}{r} + \frac{k_2}{r^2} + \cdots + \frac{k_n}{r^n}\right) \tag{3.6}$$

so

$$F(r) = -\left(\frac{k_1}{r^2} + \frac{2k_2}{r^3} + \cdots + \frac{n\ k_n}{r^{n+1}}\right) \tag{3.7}$$

The terms in this series expansion indicate force laws which are all consistent with conservation of spacetime angular momentum 3.2. The Newtonian force law and orbit are respectively:

$$F = -\frac{k_1}{r^2}, U = -\frac{k_1}{r} \tag{3.8}$$

and

$$\frac{1}{r} = \frac{1}{\alpha}(1 + \epsilon \cos\theta). \tag{3.9}$$

In this case conserved spacetime angular momentum produces universal gravitation. A force of type:

$$F = -\frac{L^2}{\mu r^3}(1 + \alpha) \tag{3.10}$$

gives the potential energy:

$$U = -\frac{L^2}{2\mu r^2}(1+\alpha) \tag{3.11}$$

and a logarithmic spiral orbit inwards towards the force centre:

$$r = r_0 \exp{(\alpha\theta)}. \tag{3.12}$$

Therefore spacetime angular momentum plays a central role in classical dynamics an electrodynamics in the ECE generally covariant unified field theory [1] - [10]. The ECE equations of motion of dynamics and electrodynamics are angular momentum equations. The basic ECE hypothesis is:

$$F^{\kappa\mu\nu} = A^{(0)} T^{\kappa\mu\nu} \tag{3.13}$$

where $F^{\kappa\mu\nu}$ is the electromagnetic field, $T^{\kappa\mu\nu}$ is the spacetime torsion tensor, and $cA^{(0)}$ is a primordial or vacuum voltage observed in the radiative corrections [1] - [10]. To define S.I. units consider the Einstein field equation:

$$R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu} = \kappa T_{\mu\nu} \tag{3.14}$$

where $R_{\mu\nu}$ is the Ricci tensor, R is the Ricci scalar, $g_{\mu\nu}$ is the symmetric metric, k is the Einstein constant, and $T_{\mu\nu}$ is the symmetric canonical energy momentum density tensor. It is seen that k has the units of $m\ kgm^{-1}$, and the left hand side of [14] has the units of m^{-2}. So $T_{\mu\nu}$ has the units of mass density, $kgm\ m^{-3}$. So in field theory [16] the three index canonical angular momentum / angular energy density tensor defined by:

$$J^{\kappa\mu\nu} = -\frac{1}{2}(T^{\kappa\mu}x^{\nu} - T^{\kappa\nu}x^{\mu}) \tag{3.15}$$

has the units of kgm^{-2}. These are the units of angular momentum $kgm\ m^2 s^{-1}$ divided by cV, where V is a volume in cubic metres. Unfortunately these are non SI units inherited from standard field theory. In these non-SI units:

$$T^{\kappa\mu\nu} = k\ J^{\kappa\mu\nu}. \tag{3.16}$$

Now define:

$$T^{\mu\nu} = \int_0^V T^{0\mu\nu}\, dV = VT^{0\mu\nu} \tag{3.17}$$

and

$$J^{\mu\nu} = \int_0^V J^{0\mu\nu}\, dV = VJ^{0\mu\nu}. \tag{3.18}$$

The volume V is taken to be a fixed volume which does not fluctuate with time. This is the basis in field theory of the derivation of conservation of the total angular momentum of a dynamically conservative system contained within the volume V. Since V is a constant:

$$D_\mu(VT^{0\mu\nu}) = D_\mu T^{\mu\nu} = VD_\mu T^{0\mu\nu}. \tag{3.19}$$

Similarly define the curvature tensor:

$$R^\mu{}_\mu{}^\nu = \int_0^V R^0{}_\mu{}^{\mu\nu}\, dV = VR^0{}_\mu{}^{\mu\nu}. \tag{3.20}$$

It is found from the Cartan Bianchi identity and the Cartan Evans dual identity that:

$$\partial_\mu T^{\mu\nu} = j^\nu \tag{3.21}$$

whose Hodge dual is:

$$\partial_\mu \widetilde{T}^{\mu\nu} = \widetilde{j}^\nu. \tag{3.22}$$

Here we define:

$$T^{\mu\nu} = \frac{k}{c} J^{\mu\nu}. \tag{3.23}$$

Eqs. (3.21) and (3.22) are equations in angular momentum, QED.

