SELF CONSISTENCY AND INTERPRETATION OF THE ECE / MINKOWSKI COSMOLOGY.

by

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ABSTRACT

A self consistent cosmology of all observable orbits is developed from the Minkowski metric. The orbit is derived directly from geometry, and various expressions deduced for the acceleration associated with the orbit, the acceleration also being a direct consequence of geometry. The Cartan tetrad and torsion are derived for the dynamic or phase dependent Minkowski metric by factorizing the latter into phase dependent Cartan tetrads. All orbits can be classified systematically with this method.

Keywords: ECE unified field theory, ECE / Minkowski cosmology.

UFT 234

1. INTRODUCTION.

In recent papers of this series {1 - 10} a useful new cosmology has been developed on the basis of the Minkowski metric without using any of the concepts of Einsteinian or Newtonian cosmology. The Minkowski metric can be factorized into phase dependent Cartan tetrads to produce a Cartan torsion. The Cartan and Evans identities {1 - 11} produce field equations of gravitation and magnetogravitation from the dynamic Minkowski metric. It has been well known for over half a century that the Einsteinian general relativity (EGR) fails completely to describe the great majority of features known from astronomy, notably the velocity curve of a spiral galaxy. The Newtonian dynamics also fails completely. These are well known experimental facts, so it is futile to claim that EGR is a precise theory when it fails completely for the vast majority of data. Recently {1 - 10} many definitive theoretical refutations of EGR have been given and accepted almost unanimously as shown by accurate scientometrology. It is is known precisely how a theory such as ECE is accepted by building up accurate scientometrics over a decade.

In the two preceding papers UFT232 and UFT233 a new cosmology has been suggested based on Ockham's Razor, the use of the simplest metric compatible with relativity - the Minkowski metric. Usually the latter is associated with special relativity in a flat spacetime with no connection. In some of the previous papers of this series of two hundred and thirty three papers and eleven volumes to date (www.aias.us), it has been shown that the Minkowski metric can be factorized into phase dependent tetrads that define a Cartan torsion. It has also been shown that the Minkowski metric gives the Einstein energy equation directly, and that the plane polar version of the metric gives an orbit directly. Any observable orbit can be described in terms of the ratio of the relativistic linear momentum $\underline{p}$ of an orbiting object to its relativistic angular momentum $\underline{L}$. All orbits can be classified with this ratio.

In Section 2, various expressions are derived for the acceleration generated by any observable orbit. The acceleration is shown to be a direct consequence of the orbit, and the latter is a direct consequence of geometry in spacetime. The use of spacetime rather than space introduces dynamics. For the Minkowski metric the acceleration is always radially directed. This is also true for any metric of a spherically symmetric spacetime. In relativity theory, the orbit is geometry itself. In the earliest attempts to understand an orbit, for example by Kepler, Hooke and Newton, the orbit was described anthropomorphically in terms of a force between the orbiting object of mass m and another mass M. There was thought to be a force of attraction between m and M, and Hooke was the first to realize that for an elliptical orbit this force must be proportional inversely to the square of the distance between m and M. He pointed this out to Newton as described in John Aubrey's classic "Brief Lives". It was natural to think of M pulling m, but this is a completely incorrect viewpoint. This force needs to be counterbalanced in order for the object m to stay in orbit, and at this point the Newtonian dynamics fails {12} as described in many textbooks. It incorrectly defines a centrifugal force from the rotational part of the kinetic energy. A force must be defined from a potential energy. EGR tried to remedy this situation by using the second Bianchi identity, but used the wrong symmetry for the connection, and incorrectly omitted torsion. It used a metric with unphysical singularities falsely attributed to Schwarzschild and in the late fifties was found to fail spectacularly in whirlpool galaxies. Section 2 remedies all these failings by using the ratio p / L for any orbit and by working out the orbital acceleration straightfowardly. This method immediately gets rid of unphysical fallacies such as the endlessly refuted "big bang" and non existent "black holes". These concepts (based entirely and simple mindedly on unphysical singularities) reduce modern physics to utter nonsense and are long overdue for the scrap heap of anthropomorphic obscurities..

In Section 3 the Minkowski metric is factorized straightfowardly into phase dependent Cartan tetrads using fundamental and very well known ideas of Cartan geometry. This factorization reveals a dynamic inner structure of the Minkowski metric from which a Cartan torsion and Cartan identity can be defined. This procedure leads to field equations for gravitation and magnetogravitation using the Evans identity, an example of the Cartan identity using Hodge duals {1 - 10}.

Finally in Section 4 some graphical analysis is given based on the fact that the miscalled Schwarzschild metric leads to an overcomplicated and unphysical theory in comparison with the Minkowski cosmology.

2. ORBITAL EQUATIONS AND ACCELERATIONS OF THE ECE / MINKOWSKI COSMOLOGY.

In notes 234(1) and 234(2) accompanying this paper on www.aias.us Some more problems of EGR are discussed and a brief account given of conservation of energy and momentum. As usual these notes should be read in conjunction with the scientific paper. The most basic concept is the relativistic linear momentum, which is the mass m of the orbiting object multiplied by the relativistic linear velocity. Consider the plane polar coordinate system (r, θ) describing any orbit in a plane. The position vector of the orbiting mass m is defined by:

$$\underline{r} = r\,\underline{e}_r \quad -(1)$$

where $\underline{e}_r$ is the radial unit vector {12}. The relativistic velocity is defined by:

$$\underline{v} = \frac{d\underline{r}}{d\tau} = \left(\frac{dr}{d\tau}\right)\underline{e}_r + r\left(\frac{d\theta}{d\tau}\right)\underline{e}_\theta \quad -(2)$$

because {12} the coordinate system is itself dynamic and $\underline{e}_r$ depends on the proper time τ . In Cartesian coordinates the relativistic velocity is:

$$\underline{v} = \frac{d\underline{r}}{d\tau} = \frac{dX}{d\tau}\,\underline{i} + \frac{dY}{d\tau}\,\underline{j} \quad -(3)$$

and the relativistic acceleration is:

$$\underline{a} = \frac{d\underline{v}}{d\tau} = \frac{d}{d\tau}\left(\frac{d\underline{r}}{d\tau}\right) \quad -(4)$$

In plane polar coordinates however {12} the unit vectors obey the equations:

$$\frac{d\underline{e}_r}{d\tau} = \left(\frac{d\theta}{d\tau}\right)\underline{e}_\theta \quad -(5)$$

and:

$$\frac{d\underline{e}_\theta}{d\tau} = -\left(\frac{d\theta}{d\tau}\right)\underline{e}_r . \quad -(6)$$

The acceleration of any orbit is therefore:

$$\underline{a} = \frac{d\underline{v}}{d\tau} = \frac{d}{d\tau}\left(\left(\frac{dr}{d\tau}\right)\underline{e}_r + r\left(\frac{d\theta}{d\tau}\right)\underline{e}_\theta\right). \quad -(7)$$

