# RIGOROUS SELF CONSISTENCY OF THE LAGRANGIAN AND HAMILTONIAN m THEORIES.

by

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ABSTRACT

It is shown that the lagrangian and hamiltonian m theories are rigorously self consistent if and only if the plane polar frame of reference is ( $r_1$, $\phi$ ), where $r_1$ is defined as $r / m(r)^{1/2}$, where m ( r) is the function that defines the infinitesimal line element of the most general spherically symmetric spacetime. In this frame the lagrangian used in recent papers is rigorously derivable form the hamiltonian theory that gives the Evans Eckardt equations of motion.

Keywords, ECE unified field theory, m theory, lagrangian and hamiltonian formalisms.

UFT 424

## 1. INTRODUCTION

In recent papers of this series {1 - 41} the lagrangian formulation of m theory has been used to derive several original and important results such as the possibility of superluminal motion, infinite energy from m space, forward and retrograde orbit precession, shrinking orbits, the possibility of expanding orbits, an explanation of the orbit of the S2 star as a non Kepler Newton ellipse, light deflection due to gravitation and several more major discoveries. The hamiltonian formalism of m theory has been used to derive the Evans Eckardt equations of motion. In Section 2 it is shown that the lagrangian and hamiltonian formalisms are rigorously equivalent if and only if the correct frame of reference is used. This is the frame of reference of the most general spherically symmetric spacetime in any coordinate system. If this frame is not used, rigorous self consistency is lost.

This paper is a short synopsis of detailed calculations given in the notes accompanying UFT424 on www.aias.us. Note 424(1) is a derivation of the lagrangian from the hamiltonian in the usual flat space plane polar coordinate system ( $r$ , $\phi$ ). The resulting lagrangian is not consistent with that used in preceding papers. Note 424(2) is a review of the geodesic method used in UFT416 to derive the hamiltonian of m theory used to define the Evans Eckardt equations of motion of classical dynamics. This geodesic procedure checks that the hamiltonian of m theory is rigorously correct. Note 424(3) shows that the inconsistency in Note 424(1) is resolved by using the correct frame of reference - that of the most general spherically symmetric spacetime. It follows that the development of the subject of classical dynamics in the most general spherically symmetric spacetime will lead to many original and major advances in understanding

## 2. THE SELF CONSISTENT HAMILTONIAN AND LAGRANGIAN.

Consider the plane polar coordinates in the most general spherical spacetime:

$$(r_1, \phi) \quad -(1)$$

where:

$$r_1 = \frac{r}{m(r_1)^{1/2}} \quad -(2)$$

and where m ( $r_1$ ) is defined by the infinitesimal line element of the most general spherically symmetric spacetime:

$$ds^2 = c^2 d\tau^2 = m(r) c^2 dt^2 - \frac{dr^2}{m(r)} - r^2 d\phi^2. \quad -(3)$$

As shown in immediately preceding papers the hamiltonian in this coordinate system is:

$$H = m(r_1) \gamma m c^2 - \frac{mMG}{r_1} \quad -(4)$$

and the angular momentum is:

$$L = \gamma m r_1^2 \dot{\phi} \quad -(5)$$

The Evans Eckardt equations of motion of dynamics in m space are:

$$\frac{dH}{dt} = 0 \quad -(6)$$

and

$$\frac{dL}{dt} = 0 \quad -(7)$$

and follow directly from the fact that H and L are constants of motion. As shown in previous work the magnitude of the velocity vector in ( $r_1, \phi$ ) is:

$$v_1 = \frac{v}{m(r_1)^{1/2}} \quad -(8)$$

From the fundamentals of Lagrangian dynamics {1 - 41}:

$$\mathcal{L} = \gamma m v_1^2 - H \quad -(9)$$

where the generalized Lorentz factor of m theory is:

$$\gamma = \left( m(r_1) - \frac{\dot{r}_1^2 + r_1^2 \dot{\phi}^2}{c^2} \right)^{-1/2} \quad -(10)$$