It follows that the electromagnetic field tensor is:

$$F^{\mu\nu} = \frac{A^{(0)}}{V} T^{\mu\nu} \tag{3.24}$$

and the electromagnetic field is proportional to angular momentum as follows:

$$F^{\mu\nu} = \frac{A^{(0)}k}{cV} J^{\mu\nu}. \tag{3.25}$$

In units of tesla the magnetic flux density is:

$$B^{\mu\nu} = F^{\mu\nu} \tag{3.26}$$

and in units of volts per metre the electric field strength is:

$$E^{\mu\nu} = cF^{\mu\nu}. \tag{3.27}$$

If it is assumed that there is no magnetic monopole, Eqs. (3.21) and (3.22) give four vector equations. The pair of homogeneous equations are:

$$\boldsymbol{\nabla} \cdot \boldsymbol{B} = 0 \tag{3.28}$$

and

$$\boldsymbol{\nabla} \times \boldsymbol{E} + \frac{\partial \boldsymbol{B}}{\partial t} = \boldsymbol{0}, \tag{3.29}$$

and the pair of inhomogeneous equations are:

$$\boldsymbol{\nabla}\cdot\boldsymbol{E}=\frac{\rho}{\epsilon_0} \tag{3.30}$$

and

$$\boldsymbol{\nabla}\times\boldsymbol{B}-\frac{1}{c^2}\frac{\partial E}{\partial t}=\mu_0\boldsymbol{J}. \tag{3.31}$$

Here ρ is the electric charge density in Cm^{-3}, J is the electric current density,ϵ_0 is the vacuum permittivity, and μ_0 is the vacuum permeability. These are the generally covariant formulation of the well known Maxwell Heaviside structure of special relativity, a Lorentz covariant structure. It is seen from Eqs. (3.26) and (3.27) that these are equations in angular momentum of spacetime:

$$\partial_\mu\widetilde{J}^{\mu\nu}=0 \tag{3.32}$$

and

$$\partial_\mu J^{\mu\nu}=\frac{k}{c}j^\nu. \tag{3.33}$$

In ECE theory Eqs. (3.32) and (3.33) are also the equations of dynamics. Most generally, their structure in both dynamics and electrodynamics are:

$$\partial_\mu\widetilde{J}^{\mu\nu}=\widetilde{j}^{\nu'}=\frac{k}{c}\widetilde{j}^\nu \tag{3.34}$$

and

$$\partial_\mu J^{\mu\nu}=j^{\nu'}=\frac{k}{c}j^\nu \tag{3.35}$$

i.e. ECE allows a non-zero âĂIJmagnetic monpoleâĂİ which is actually a spacetime structure [1] - [10].

It is well known [1] - [10] that the electromagnetic field tensor is:

$$F^{\mu\nu}=\begin{bmatrix}0&-\frac{E_X}{c}&-\frac{E_Y}{c}&-\frac{E_Z}{c}\\ \frac{E_X}{c}&0&-B_Z&B_Y\\ \frac{E_Y}{c}&B_Z&0&-B_X\\ \frac{E_Z}{c}&B_Y&B_X&0\end{bmatrix}. \tag{3.36}$$

Therefore this tensor is based on the following angular momentum structure:

$$J^{\mu\nu}=\begin{bmatrix}0&-L_X&-L_Y&-L_Z\\ L_X&0&-S_Z&S_Y\\ L_Y&S_Z&0&-S_X\\ L_Z&-S_Y&S_X&0\end{bmatrix} \tag{3.37}$$

and consists of orbital L and spin S angular momentum components. It follows that Eq. (3.35) becomes two inhomogeneous vector equations of field theory:

$$\boldsymbol{\nabla}\cdot\boldsymbol{L}=j^{'0} \tag{3.38}$$

and

$$\boldsymbol{\nabla} \times \boldsymbol{S} - \frac{1}{c}\frac{\partial \boldsymbol{L}}{\partial t} = \boldsymbol{j}^{'}. \tag{3.39}$$