By use of the Leibnitz Theorem:

$$\underline{a} = \left(\frac{dr}{d\tau}\right)\left(\frac{d\theta}{d\tau}\right)\underline{e}_\theta + r\frac{d}{d\tau}\left(\frac{d\theta}{d\tau}\right)\underline{e}_\theta + r\left(\frac{d\theta}{d\tau}\right)\left(\frac{d\underline{e}_\theta}{d\tau}\right) + \frac{d}{d\tau}\left(\frac{dr}{d\tau}\right)\underline{e}_r + \left(\frac{dr}{d\tau}\right)\left(\frac{d\underline{e}_r}{d\tau}\right) \quad -(8)$$

Using Eqns. (5) and (6) gives:

$$\underline{a} = \left(\frac{d^2 r}{d\tau^2} - r\left(\frac{d\theta}{d\tau}\right)^2\right)\underline{e}_r + \left(r\frac{d^2\theta}{d\tau^2} + 2\left(\frac{dr}{d\tau}\right)\left(\frac{d\theta}{d\tau}\right)\right)\underline{e}_\theta \quad -(9)$$

which is a pure kinematic result of general validity. It is equivalent to the result (4) in Cartesian coordinates.

This general result can now be applied to the Minkowski cosmology.

Consider the Minkowski metric in a plane in plane polar coordinates. It produces the infinitesimal line element:

$$ds^2 = c^2 d\tau^2 = c^2 dt^2 - dr^2 - r^2 d\theta^2 . \quad -(10)$$

In relativity it is thought that the vacuum speed of light is a universal constant, so the following quantity is a constant:

$$c^2 = g_{\mu\nu} \frac{dx^\mu}{d\tau} \frac{dx^\nu}{d\tau} = \left(\frac{dt}{d\tau}\right)^2 - \left(\frac{dr}{d\tau}\right)^2 - r^2 \left(\frac{d\theta}{d\tau}\right)^2 . \quad -(11)$$

Therefore the following variation vanishes:

$$\delta \int ds = \delta \int \left(g_{\mu\nu} \frac{dx^\mu}{d\tau} \frac{dx^\nu}{d\tau} \right)^{1/2} d\tau = 0 \quad -(12)$$

and the lagrangian:

$$\mathcal{L} = \frac{1}{2} m c^2 \quad -(13)$$

is an invariant. The Euler Lagrange equation is:

$$\frac{d}{d\tau}\left(\frac{\partial \mathcal{L}}{\partial \dot{x}^\mu} \right) = \frac{\partial \mathcal{L}}{\partial x^\mu} \quad -(14)$$

where in this notation:

$$\dot{x}^\mu = \frac{dx^\mu}{d\tau} . \quad -(15)$$

It follows from Eq. (10) that:

$$\frac{1}{2} m c^2 = \frac{1}{2} m \left(c^2 \left(\frac{dt}{d\tau}\right)^2 - \left(\frac{dr}{d\tau}\right)^2 - r^2 \left(\frac{d\theta}{d\tau}\right)^2 \right) \quad -(16)$$

Therefore:

$$\frac{d}{d\tau}\left(\frac{\partial \mathcal{L}}{\partial \left(\frac{dt}{d\tau}\right)} \right) = \frac{d}{d\tau}\left(m c^2 \left(\frac{dt}{d\tau}\right)\right) = \frac{\partial \mathcal{L}}{\partial t} = 0 \quad -(17)$$

and the relativistic energy E:

$$E = \left(\frac{dt}{d\tau}\right) mc^2 \quad -(18)$$

is a constant of motion, meaning that:

$$\frac{dE}{d\tau} = 0. \quad -(19)$$

Similarly:

$$\frac{d}{d\tau}\left(\frac{\partial \mathcal{L}}{\partial\left(\frac{d\theta}{d\tau}\right)}\right) = \frac{d}{d\tau}\left(mr^2\frac{d\theta}{d\tau}\right) = \frac{\partial \mathcal{L}}{\partial \theta} = 0 \quad -(20)$$

so the angular momentum L:

$$L = mr^2\frac{d\theta}{d\tau} \quad -(21)$$

is also a constant of motion:

$$\frac{dL}{d\tau} = 0. \quad -(22)$$

The metric (10) can be written as:

$$ds^2 = c^2 d\tau^2 = c^2 dt^2 - \underline{dr} \cdot \underline{dr} = \left(c^2 - v^2\right) dt^2 \quad -(23)$$

so the total relativistic momentum is defined as:

$$p^2 = m^2 v^2 = m^2\left(\left(\frac{dr}{d\tau}\right)^2 + r^2\left(\frac{d\theta}{d\tau}\right)^2\right) = \gamma^2 m^2\left(\left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\theta}{dt}\right)^2\right) \quad -(24)$$

in which the Lorentz factor is:

$$\gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} \quad -(25)$$

These results can be applied to Eq. (9) to show that:

$$r\frac{d}{d\tau}\left(\frac{d\theta}{d\tau}\right)+2\left(\frac{dr}{d\tau}\right)\left(\frac{d\theta}{d\tau}\right)=\frac{Lr}{m}\frac{d}{d\tau}\left(\frac{1}{r^2}\right)+2\left(\frac{dr}{d\tau}\right)\left(\frac{d\theta}{d\tau}\right)$$

$$=-\frac{2L}{mr^2}\left(\frac{dr}{d\tau}\right)+\frac{2L}{mr^2}\left(\frac{dr}{d\tau}\right)=0 \quad -(26)$$

so that the acceleration of the orbit is always radially directed. This result is also true for the metric:

$$ds^2=c^2d\tau^2=Ac^2dt^2-Bdr^2-r^2d\theta^2 \quad -(27)$$

of any spherically symmetric spacetime. Therefore for any orbit in any spherically symmetric spacetime, its acceleration is always radial and always a property of geometry, i.e. of the metric itself. It is important to note that this acceleration does not need to be "counterbalanced" because the orbit is the path or geodesic of object m as dictated by the metric. This is the basic idea of relativity, and is completely different from the Newtonian point of view. In fact the latter does not describe an orbit because it fails to define correctly the centrifugal "force", needed to "counterbalance" the "force of attraction".

The acceleration of any orbit in any spherically symmetric spacetime is therefore:

$$\underline{a}=\left(\frac{d^2r}{d\tau^2}-\frac{L^2}{m^2r^3}\right)\underline{e}_r \quad -(28)$$

and the Minkowski orbit is described by:

$$\left(\frac{dr}{d\theta}\right)^2=r^4\left(\left(\frac{p}{L}\right)^2-\frac{1}{r^2}\right) \quad -(29)$$

where:

$$p = \gamma m v \; ; \qquad -(30)$$

$$L = \gamma m r^2 \omega . \qquad -(31)$$

Self consistently, the square of p is:

$$p^2 = \gamma^2 m^2 \left(\left(\frac{dr}{dt} \right)^2 + r^2 \left(\frac{d\theta}{dt} \right)^2 \right) \qquad -(32)$$

and the square of L is:

$$L^2 = \gamma^2 m^2 r^4 \omega^2 = \gamma^2 m^2 r^4 \left(\frac{d\theta}{dt} \right)^2 . \qquad -(33)$$

Dividing Eq. (32) by Eq. (33) gives the orbit (29) directly.