The magnitude of the relativistic momentum is:

$$p_1 = \gamma m v_1 \quad -(11)$$

so:

$$v_1^2 = \frac{p_1^2}{\gamma^2 m^2} \quad -(12)$$

and:

$$\mathcal{L} = \frac{p_1^2 c^2}{\gamma m c^2} - H. \quad -(13)$$

Using:

$$p_1 = \gamma m v_1 \quad -(14)$$

it follows that:

$$p_1^2 c^2 = \gamma^2 m^2 c^4 \frac{v_1^2}{c^2}. \quad -(15)$$

From Eq. ( 10 ):

$$\frac{1}{\gamma^2} = m(r_1) - \frac{v_1^2}{c^2} \quad -(16)$$

so:

$$\frac{v_1^2}{c^2} = m(r_1) - \frac{1}{\gamma^2} \quad -(17)$$

From Eqs. ( 15 ) and ( 17 ):

$$p_1^2 c^2 = \gamma^2 m^2 c^4 m(r_1) - m^2 c^4 \quad -(18)$$

The Einstein energy equation in m space is therefore:

$$E^2 = m(r_1)\left(p_1^2 c^2 + m^2 c^4\right) \quad -(19)$$

where:

$$E = m(r_1)\gamma m c^2 \quad -(20)$$

is the total relativistic energy in m space as shown by the geodesic method of Note 424(2).

The lagrangian in ( $r_1, \phi$ ) corresponding to the hamiltonian ( 4 ) is therefore:

$$\mathcal{L} = \frac{p_1^2 c^2}{\gamma m c^2} - m(r_1)\gamma m c^2 + \frac{mMG}{r_1} \quad -(21)$$

and from Eqs. ( 18 ) and ( 21 ):

$$\mathcal{L} = m(r_1)\gamma m c^2 - \frac{mc^2}{\gamma} - m(r_1)\gamma m c^2 + \frac{mMG}{r_1}$$

$$= -\frac{mc^2}{\gamma} + \frac{mMG}{r_1} \quad -(22)$$

which is the lagrangian used in immediately preceding UFT papers, Q. E. D.

The hamiltonian and lagrangian formulations of m theory are rigorously equivalent if and only if the coordinate system of the most general spherically symmetric space is used.

Otherwise, as shown in Note 424(1) self consistency is lost. The lagrangian ( 22 ) produces the correct relativistic momentum:

$$p_1 = \frac{\partial \mathcal{L}_1}{\partial v_1} = \gamma m v_1 \qquad (23)$$

in frame ( $r_1, \phi$ ) but this is not true in frame ( r , $\phi$ ). The entire subject of classical dynamics must be redeveloped in frame ( $r_1, \phi$ ). The Evans Eckardt equations must always be developed in frame ( $r_1, \phi$ ) with the hamiltonian ( 4 ) and the angular momentum ( 5 ). The latter is found from:

$$\underline{L}_1 = \underline{r}_1 \times \underline{p}_1 = \gamma m r_1^2 \dot{\phi} \, \underline{k} \qquad (24)$$

The magnitude of linear velocity in m space must be defined by Eq. ( 8 ) in order that the lagrangian and hamiltonian formulations be equivalent. The lagrangian of m theory must always be defined in frame ( $r_1, \phi$ ) and is:

$$\mathcal{L} = \frac{p_1^2 c^2}{\gamma m c^2} - H = -\frac{mc^2}{\gamma} + \frac{mMG}{r_1}. \qquad (25)$$

The Euler Lagrange equations must be:

$$\frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{r}_1} = \frac{\partial \mathcal{L}}{\partial r_1} \qquad (26)$$

and

$$\frac{d}{dt}\frac{\partial \mathcal{L}}{\partial \dot{\phi}} = \frac{\partial \mathcal{L}}{\partial \phi}. \qquad (27)$$

3. SOME GRAPHICAL RESULTS FOR DIFFERENT m FUNCTIONS

(Section by Dr. Horst Eckardt)

# Rigorous self consistency of the Lagrangian and Hamiltonian m theories


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## 3 Additional computations and graphical results

### 3.1 Constraints for angular momentum

The Hamiltonian and Lagrangian method give different results in space $(r, \phi)$. For the Hamiltonian method, we obtain the results already discussed in UFT 420. The results are quite complicated due to the additional terms in the Lagrangian (22). In particular the angular momentum (being the constant of motion) contains an additional term:

$$L = \gamma m r^2 \dot{\phi} + (\mathrm{m}(r) - 1)\gamma^3 m r^2 \dot{\phi}. \tag{28}$$