Here:

$$\begin{array}{ll} L_X = J^{10} = -J^{01}, & S_Z = J^{21} = -J^{12} \\ L_y = J^{20} = -J^{02}, & S_Y = J^{13} = -J^{31} \\ L_Z = J^{30} = -J^{03}, & S_X = J^{32} = -J^{23} \end{array} \tag{3.40}$$

and

$$\boldsymbol{L} = L_X \boldsymbol{i} + L_Y \boldsymbol{j} + L_Z \boldsymbol{k}, \tag{3.41}$$

$$\boldsymbol{S} = S_X \boldsymbol{i} + S_Y \boldsymbol{j} + S_Z \boldsymbol{k}. \tag{3.42}$$

The acceleration due to gravity may be defined as:

$$\boldsymbol{g} = \frac{ck}{V}\boldsymbol{L} \tag{3.43}$$

and the electric field strength may be defined as:

$$\boldsymbol{E} = A^{(0)}\frac{k}{V}\boldsymbol{L}. \tag{3.44}$$

In previous work Eq. (3.38) was reduced to the form:

$$\boldsymbol{\nabla} \cdot \boldsymbol{g} = 4\pi G \rho_m = c^2(R - \omega T) \tag{3.45}$$

where:

$$k = \frac{8\pi G}{c^2}, \tag{3.46}$$

G being Newton's gravitational constant. Here ρ_m denotes mass density in kgm per cubic metre, R is a well defined curvature, ω a well defined spin connection, and T a well defined torsion. Therefore:

$$\boldsymbol{\nabla} \cdot L = \frac{1}{2}c\, V \rho_m. \tag{3.47}$$

If it is assumed that the mass density is:

$$\rho_m = \frac{m}{V} \tag{3.48}$$

then:

$$\boldsymbol{\nabla} \cdot L = \frac{1}{2}mc. \tag{3.49}$$

Similarly:

$$\boldsymbol{\nabla} \times \boldsymbol{S} - \frac{1}{c}\frac{\partial \boldsymbol{L}}{\partial t} = \frac{1}{2}V\boldsymbol{j}^{'}_m \tag{3.50}$$

where the mass four-current is:

$$j'^{\mu} = (\rho_m, \frac{\boldsymbol{j}'_m}{c}). \tag{3.51}$$

The dual Eq. (3.34) gives:

$$\boldsymbol{\nabla} \cdot \boldsymbol{S} = \frac{1}{2} c\, V \widetilde{\rho}_m \tag{3.52}$$

and

$$\boldsymbol{\nabla} \times \boldsymbol{L} + \frac{1}{c}\frac{\partial \boldsymbol{S}}{\partial t} = \frac{1}{2} V \widetilde{\boldsymbol{j}}'_m. \tag{3.53}$$

Eq. (3.47) is the dynamical equivalent of the Coulomb law, Eq. (3.50) is the dynamical equivalent of the Ampere Maxwell law, Eq. (3.52) is the dynamical equivalent of the Gauss law of magnetism, and Eq. (3.53) is the dynamical equivalent of the Faraday law of induction.

Usually in classical dynamics, only the Newtonian structure 3.45 is used in the non-relativisic limit, whereas all four ECE equations are generally covariant. In the Newtonian limit:

$$g = -\frac{1}{m}\frac{\partial U}{\partial r} = -\frac{mG}{r^2} = \frac{ckL}{V} \tag{3.54}$$

so the force due to gravity is:

$$F = \frac{8\pi G m}{cV} L. \tag{3.55}$$

This result shows that spacetime is inherently chiral, or handed, because the force, a polar vector, is proportional to orbital angular momentum, an axial vector. In the Newtonian interpretation the potential energy produces an attractive, negative valued, force between masses m and M and there is no angular momentum of spacetime. In ECE theory the dynamics are controlled by the angular momentum of spacetime and by spacetime geometry. For example, the conserved angular momentum of orbits in a plane is the conserved angular momentum of spacetime itself. The latter produces the $\boldsymbol{r}$ and $\boldsymbol{p}$ of orbits. In Newtonian theory the converse is thought to be the case, the angular momentum is produced by the $\boldsymbol{r}$ and $\boldsymbol{p}$ of already existing orbits in a uniform space distinct from time.