Using the fundamental derivative definitions:

$$\frac{dr}{d\tau} = \frac{dr}{d\theta} \frac{d\theta}{d\tau} , \quad \frac{d\theta}{d\tau} = \frac{L}{mr^2} , \quad \frac{dr}{d\tau} = \frac{L}{mr^2} \frac{dr}{d\theta} \qquad -(34)$$

then the derivative of r with respect to proper time τ is:

$$f = \frac{dr}{d\tau} = \frac{L}{mr^2} \frac{dr}{d\theta} . \qquad -(35)$$

Its derivative in turn with respect to proper time is:

$$\frac{df}{d\tau} = \frac{df}{dr} \frac{dr}{d\tau} = \frac{df}{dr} \left(\frac{L}{mr^2} \right) \frac{dr}{d\theta} \qquad -(36)$$

i.e.:

$$\frac{d}{d\tau} \left(\frac{dr}{d\tau} \right) = \left(\frac{L}{mr} \right)^2 \left(\frac{dr}{d\theta} \right) \frac{d}{dr} \left(\frac{1}{r^2} \frac{dr}{d\theta} \right) . \qquad -(37)$$

So the acceleration with respect to any observable orbit of the universe is:

$$\underline{a} = \left(\frac{L}{mr}\right)^2 \left(\left(\frac{dr}{d\theta}\right) \frac{d}{dr}\left(\frac{1}{r^2}\frac{dr}{d\theta}\right) - \frac{1}{r}\right) \underline{e}_r . \quad -(38)$$

This is a useful and important result because it describes all orbits, not just solar system orbits.

If the orbit is an ellipse:

$$r = \frac{\alpha}{1 + \epsilon \cos\theta} \quad -(39)$$

then:

$$\frac{dr}{d\theta} = \frac{\epsilon r^2 \sin\theta}{\alpha} \quad -(40)$$

and the acceleration is:

$$\underline{a} = \left(\frac{L^2 \epsilon^2}{m^2 \alpha^2} \sin\theta \frac{d}{dr}(\sin\theta) - \frac{L^2}{m^2 r^3} \right) \underline{e}_r \quad -(41)$$

where:

$$\frac{d \sin\theta}{dr} = \cos\theta \frac{d\theta}{dr} = \frac{\alpha \cos\theta}{\epsilon r^2 \sin\theta} \quad -(42)$$

so:

$$\underline{a} = \left(\frac{L}{mr}\right)^2 \left(\frac{\epsilon}{\alpha} \cos\theta - \frac{1}{r} \right) \underline{e}_r \quad -(43)$$

which is the result given in UFT196 and note 234(4) QED.

For the ellipse:

$$\cos\theta = \frac{1}{\epsilon}\left(\frac{\alpha}{r} - 1\right) \quad -(44)$$

so the acceleration reduces to:

$$\underline{a} = -\left(\frac{L}{mr}\right)^2 \cdot \frac{1}{\alpha}\, \underline{e}_r \quad -(45)$$

where α is the half right latitude. The angular momentum in Eq. (45) is a constant of motion and is defined as:

$$L = \gamma m r^2 \omega \quad -(46)$$

where ω is the angular velocity. So the acceleration is:

$$\underline{a} = -\gamma^2 \frac{r}{\alpha} \omega^2 \underline{e}_r . \quad -(47)$$

In the limit:

$$v << c \quad -(48)$$

the Lorentz factor approaches unity, so:

$$\underline{a} \rightarrow -\omega^2 \frac{r}{\alpha} \underline{e}_r . \quad -(49)$$

For a circular orbit:

$$r = \alpha \quad -(50)$$

so the acceleration is:

$$\underline{a} = -\omega^2 r\, \underline{e}_r \quad -(51)$$

and is the familiar acceleration produced by a rotating frame of reference {12}, known as the centrifugal acceleration. In ECE theory {1-10} it has been shown to be due to torsion. It has been shown here to be a special case of the general result (28).

This analysis can be extended to spherically symmetric spacetime by considering the line element:

$$ds^2 = c^2 d\tau^2 = Ac^2 dt^2 - B dr^2 - r^2 d\theta^2 \quad -(52)$$

so:

$$mc^2 = Amc^2\left(\frac{dt}{d\tau}\right)^2 - Bm\left(\frac{dr}{d\tau}\right)^2 - mr^2\left(\frac{d\theta}{d\tau}\right)^2 \quad -(53)$$

and the constants of motion are:

$$E = Amc^2\frac{dt}{d\tau}, \quad L = mr^2\frac{d\theta}{d\tau}. \quad -(54)$$

It follows that:

$$Bm\left(\frac{dr}{d\tau}\right)^2 = Amc^2\left(\frac{dt}{d\tau}\right)^2 - mc^2 - mr^2\left(\frac{d\theta}{d\tau}\right)^2 \quad -(55)$$

from which the orbital equation is:

$$\left(\frac{dr}{d\theta}\right)^2 = \frac{r^4}{B}\left(\frac{1}{A}\left(\frac{E}{cL}\right)^2 - \left(\frac{mc}{L}\right)^2 - \frac{1}{r^2}\right) \quad -(56)$$

Defining:

$$a = \frac{cL}{E}, \quad b = \frac{L}{mc}, \quad -(57)$$

then:

$$\left(\frac{dr}{d\theta}\right)^2 = \frac{r^4}{B}\left(\frac{1}{Aa^2} - \frac{1}{b^2} - \frac{1}{r^2}\right). \quad -(58)$$

For the Minkowski metric:

$$\left(\frac{dr}{d\theta}\right)^2 = r^4\left(\left(\frac{E}{cL}\right)^2 - \left(\frac{mc}{L}\right)^2 - \frac{1}{r^2}\right) \quad -(59)$$

which can be written as:

$$\left(\frac{dr}{d\theta}\right)^2 = r^4\left(\left(\frac{p}{L}\right)^2 - \frac{1}{r^2}\right) \quad -(60)$$

using:

$$E^2 = c^2p^2 + m^2c^4 \quad -(61)$$

Therefore for the Minkowski metric:

$$\frac{dr}{d\theta} = r^2\left(x - \frac{1}{r^2}\right)^{1/2}, \quad x = \left(\frac{p}{L}\right)^2. \quad -(62)$$