The first term is the regular one, the second is an extension due to $\mathrm{m}(r)$ which disappears for $\mathrm{m}(r)$=1. In order to reconcile the equations of motion of both spaces $(r, \phi)$ and $(r_1, \phi)$, we have to use the constraint equation (19) of note 424(3):

$$\frac{\partial \mathscr{L}}{\partial \dot{\phi}} = \frac{\gamma}{\mathrm{m}(r)} m r^2 \dot{\phi}. \tag{29}$$

Since the partial derivative of $\dot{\phi}$ has to be taken, we respect only occurrences of $\dot{\phi}$ in the Lagrangian directly, without indirect dependencies. Then the left hand side of Eq. (29) gives exactly the above result (28) for the angular momentum. This is equated with the "expected" relativistic angular momentum at the right hand side of (29). Then the equation

$$\gamma m \, \dot{\phi} \, r^2 \, \left(\gamma^2 \, \mathrm{m}(r) - \gamma^2 + 1\right) = \frac{\gamma}{\mathrm{m}(r)} m r^2 \, \dot{\phi} \tag{30}$$

results which has two solutions for $\mathrm{m}(r)$:

$$\mathrm{m}_1(r) = -\frac{1}{\gamma^2}, \tag{31}$$

$$\mathrm{m}_2(r) = 1. \tag{32}$$


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The second solution means the case of special relativity where the Hamiltonian and Lagrangian method give identical results. The first solution is negative and may or may not describe a special physical situation. Both the Hamiltonian and Lagrangian method should also give identical results in this case.

The current calculation resolves the problem of constraints which could not be specified precisely in preceding papers.

### 3.2 Equations of motion in coordinate system $(r_1, \phi)$

We computed the $(r_1, \phi)$ equations of motion from the Hamiltonian and Lagrangian method. The equations coincide as expected. They are significantly simpler than in the $(r, \phi)$ coordinate system and had already been derived in UFT 416, Eqs. (60, 61), in that case as Euler-Lagrange equations only.

The equations of motion based on the Hamiltonian have been derived from

$$\frac{dH}{dt} = 0, \quad \frac{dL}{dt} = 0 \tag{33}$$

with the Hamiltonian in the rest system

$$H = m(r_1)\gamma\, m\, c^2 - \frac{mMG}{r_1} \tag{34}$$

and angular momentum in $Z$ direction

$$L = \gamma\, m\, {r_1}^2\, \dot{\phi}. \tag{35}$$

The generalized Lorentz factor $\gamma$ is defined in this case by

$$\gamma = \left( \mathrm{m}(r_1) - \frac{\dot{r_1}^2 + {r_1}^2\dot{\phi}^2}{c^2} \right)^{-1/2}. \tag{36}$$

The equations of motion obtained by computer algebra from (33) are

$$\ddot{\phi} = \dot{\phi}\, \dot{r}_1 \left( \frac{1}{\mathrm{m}(r_1)} \left( \frac{d}{dr_1}\, \mathrm{m}\,(r_1) + \frac{GM}{\gamma\, c^2\, {r_1}^2} \right) - \frac{2}{r_1} \right), \tag{37}$$

$$\ddot{r}_1 = \left( \frac{d}{dr_1}\, \mathrm{m}\,(r_1) \right) \left( c^2 \left( \frac{1}{2} - \frac{1}{\gamma^2\, \mathrm{m}\,(r_1)} \right) - \frac{\dot{\phi}^2 \dot{r_1}^2}{\mathrm{m}\,(r_1)} \right) - \frac{GM\, \dot{\phi}^2}{\gamma\, c^2\, \mathrm{m}\,(r_1)} + \dot{\phi}^2\, r_1 - \frac{GM}{\gamma^3\, {r_1}^2\, \mathrm{m}\,(r_1)}. \tag{38}$$

The last term of $\ddot{\phi}$ and the two last terms of $\ddot{r}$ are the non-relativistic expressions, where the gravitational force has a factor of $1/\gamma^3$ as already observerd in UFT 415/416.