Spin connection resonance enters into EEC dynamics by considering the first Cartan structure equation [1] - [10] in addition to the Cartan Bianchi identity and the Cartan Evans dual identity. The first structure equation may be written in vector notation as:

$$\boldsymbol{g} = \frac{1}{c}(-\boldsymbol{\nabla} U - \frac{1}{c}\frac{\partial \boldsymbol{U}}{\partial t} + U\boldsymbol{\omega} - \omega_0 \boldsymbol{U}) \tag{3.56}$$

where:

$$U^{\mu} = (U, \boldsymbol{U}) \tag{3.57}$$

is a four-vector of potential energy. The orbital angular momentum is:

$$\boldsymbol{L} = \frac{V}{ck}\,\boldsymbol{g} \tag{3.58}$$

and:

$$\boldsymbol{\nabla}\cdot\boldsymbol{L} = j^{'0} = \frac{1}{2}c\;V\rho_m. \tag{3.59}$$

Similarly, the first Cartan structure equation defines the gravitomagnetic field:

$$\boldsymbol{h} = \frac{1}{m}(\boldsymbol{\nabla}\times\boldsymbol{U} - \boldsymbol{\omega}\times\boldsymbol{U}) \tag{3.60}$$

in units of ms^{-2}, the same units as g. The field h is the gravitational equivalent of the magnetic flux density B in ECE electrodynamics. Eq. (3.59) is therefore:

$$\boldsymbol{\nabla}^2 U + \frac{1}{c}\boldsymbol{\nabla}\cdot\frac{\partial\boldsymbol{U}}{\partial t} - U\boldsymbol{\nabla}\cdot\omega + \omega_0\boldsymbol{\nabla}\cdot\boldsymbol{U} = -\frac{1}{2}mc^2k\rho_m \tag{3.61}$$

which [1]- [10] has a Bernoulli Euler resonance structure 3.13 in general. The term on the right hand side of Eq. (3.61) is the driving term. A great deal of work has been completed [1]- [10] on such structures, including the development of a finite element numerical integration technique 3.17. The important feature of spin connection resonance is the amplification at resonance of U by an initially small driving term. The amplification process is a Bernoulli Euler process which is well known and developed in classical dynamics and electrical circuit theory. At resonance U becomes very large while the driving mass density ρ_m remains very small. The angular momentum $\boldsymbol{L}$ is in turn amplified at resonance because:

$$L = \frac{V}{ckm}\,(-\boldsymbol{\nabla}U - \frac{1}{c}\frac{\partial\boldsymbol{U}}{\partial t} + U\boldsymbol{\omega} - \omega_0\boldsymbol{U}). \tag{3.62}$$

In order to apply these ideas to initial events in cosmology, it is plausible to consider the initial event as the initial condition of the differential equation Eq. (3.61). At the initial event the angular momentum L is very large, so produces an outward surge of momentum p through:

$$\boldsymbol{L} = \boldsymbol{r}\times\boldsymbol{p}. \tag{3.63}$$

As the dynamics of Eq. (3.61) develop, the angular momentum dissipates, the process becomes off resonance. Finally, equilibrium is reached. The state of equilibrium in a whirlpool galaxy for example consists of a central part and of logarithmic spirals of galaxies as observed for example in M51. It is conceivable that other structures in cosmology may be formed by similar initial events. In the next section we discuss the spacetime dynamics underlying a logarithmic spiral trajectory as an example of a dissipated initial event caused by spin connection resonance.

3.3 Spacetime Dynamics Underlying a Logarithmic Spiral Trajectory

By observation, the spiral arms of a whirlpool galaxy are arranged on a logarithmic spiral:

$$r = r_0 \exp{(b\theta)} \tag{3.64}$$

where r_0 is a characteristic radius and where b determines the characteristics of the spiral. When b becomes very large the spiral consists of one turn and an essentially straight arm. When b is very small the spiral approaches a circle, so looks like a tightly wound watch spring. In Eq. (3.64), plane polar [13] coordinates are used (r, θ). Differentiating Eq. (3.64) with respect to time:

$$\dot{r} = r_0 b\dot{\theta} \exp{(b\theta)}. \tag{3.65}$$

The velocity in plane polar coordinates is 3.13:

$$\boldsymbol{v} = \dot{r}\boldsymbol{e}_r + r\dot{\theta}\boldsymbol{e}_\theta \tag{3.66}$$

so

$$\boldsymbol{v} = |\boldsymbol{v}| = (\dot{r^2} + r^2\dot{\theta^2})^{\frac{1}{2}} = r\dot{\theta}(1+b^2)^{\frac{1}{2}}. \tag{3.67}$$