For the miscalled Schwarzschild metric:

$$A = \frac{1}{B} = 1 - \frac{r_0}{r} \quad -(63)$$

and the orbital theorem is needlessly complicated:

$$\frac{dr}{d\theta} = r^2\left(\frac{1}{a^2} - \left(1 - \frac{r_0}{r}\right)\left(\frac{1}{b^2} + \frac{1}{r^2}\right)\right)^{1/2}. \quad -(64)$$

The Einstein energy equation (61) can be derived {12} directly from the relativistic momentum:

$$\underline{p} = \gamma m \underline{v} \quad -(65)$$

as is well known. It may also be derived directly from the Minkowski metric (10) by

$$mc^2 = mc^2\left(\frac{dt}{d\tau}\right)^2 - m\left(\left(\frac{dr}{d\tau}\right)^2 + r^2\frac{d\theta^2}{d\tau^2}\right)$$

$$= mc^2\left(\frac{dt}{d\tau}\right)^2 - \frac{p^2}{m}. \quad -(66)$$

Expressing it as:

$$mc^2 = \frac{E^2}{mc^2} - \frac{p^2}{m} \quad -(67)$$

using the definitions of E, p and L, Eq. (66) is:

$$E^2 = c^2p^2 + m^2c^4 \quad -(68)$$

So the relativistic momentum and energy equation are expressions of the metric and therefore of geometry. Considering Eq. (29), and denoting:

$$x = (p/L)^2 \quad -(69)$$

then if for ease of notation:

$$y = x(r) - \frac{1}{r^2}, \quad f = \frac{1}{r^2}\frac{dr}{d\theta} \quad -(70)$$

it follows that:

$$\frac{df}{dr} = \frac{df}{dy}\frac{dy}{dr} \quad -(71)$$

and:

$$\frac{df}{dy} = \frac{1}{2}y^{-1/2}, \quad \frac{dy}{dr} = \frac{dx}{dr} + \frac{2}{r^3} \quad -(72)$$

so:

$$\frac{dr}{d\theta}\frac{d}{dr}\left(\frac{1}{r^2}\frac{dr}{d\theta}\right) = \frac{r^2}{2}\left(\frac{dx}{dr} + \frac{2}{r^3}\right) \quad -(73)$$

From Eqs. (38) and (73) the acceleration may be defined as:

$$\underline{a} = \frac{L^2}{2m^2}\frac{dx}{dr}\,\underline{e}_r = \frac{L^2}{2m^2}\frac{d}{dr}\left(\frac{p}{L}\right)^2\underline{e}_r \quad -(74)$$

i.e. in terms of p / L. The acceleration of any orbit may be expressed in this way. The ratio p / L may be defined as:

$$p / L = v / (\omega r^2) \quad -(75)$$

so:

$$\underline{a} = \frac{L^2}{2m^2}\frac{d}{dr}\left(\frac{v}{\omega r^2}\right)^2\underline{e}_r \,. \quad -(76)$$

As in UFT232 and UFT233 the elliptical orbit may be expressed as:

$$\left.\begin{aligned}\left(\frac{dr}{d\theta}\right)^2 &= \left(\frac{\epsilon}{\alpha}\right)^2 r^4 \sin^2\theta \\ &= r^2\left(\frac{1-\epsilon}{1+\epsilon}\right)\left(\frac{(r_{max}-r)(r-r_{min})}{r_{min}^2}\right) \\ &= r^2\left(\frac{1+\epsilon}{1-\epsilon}\right)\left(\frac{(r_{max}-r)(r-r_{min})}{r_{max}^2}\right)\end{aligned}\right\} \quad -(77)$$

where r_{min} is the minimum distance between m and M and where r_{max} is the maximum distance. These are the quantities usually used in cosmology.

From Eqs. (60) and (75) any orbit in Minkowski cosmology may be expressed as:

$$\left(\frac{v}{\omega}\right)^2 = \left(\frac{dr}{d\theta}\right)^2 + r^2 \quad -(78)$$

and all orbits can be catalogues in terms of v / ω . For the elliptical orbit:

$$\left(\frac{v}{\omega}\right)^2 = \left(\frac{\epsilon r^2}{\alpha}\right)^2 \sin^2\theta + r^2 \quad -(79)$$

and for the precessing elliptical orbit:

$$\left(\frac{v}{\omega}\right)^2 = \left(\frac{x\epsilon r^2}{\alpha} \sin(x\theta)\right)^2 + r^2 \quad -(80)$$

In general any orbit can be expressed as:

$$\frac{dr}{d\theta} = f(\theta) \quad -(81)$$

so:

$$\left(\frac{v}{\omega}\right)^2 = f^2(\theta) + r^2 \quad -(82)$$

For a circular orbit:

$$\frac{dr}{d\theta} = 0 \quad -(83)$$

so:

$$v = \omega r \quad -(84)$$

which is the familiar textbook result.

As in UFT232 and UFT233 the relation between Minkowski cosmology and the ideas of Hooke and Newton may be worked out by expressing the Minkowski orbit as:

$$\left(\frac{d\theta}{dr}\right)^2 = \frac{1}{r^4}\left(\left(\frac{p}{L}\right)^2 - \frac{1}{r^2}\right)^{-1} = \frac{L^2}{r^2(r^2p^2 - L^2)}. \quad -(85)$$

Newtonian dynamics are valid for:

$$v \ll c \quad -(86)$$

and use the idea:

$$E = \frac{p^2}{2m} + U \qquad -(87)$$

where E is the total non-relativistic energy and U the potential energy. The non relativistic kinetic energy is:

$$T = \frac{p^2}{2m}. \qquad -(88)$$

The total momentum in Newtonian dynamics is {12}:

$$p^2 = m^2\left(\left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\theta}{d\tau}\right)^2\right) \qquad -(89)$$

which is the non-relativistic limit of Eq. (32). Using:

$$\frac{dr}{d\theta} = \frac{dr}{dt}\frac{dt}{d\theta} \qquad -(90)$$

it follows that Newtonian dynamics are described by {12}:

$$\left(\frac{d\theta}{dr}\right)^2 = \frac{L^2}{r^4}\left(2m\left(E - U - \frac{L^2}{2mr^2}\right)\right)^{-1} \qquad -(91)$$

i.e. by:

$$\left(\frac{d\theta}{dr}\right)^2 = \frac{L^2}{r^2\left(2mr^2(E-U) - L^2\right)} \qquad -(92)$$

Eqs. (85) of the Minkowski cosmology and (92) of Newtonian dynamics are the same in the limit v << c if:

$$p^2 = 2m(E - U) \qquad -(93)$$

which is Eq. (87), QED.