It is interesting to compare the differences of the calculational bases $(r, \phi)$ and $(r_1, \phi)$ in certain critical cases. We investigated an example of an event horizon with collapsing orbits in UFT 416, Fig. 9. The example was computed with an exponential m function in the $(r, \phi)$ system for the $r$ orbit. The corresponding $r_1$ orbit then was derived a posteriori by

$$r_1 = \frac{r}{\sqrt{\mathrm{m}(r)}}. \tag{39}$$

This gives the orbits graphed in Fig. 1 which is a copy of Fig. 9 of UFT 416. The $r$ orbit ends at the horizon while the derived coordinate $r_1$ diverges. In the current paper we used the $(r_1, \phi)$ system as a computational basis, solving equations (37, 38) numerically, with the same m function and parameters as used for Fig. 1. Afterwards the coordinate trajectory $r$ was computed by

$$r = r_1 \sqrt{\mathrm{m}(r_1)}. \tag{40}$$

The result is graphed in Fig. 2. Now the primary coordinate $r_1$ ends at the horizon while the derived coordinate $r$ ends in the gravitational centre. Obviously the m function "transforms away" the singularity at the event horizon, shifting it to the centre. This would mean that an external observer would not see the horizon at all, in contrast to the results in the $(r, \phi)$ system. Obviously there are intricate differences in both bases of observation.

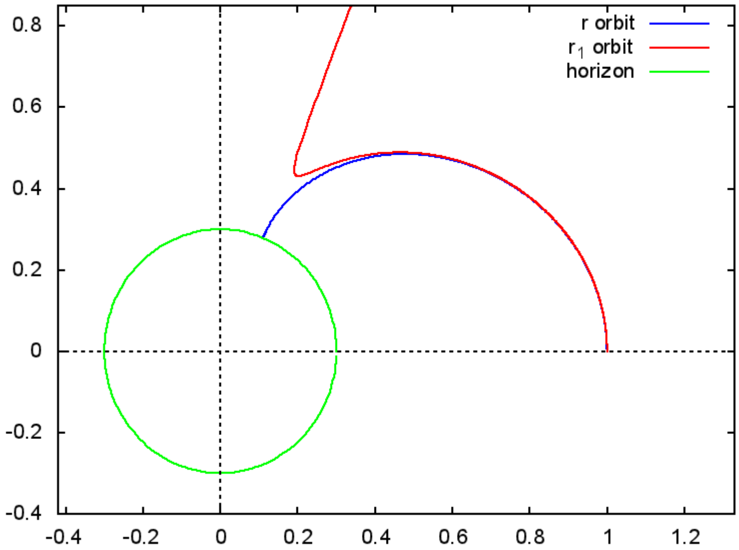


Figure 1: Collapsing orbits outside of event horizon, coordinate system $(r, \phi)$.

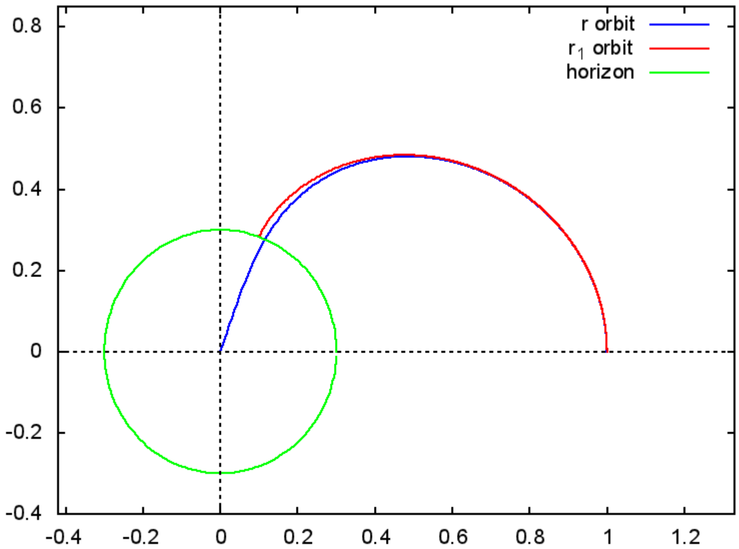


Figure 2: Collapsing orbits outside of event horizon, coordinate system $(r_1, \phi)$.

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