The velocity curve of the galaxy is therefore:

$$v = v_\theta(1+b^2)^{\frac{1}{2}}, \;\; V_\theta = r\dot{\theta}. \tag{3.68}$$

It is observed that v becomes constant as r becomes very large, contrary to Newtonian dynamics. This means that for a given b, the transverse velocity V_θ becomes constant. We seek the underlying spacetime dynamics that gives this observed behaviour. The acceleration in plane polar coordinates is [13]:

$$\boldsymbol{a} = \frac{\partial \boldsymbol{v}}{\partial t} = (\ddot{r} - r\dot{\theta}^2)\boldsymbol{e}_r + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\boldsymbol{e}_\theta \tag{3.69}$$

and the force:

$$\boldsymbol{F} = m\boldsymbol{a} \tag{3.70}$$

has radial and transverse components. The kinetic energy is:

$$T = \frac{1}{2}mv^2 = \frac{1}{2}mr^2\dot{\theta}^2(1+b^2) \tag{3.71}$$

and the conversed angular momentum on spacetime is:

$$L = mrv = mr^2\dot{\theta}(1+b^2)^{\frac{1}{2}}. \tag{3.72}$$

Therefore

$$T = \frac{1}{2}\omega L \tag{3.73}$$

where

$$\omega = \dot{\theta} \tag{3.74}$$

is the spacetime angular velocity. The conserved angular momentum gives rise to the pontentila energy [13]:

$$U = \frac{L^2}{mr^2}, \quad F_r = -\frac{\partial U}{\partial r} = mr\dot{\theta}^2(1+b^2) \tag{3.75}$$

and a effective radial force outwards from the centre. This is the force caused by the initial event discussed in Section 2. The effective radial force is one of spacetime itself, and moves a star of the galaxy in the logarithmic spiral trajectory Eq. (3.64) outwards. More generally:

$$\boldsymbol{F} = -\boldsymbol{\nabla} U = m(\ddot{r} - r\dot{\theta}^2)\boldsymbol{e}_r + (r\ddot{\theta} + \partial\dot{r}\dot{\theta})\boldsymbol{e}_\theta. \tag{3.76}$$

In the simplest instance define:

$$F = m\frac{dv}{dt} = m(\dot{r}\dot{\theta} + r\ddot{\theta})(1+b^2)^{\frac{1}{2}}. \tag{3.77}$$

Comparing Eqs. (3.75) and (3.77):

$$r\dot{\theta}^2 = \dot{r}\dot{\theta} + r\ddot{\theta} \tag{3.78}$$

and using Eq. (3.64):

$$\ddot{\theta} = (1-b)\dot{\theta}^2 \tag{3.79}$$

i.e. there exists the supplementary constraint:

$$\ddot{\theta} = (1-b)\dot{\theta}^2 \tag{3.80}$$

This is the constraint needed for the force law Eq. (3.75) to produce the logarithmic spiral trajectory Eq. (3.64), with the stars moving outwards around the spiral form its centre. There is an effective inverse cubed radial spacetime force Eq. (3.77) outwards from the centre.

The lagrangian for the problem is:

$$L = T - U \tag{3.81}$$

where the kinetic energy is:

$$T = \frac{1}{2}m(\dot{r}^2 + r^2\dot{\theta}^2) \tag{3.82}$$

and the potential energy is in general:

$$U = U(r, \theta, \dot{r}, \dot{\theta}). \tag{3.83}$$

The Euler Lagrange equations are:

$$\frac{\partial L}{\partial r} = \frac{d}{dt}\frac{\partial L}{\partial \dot{r}} \tag{3.84}$$

and

$$\frac{\partial L}{\partial \theta} = \frac{d}{dt}\frac{\partial L}{\partial \dot{\theta}}. \tag{3.85}$$