This result means that Newtonian dynamics introduces the concept of U, whereas Minkowski cosmology is based on geometry without the need for the concept of U. The concept of force in Newtonian dynamics is derived from U:

$$F = -\frac{\partial U}{\partial r} \quad -(94)$$

In the Minkowski cosmology and in relativity there is no concept of U, all is geometry. So Minkowski cosmology is preferred by Ockham's Razor, being the simpler and much more powerful theory, able to rationalize all observable orbital data in the universe in terms of the simple ratio p / L. The concept of force appears to have been introduced by Kepler, and the inverse square law by Hooke, communicated to Newton in a letter.

From Eqs. (74) and (60), the acceleration of any orbit in the universe may be expressed in Minkowski cosmology as:

$$\underline{a} = \frac{L^2}{2m^2}\frac{d}{dr}\left(\frac{1}{r^4}\left(\frac{dr}{d\theta}\right)^2 + \frac{1}{r^2}\right)\underline{e}_r . \quad -(95)$$

This result shows the most clearly that the acceleration is a property of the orbit and of geometry, and is not the result of the anthropomorphic ideas of Kepler, Hooke and Newton. The acceleration is the result of the orbit, which exists due to the metric and geometry. In the seventeenth century it was entirely natural to think of the orbit as the result of the force, which was defined as the acceleration divided by m. the relativistic viewpoint was introduced by Einstein, and that part of his work is sound. It is most important to note however that neither Newtonian nor Einsteinian dynamics can describe the vast majority of astronomical data, whereas the Minkowski cosmology developed here and in UFT232 and UFT233 can rationalize all orbital data in terms of p / L.

For an elliptical orbit Eqs (40) and (95) give:

$$\underline{a} = \frac{L^2}{2m^2}\frac{d}{dr}\left(\left(\frac{\epsilon}{\alpha}\right)^2 \sin^2\theta + \frac{1}{r^2}\right)\underline{e}_r \tag{96}$$

$$= \left(\left(\frac{\epsilon L}{m\alpha}\right)^2 \sin\theta\cos\theta\,\frac{d\theta}{dr} - \frac{L^2}{m^2 r^3}\right)\underline{e}_r$$

where:

$$\frac{d\theta}{dr} = \frac{\alpha}{\epsilon r^2 \sin\theta}. \tag{97}$$

So we arrive again at Eq. (43) self consistently, QED.

The orbital equation for any spherically symmetric spacetime is:

$$\left(\frac{dr}{d\theta}\right)^2 = \frac{r^4}{B}\left(\frac{1}{Aa^2} - \frac{1}{b^2} - \frac{1}{r^2}\right) \tag{98}$$

from the metric (52). If Eq. (98) is used in Eq. (95) then the resultant acceleration is:

$$\underline{a} = \left(\frac{L^2}{m^2 B^{1/2}}\left(\frac{1}{Aa^2} - \frac{1}{b^2} - \frac{1}{r^2}\right)^{1/2}\frac{d}{dr}\left(\frac{r^2}{B^{1/2}}\left(\frac{1}{Aa^2} - \frac{1}{b^2} - \frac{1}{r^2}\right)^{1/2}\right) - \frac{L^2}{m^2 r^3}\right)\underline{e}_r \tag{99}$$

This is worked out by computer algebra in Section 4, and leads to a very complicated result which is not the acceleration of a precessing ellipse. The latter acceleration is:

$$\underline{a} = -\left(\frac{L}{mr}\right)^2\left(\frac{x^2}{\alpha} + \frac{1}{r}\left(1 - x^2\right)\right) \tag{100}$$

as first worked out in preceding papers of this series {1-10}, and is the sum of terms inverse square and inverse cubed in r. This is another clear refutation of Einstein's ideas.

In summary of this section, the following expressions have been derived for the acceleration of any orbit in Minkowski cosmology:

$$\underline{a} = \left(\frac{d}{d\tau}\left(\frac{dr}{d\tau}\right) - r\left(\frac{d\theta}{d\tau}\right)^2\right)\underline{e}_r$$

$$= \frac{L^2}{2m^2}\frac{d}{dr}\left(\frac{1}{r^4}\left(\frac{dr}{d\theta}\right)^2 + \frac{1}{r^2}\right)\underline{e}_r$$

$$= \left(\frac{L}{mr}\right)^2\left(\left(\frac{dr}{d\theta}\right)\frac{d}{dr}\left(\frac{1}{r^2}\frac{dr}{d\theta}\right) - \frac{1}{r}\right)\underline{e}_r$$

$$= \frac{L^2}{2m^2}\frac{d}{dr}\left(\frac{p}{L}\right)^2\underline{e}_r . \quad -(101)$$

For an elliptical orbit the acceleration reduces to:

$$\underline{a} = -\left(\frac{L}{mr}\right)^2 \cdot \frac{1}{\alpha}\,\underline{e}_r \quad -(102)$$

so the elliptical orbit is described by:

$$\underline{a} = -\gamma^2 \frac{r}{\alpha}\,\omega^2\,\underline{e}_r . \quad -(103)$$

3. CONNECTION AND TORSION OF THE DYNAMIC MINKOWSKI METRIC

The Minkowski metric is defined in the Cartesian basis by:

$$g_{\mu\nu} = g^{\mu\nu} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} \quad -(104)$$

where $g^{\mu\nu}$ is the inverse metric. The infinitesimal line element is derived from the metric by:

$$ds^2 = g_{\mu\nu} \cdot dx^\mu dx^\nu . \quad -(105)$$

The metric in the Cartesian basis may be réalted to the metric in any other basis by factorizing it into Cartan tetrads:

$$g_{\mu\nu} = q^a_\mu q^b_\nu \eta_{ab} . \quad -(106)$$

In the complex circular basis {1 - 10} the unit vectors are:

$$\underline{e}^{(1)} = \frac{1}{\sqrt{2}}(\underline{i} - i\underline{j}), \quad \underline{e}^{(2)} = \frac{1}{\sqrt{2}}(\underline{i} + i\underline{j}), \quad -(107)$$

and the tetrad may be defined as:

$$V^{(a)} = q^{(a)}_\mu V^\mu \quad -(108)$$

where V is any vector field. Considering fo rthe sake of illustration the transverse components, then:

$$\begin{bmatrix} \underline{e}^{(1)} \\ \underline{e}^{(2)} \end{bmatrix} = \begin{bmatrix} q^{(1)}_1 & q^{(1)}_2 \\ q^{(2)}_1 & q^{(2)}_2 \end{bmatrix} \begin{bmatrix} \underline{i} \\ \underline{j} \end{bmatrix} \quad -(109)$$

i.e.

$$\underline{e}^{(1)} = q^{(1)}_1 \underline{i} + q^{(1)}_2 \underline{j} \quad -(110)$$

$$\underline{e}^{(2)} = q^{(2)}_1 \underline{i} + q^{(2)}_2 \underline{j} . \quad -(111)$$

The position vector in the Cartesian and complex circular bases is defined by:

$$\underline{r} = X\underline{i} + Y\underline{j} = r^{(2)}\underline{e}^{(1)} + r^{(1)}\underline{e}^{(2)} . \quad -(112)$$

The complex conjugate of $\underline{r}$ is:

$$\underline{r}^{*} = r^{(1)}\underline{e}^{(2)} + r^{(2)}\underline{e}^{(1)} \quad -(113)$$

So:

$$\underline{r}\cdot\underline{r}^{*} = r^{(1)}r^{(2)}\underline{e}^{(1)}\cdot\underline{e}^{(2)} + r^{(2)}r^{(1)}\underline{e}^{(2)}\cdot\underline{e}^{(1)} + r^{(1)2}\underline{e}^{(1)}\cdot\underline{e}^{(1)} + r^{(2)2}\underline{e}^{(2)}\cdot\underline{e}^{(2)}$$

because:

$$= r^{(1)}r^{(2)} + r^{(2)}r^{(1)} \quad -(114)$$

$$\underline{e}^{(1)}\cdot\underline{e}^{(2)} = \underline{e}^{(2)}\cdot\underline{e}^{(1)} = 1 \quad -(115)$$

and

$$\underline{e}^{(1)}\cdot\underline{e}^{(1)} = \underline{e}^{(2)}\cdot\underline{e}^{(2)} = 0. \quad -(116)$$

Therefore:

$$X^2 + Y^2 = r^{(1)}r^{(2)} + r^{(2)}r^{(1)}. \quad -(117)$$

From Eq. (168) it follows that:

$$\begin{bmatrix} r^{(1)} \\ r^{(2)} \end{bmatrix} = \begin{bmatrix} q_1^{(1)} & q_2^{(1)} \\ q_1^{(2)} & q_2^{(2)} \end{bmatrix} \begin{bmatrix} X \\ Y \end{bmatrix} \quad -(118)$$

where:

$$q_1^{(1)} = \frac{1}{\sqrt{2}}, \quad q_2^{(1)} = -\frac{i}{\sqrt{2}}, \quad -(119)$$
$$q_1^{(2)} = \frac{1}{\sqrt{2}}, \quad q_2^{(2)} = \frac{i}{\sqrt{2}}.$$

So

$$r^{(1)} = \frac{1}{\sqrt{2}}\left(X - iY\right), \quad r^{(2)} = \frac{1}{\sqrt{2}}\left(X + iY\right). \quad -(120)$$

It follows that:

$$\underline{r} = r^{(2)}\underline{e}^{(1)} + r^{(1)}\underline{e}^{(2)} = \frac{1}{\sqrt{2}}\left(X + iY\right)\frac{1}{\sqrt{2}}\left(\underline{i} - i\underline{j}\right) \quad -(121)$$

$$+ \frac{1}{\sqrt{2}}\left(X - iY\right)\frac{1}{\sqrt{2}}\left(\underline{i} + i\underline{j}\right) = X\underline{i} + Y\underline{j}$$

QED. When the complex circular basis is multiplied by a phase, it describes circularly polarized radiation {1 - 10}.

From the basic definition:

$$\underline{r} = X\underline{i} + Y\underline{j} \quad -(122)$$

it follows that:

$$\frac{d\underline{r}}{dX} = \underline{i}, \quad \frac{d\underline{r}}{dY} = \underline{j} \quad -(123)$$

so the infinitesimal of the position vector is:

$$d\underline{r} = \left(\frac{d\underline{r}}{dX}\right)dX + \left(\frac{d\underline{r}}{dY}\right)dY = \underline{i}\,dX + \underline{j}\,dY \quad -(124)$$

The infinitesimal of the line element is therefore:

$$ds^2 = d\underline{r} \cdot d\underline{r} = dX^2 + dY^2 \quad -(125)$$

and therefore for two dimensional space the metric on the Cartesian basis is:

$$g_{\mu\nu} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}. \quad -(126)$$

In the complex circular basis:

$$\underline{r} = r^{(2)}\underline{e}^{(1)} + r^{(1)}\underline{e}^{(2)} \quad -(127)$$

so:

$$\underline{e}^{(1)} = \frac{d\underline{r}}{dr^{(2)}}, \quad \underline{e}^{(2)} = \frac{d\underline{r}}{dr^{(1)}} \quad -(128)$$

and the infinitesimal is:

$$d\underline{r} = \frac{d\underline{r}}{dr^{(2)}}dr^{(2)} + \frac{d\underline{r}}{dr^{(1)}}dr^{(1)} = \underline{e}^{(1)}dr^{(2)} + \underline{e}^{(2)}dr^{(1)}, \quad -(129)$$

and the infinitesimal of the line element is:

$$ds^2 = d\underline{r} \cdot d\underline{r}^* = dr^{(2)}dr^{(1)} + dr^{(1)}dr^{(2)} \ldots \quad -(130)$$

These results can be summarized in matrix notation by:

$$ds^2 = \begin{bmatrix} dX & dY \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} dX \\ dY \end{bmatrix} = \begin{bmatrix} dr^{(2)} & dr^{(1)} \end{bmatrix} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} dr^{(1)} \\ dr^{(2)} \end{bmatrix}. \quad -(131)$$

It follows that:

$$g_{\mu\nu} = \begin{bmatrix} g_{11} & 0 \\ 0 & g_{22} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \quad -(132)$$

and

$$\eta_{(a)(b)} = \begin{bmatrix} \eta_{(2)(1)} & 0 \\ 0 & \eta_{(1)(2)} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}. \quad -(133)$$

The two metrics represent the same plane in two different ways. They are related by:

$$g_{\mu\nu} = q^{(b)}_{\mu} \cdot q^{(a)}_{\nu} \, \eta_{(a)(b)} \quad -(134)$$

i.e.

$$g_{11} = q^{(1)}_{1} q^{(2)}_{1} \eta_{(2)(1)} + q^{(2)}_{1} q^{(1)}_{1} \eta_{(1)(2)} \quad -(135)$$

$$g_{22} = q^{(1)}_{2} q^{(2)}_{2} \eta_{(2)(1)} + q^{(2)}_{2} q^{(1)}_{2} \eta_{(1)(2)} \quad -(136)$$

where the tetrad elements are given by Eq. (119) and the metric elements by Eqs. (132) and (133).

To introduce the idea of a dynamic Minkowski spacetime note carefully that Eqs. (134) to (136) are still valid when a phase is incorporated, for example the phase of a plane wave:

$$\phi = \omega t - \kappa Z \quad -(137)$$

where ω is the angular frequency and κ the magnitude of the wave vector. In this case {1 - 10}:

$$\underline{q}^{(1)} = \frac{1}{\sqrt{2}} (\underline{i} - i \underline{j}) e^{i\phi} \quad -(138)$$

$$\underline{q}^{(2)} = \frac{1}{\sqrt{2}} (\underline{i} + i \underline{j}) e^{-i\phi} \quad -(139)$$

so:

$$q^{(1)}_{1} = \frac{1}{\sqrt{2}} e^{i\phi}, \quad q^{(2)}_{1} = \frac{1}{\sqrt{2}} e^{-i\phi}, \quad -(140)$$

$$q^{(2)}_{1} = -\frac{i}{\sqrt{2}} e^{i\phi}, \quad q^{(2)}_{2} = \frac{i}{\sqrt{2}} e^{-i\phi}, \quad -(141)$$

and Eqs. (134) to (136) are still true.