These produce the equations of motion:

$$mr\dot{\theta}^2 - \frac{\partial U}{\partial r} - m\ddot{r} + \frac{d}{dt}\frac{\partial U}{\partial \dot{r}} = 0 \tag{3.86}$$

$$-\frac{\partial U}{\partial \theta} - mr^2\ddot{\theta} - \partial mr\dot{r}\dot{\theta} + \frac{d}{dt}\frac{\partial U}{\partial \dot{\theta}} = 0 \tag{3.87}$$

wich can be re-arrenged as the well determined system of equations:

$$\dot{r} = V_r \tag{3.88}$$

$$\dot{\theta} = \omega \tag{3.89}$$

$$\ddot{r} = r\omega^2 + \frac{1}{m}F_r + \frac{1}{m}F_{v_r} \tag{3.90}$$

$$\ddot{\theta} = -2\frac{v_r}{r}\omega + \frac{1}{m}F_\theta + \frac{1}{m}F_\omega \tag{3.91}$$

Here there are four types of spacetime force in general:

$$\begin{aligned} F_r &= -\frac{\partial U}{\partial r}, \quad F_{v_r} = \frac{d}{dt}\frac{\partial U}{\partial \dot{r}}, \\ F_\theta &= -\frac{\partial U}{\partial \theta}, \quad F_\omega = \frac{d}{dt}\frac{\partial U}{\partial \dot{\theta}}. \end{aligned} \tag{3.92}$$

If it is assumed that the force is purely radial, these reduce to:

$$\ddot{r} = r\omega^2 + \frac{1}{m}F_r \tag{3.93}$$

(which is consistent with Eq. (3.76), and

$$\ddot{\theta} = -2\frac{v_r}{r}\omega. \tag{3.94}$$

Comparing Eq. (3.80) with the constraint Eq. (3.94) gives:

$$3b^2 - 2b + 3 = 0 \tag{3.95}$$

wich is a quadratic equation for b. Therefore the analysis is self consistent. In general a logarithmic spiral trajectory outwards must be sustained by four tyoes of spacetime force component. These are all caused by a resonant initial event.

ACKNOWLEDGMENTS
The British Government is thanked for a Civil List pension to MWE and the staff of AIAS and others for many interesting discussions.

Bibliography

[1] M. W. Evans, "Generally Covariant Unified Field Theory" (Abramis, 2005 onwards), vols. 1 - 5, vol. 6 in prep., (see www.aias.us).

[2] L. Felker, "The Evans Equations of Unified Field Theory" (Abramis 2007).

[3] K. Pendergast, "The Life of Myron Evans" (Abramis 2009, preprint on www.aias.us).

[4] M. W. Evans, "Modern Non-Linear Optics" (Wiley 2001, second edition); M. W. Evans and S. Kielich (eds., ibid., first edition, 1992, 1993, 1997).

[5] M. W. Evans and L. B. Crowell, "Classical and Quantum Electrodynamics and the B(3) Field" (World Scientific 2001).

[6] M. W. Evans and J.-P. Vigier, "The Enigmatic Photon" (Kluwer, 1994 to 2002, hardback and softback), in five volumes.

[7] ECE Papers and Articles on www.aias.us www.atomicprecision.com, ECE source papers, ECE papers by other authors and ECE educational articles.

[8] M. W. Evans et al., Omnia Opera section of www.aias.us, notably from 1992 to present on the ECE theory and its precursor gauge theories homomorphic with those of Barrett, Harmuth and Lehnert.

[9] M. W. Evans, Acta Phys. Polonica, 400, 175 (2007); M. W. Evans, Physica B, 403, 517 (2008)

[10] M. W. Evans and H. Eckardt, invited papers to journal special issue, 2010.

[11] L. H. Ryder, "Quantum Field Theory" (Cambridge, 2nd ed., 1996).

[12] J. B. Marion and S. T. Thornton, "Classical Dynamics" (HBC, New York, 1988, 3rd.ed.).

[13] J. P. Marion and S. T. Thornton, "Classical Dynamics of Particles and Systems" (HCB, New York, 1988, third ed.).

[14] See paper 76 of ECE theory and animations on www.aias.us.

[15] M. W. Evans and H. Eckardt, paper 123 on www.aias.us.

[16] L. H. Ryder, "Quantum Field Theory" (Cambridge Univ. Press, 2nd. Ed., 1996), chapter three.

[17] D. Lindstrom, two papers on www.aias.us.