Therefore the dynamic Minkowski space is definable by the phase dependent

Cartan tetrads. The completed Minkowski metric (104) is defined with the addition of:

$$q^{(0)}_{0} = q^{(3)}_{3} = 1 . \quad -(142)$$

In ECE theory the electromagnetic potential is:

$$A^{(a)}_{\mu} = A_0 \, q^{(a)}_{\mu} \quad -(143)$$

and the Cartan torsion of the dynamic Minkowski metric is:

$$T^{(a)}_{\mu\nu} = \partial_\mu q^{(a)}_{\nu} - \partial_\nu q^{(a)}_{\mu} + \omega^{(a)}_{\mu(b)} q^{(b)}_{\nu} - \omega^{(a)}_{\nu(b)} q^{(b)}_{\mu} . \quad -(144)$$

The tetrad postulate {1 - 10} is:

$$D_\mu q^{(a)}_{\nu} = \partial_\mu q^{(a)}_{\nu} + \omega^{(a)}_{\mu(b)} q^{(b)}_{\nu} - \Gamma^{\lambda}_{\mu\nu} q^{(a)}_{\lambda} = 0 \quad -(145)$$

which can be denoted by:

$$\partial_\mu q^{(a)}_{\nu} = \Gamma^{(a)}_{\mu\nu} - \omega^{(a)}_{\mu\nu} := \varsigma^{(a)}_{\mu\nu} . \quad -(146)$$

The connection of the dynamic Minkowski spacetime may therefore be defined by:

$$\varsigma^{(a)}_{\mu\nu} := \partial_\mu q^{(a)}_{\nu} . \quad -(147)$$

For example:

$$\varsigma^{(1)}_{31} = \frac{1}{\sqrt{2}} \frac{\partial}{\partial Z} e^{i(\omega t - \kappa Z)} = -\frac{i\kappa}{\sqrt{2}} e^{i(\omega t - \kappa Z)} . \quad -(148)$$

The real part of the dynamic connection is non-zero:

$$\mathrm{Real}\left(\varsigma^{(1)}_{31}\right) = \frac{\kappa}{\sqrt{2}} \sin(\omega t - \kappa Z) \quad -(149)$$

When the angular frequency and wave vector go to zero the Minkowski metric becomes static and there is no connection or torsion. In the dynamic Minkowski spacetime it is possible as shown to define both a connection and torsion, so the Cartan identity gives the field equations of gravitation and magnetogravitation. These concepts will be developed in future work.

4. GRAPHICAL ANALYSIS OF THE ACCELERATION OF THE "SCHWARZSCHILD" METRIC AND CRITICISM OF EGR.

Section by Dr. Horst Eckardt

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Self consistency and interpretation of the ECE/Minkowski cosmology

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4 Graphical analysis of the acceleration of the "Schwarzschild" metric and criticism of EGR

We compare the acceleration obtained from the so-called Schwarzschild metric with the result of the Minkowski metric for a precessing ellipse. The line element for a spherical symmetric spacetime was given by Eq.(52). The corresponding orbit according to Eq.(58) is

$$\left(\frac{dr}{d\theta}\right)^2 = \frac{r^4}{B}\left(\frac{1}{Aa^2} - \frac{1}{b^2} - \frac{1}{r^2}\right). \tag{150}$$

For the Schwarzschild metric the parameter B is defined by

$$B = \frac{1}{r - \frac{r_0}{r}} \tag{151}$$

with so-called Schwarzschild radius r_0. Inserting this into the definition of the acceleration, Eq.(38),

$$\mathbf{a} = \left(\frac{L}{mr}\right)^2 \left(\frac{dr}{d\theta}\frac{d}{dr}\left(\frac{1}{r^2}\frac{dr}{d\theta}\right) - \frac{1}{r}\right)\mathbf{e}_r \tag{152}$$

leads to the intermediate result (99), which can greatly be simplified by computer algebra to result in

$$\mathbf{a}_S = -\frac{r_0 L}{m^2}\frac{1}{r^4}\mathbf{e}_r. \tag{153}$$

The constants A, a and b all cancel out. Compared to this equation, the Minkowski space acceleration for a precessing ellipse is (see Eq.(100)):

$$\mathbf{a}_M = -\left(\frac{L}{mr}\right)^2 \left(\frac{x^2}{\alpha} + \frac{1}{r}(1 - x^2)\right)\mathbf{e}_r. \tag{154}$$

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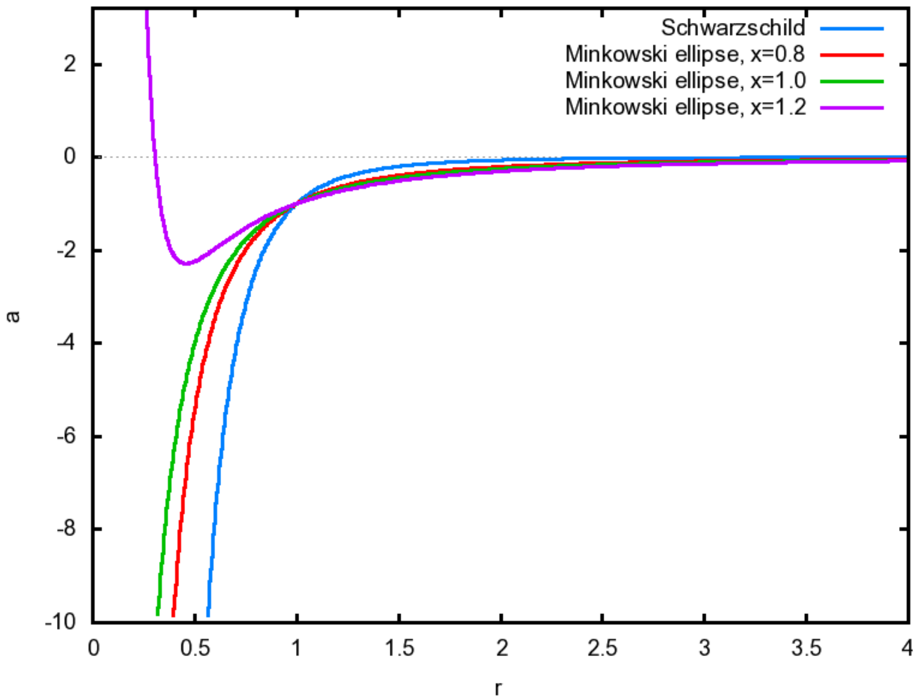

Figure 1: Comparison of accelerations for orbits of Schwarzschild metric and Minkowski ellipses with x=0.8, 1 and 1.2.

This is a function of $1/r^2$ and $1/r^3$ while the Schwarzschild acceleration is proportional to $1/r^4$. Both accelerations are definitly different. An example is shown in Fig.1 with all constants set to unity. It is seen that the Schwarzschild acceleration drops much more massively for small r than in the Minkowski cases. Different values of x lead variations of the curve. Even a repulsive behaviour can arise for $x > 1$ as discussed for galaxies in earlier papers [1].

An additional aspect is the mass dependence of the acceleration. According to the covariant force field concept, the acceleration is independent of the "probe mass". Multiplication with m gives the strength of the force field. This is fulfilled for the Minkowski acceleration because the mass m appearing in Eq.(154) cancels out with the factor m contained in the angular momentum:

$$\mathbf{L} = \gamma m r^2 \boldsymbol{\omega}_r, \tag{155}$$

see Eq.(31). This does not hold for the acceleration of the Schwarzschild metric, Eq.(153), where a factor of m remains in the denominator. So we arrive at the paradoxical situation that the acceleration depends on the "probe mass", showing that EGR delivers an absurde result. This is another refutation of EGR.

```
(%i1) kill(all);
```
(%o0) *done*

1 Schwartzschild acceleration

Eq.(66)

```
(%i1) drdth: sqrt(r^4/B*(1/(A*a^2)-1/b^2-1/r^2));
```
(%o1) $r^2\sqrt{\dfrac{\frac{1}{a^2 A}-\frac{1}{r^2}-\frac{1}{b^2}}{B}}$

```
(%i2) d: diff(1/r^2*drdth,r);
```
(%o2) $\dfrac{1}{r^3\sqrt{\dfrac{\frac{1}{a^2 A}-\frac{1}{r^2}-\frac{1}{b^2}}{B}}\,B}$

Eq.(67)

```
(%i3) a: L/(m^2*r^2)*(drdth*diff(1/r^2*drdth,r)-1/r);
```
(%o3) $\dfrac{\left(\frac{1}{r\,B}-\frac{1}{r}\right)L}{m^2\,r^2}$

Eq.(70)

```
(%i4) B: 1/(1-r0/r);
```
(%o4) $\dfrac{1}{1-\frac{r0}{r}}$

Final Schwarzschild result

```
(%i5) a_S: ratsimp(ev(a));
```
(%o5) $-\dfrac{r0\,L}{m^2\,r^4}$

2 Acceleration of precessing ellipse

Eq.(9) of paper 193

```
(%i6) a_e: -L^2/r^2*(x^2/alpha+1/r*(1-x^2));
```
(%o6) $-\dfrac{\left(\frac{x^2}{\alpha}+\frac{1-x^2}{r}\right)L^2}{r^2}$

```
(%i7) a1: ev(a_S, [r0=1, L=1, m=1]);
```

(%o7) $-\frac{1}{r^4}$

```
(%i13) a2: ev(a_e, [alpha=1, L=1, x=0.8]);
```

(%o13) $-\frac{\frac{0.36}{r}+0.64}{r^2}$

```
(%i14) a3: ev(a_e, [alpha=1, L=1, x=1.0]);
```

(%o14) $-\frac{1.0}{r^2}$

```
(%i15) a4: ev(a_e, [alpha=1, L=1, x=1.2]);
```

(%o15) $-\frac{1.44-\frac{0.44}{r}}{r^2}$

```
(%i21) wxplot2d([a1,a2,a3,a4], [r,0,4], [y,-10,3.2],
       [legend, "Schwarzschild", "Minkowski ellipse, x=0.8", "Minkowski elli
       "Minkowski ellipse, x=1.2"],
       [xlabel, "r"], [ylabel, "a"])$
plot2d: expression evaluates to non-numeric value somewhere in plotting rang
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plot2d: expression evaluates to non-numeric value somewhere in plotting rang
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plot2d: some values were clipped.
```
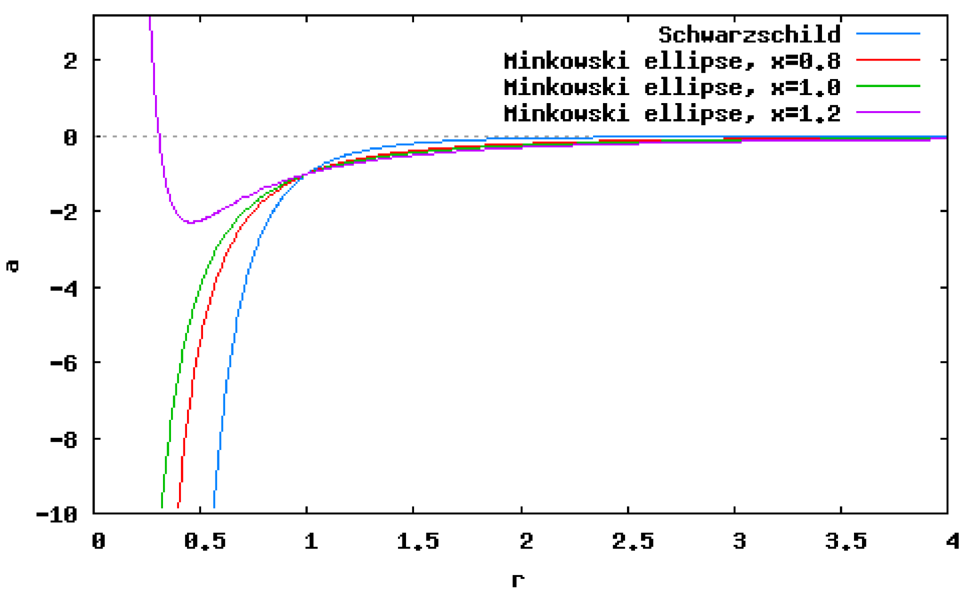

(%t21)



```
(%i22) plot2d([a1,a2,a3,a4], [r,0,4], [y,-10,3.2],
       [legend, "Schwarzschild", "Minkowski ellipse, x=0.8", "Minkowski elli
       "Minkowski ellipse, x=1.2"],
       [xlabel, "r"], [ylabel, "a"],
       [gnuplot_term, "png linewidth 3 font 'Arial' 14 size 800,600"],
       [gnuplot_out_file, "D:/Doc/Artikel-Eck/ECE-Theorie/paper234/Fig1.png"
plot2d: expression evaluates to non-numeric value somewhere in plotting rang
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plot2d: expression evaluates to non-numeric value somewhere in plotting rang
plot2d: some values were clipped.
(%o22) D:/Doc/Artikel-Eck/ECE-Theorie/paper234/Fig1.png
```

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