

TOWARDS AN ECE COSMOLOGY: PRECESSION OF THE PERIHELION,  
WHIRLPOOL GALAXIES AND BINARY PULSARS.

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ABSTRACT

A new cosmology is developed based on spherically symmetric spacetime and the use of one antisymmetric connection in accordance with ECE theory. The new cosmology is illustrated with a precessing ellipse (solar system), whirlpool galaxy and binary pulsar and a self consistent description of all systems given in terms of spherically symmetric spacetime described by an infinitesimal line element characterized by a function  $m$  of the radial coordinate  $r$ . Using this method it is shown straightforwardly that the standard model description of the solar system is wildly erroneous, and that claims to precision tests of this erroneous theory cannot be true. The new ECE cosmology is analyzed with computer algebra.

Keywords: ECE cosmology, solar system, whirlpool galaxy, binary pulsar.

UFT 192

1. INTRODUCTION

In recent papers of this series of 192 papers to date {1 - 10} on Einstein Cartan Evans (ECE) unified field theory a new cosmology has been initiated using the antisymmetric connection, metric compatibility and Evans identity. In UFT 190 ([www.aias.us](http://www.aias.us)) severe problems were encountered in the claims by the standard model of physics, notably, the Schwarzschild metric is incorrectly attributed to him. It is well known that the claims by Einstein are riddled with errors {11, 12} and what appear to be deliberate obfuscations, so Einstein's role in physics has been revised negatively by contemporary scholarship. In particular Schwarzschild {11} strongly criticised Einstein's calculation of the precession of the perihelion in a letter of 22<sup>nd</sup> Dec. 1915. Subsequently criticisms of this calculation have multiplied {12}. During the course of development of ECE theory {1 - 12} many more errors have been uncovered in Einsteinian general relativity, the most serious being the neglect of torsion, the use of an incorrect symmetry for the Christoffel connection. This means that the Einstein field equation is incorrect, as is well known by now, and all metrics and cosmologies based on that equation are incorrect and should be discarded as meaningless dogma.

In Section 2 a new cosmology is suggested based on a spherical spacetime characterized by an infinitesimal line element in a plane and a function  $m$  of the radial coordinate  $r$ . The orbital equation is deduced straightforwardly from this line element and compared with the analytical equation of the observed orbit. In the solar system this has been observed since ancient times to be a precessing ellipse. So  $m$  for the solar system can be derived by elementary calculus checked by computer algebra. Using this method it is easy to show that the standard model is complete nonsense, a classic example of Langmuir's pathological science or repeated dogma. The Newtonian limit is defined by using the correct  $m$ , whose characteristics are analysed by computer. This method is applied to the whirlpool galaxy, in which the stars are arranged on a logarithmic spiral. So the  $m$  function of a whirlpool galaxy is easily obtained by elementary calculus again checked by computer. It is

well known that Einsteinian general relativity fails completely for a whirlpool galaxy. Finally the method is extended to the binary pulsar, in which two objects orbit in a precessing ellipse which slowly spirals inwards. Using the  $m$  function the correct method of calculating the precession of the perihelion is given in the solar system.

In Section 3 the results of Section 2 are analysed with computer algebra and by schematics that clarify the orbits visually.

## 2. THE $m$ FUNCTION FOR THE SOLAR SYSTEM, WHIRLPOOL GALAXY AND BINARY PULSAR.

Consider the infinitesimal line element of a spherically symmetric spacetime:

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

in the plane:

$$dz = 0 \quad - (2)$$

in cylindrical polar coordinates  $(r, \theta)$ . Here  $\tau$  is the proper time and  $m$  is a function characteristic of a spherically symmetric spacetime. In recent papers of this series,  $m$  has been derived from ECE theory using a single antisymmetric Christoffel connection. One possible result of this theory is:

$$m(r) = 2 - \exp\left(2 \exp(-r/R)\right) \quad - (3)$$

where  $R$  is a characteristic distance. This result assumes that  $m$  is a function only of  $r$ . This paper derives  $m$  for various observed orbits and fits them by computer to Eq. (3). For a precessing ellipse:

$$r = \frac{d}{1 + \epsilon \cos(x\theta)} \quad - (4)$$

where  $\alpha$  is a basic property of the ellipse, its semi right magnitude with units of metres.

Here  $\epsilon$  is the eccentricity and  $x$  the precession constant. Therefore:

$$\frac{dr}{d\theta} = \frac{x\epsilon}{d} r^2 \sin(x\theta) \quad - (5)$$

However, the orbital equation can also be derived from Eq. (4) (1-10) using well known methods and is:

$$\frac{dr}{d\theta} = r^2 \left( \frac{1}{b^2} - m(r) \left( \frac{1}{a^2} + \frac{1}{r^2} \right) \right)^{1/2} \quad - (6)$$

where  $a$  and  $b$  are constants of motion with the units of metres defined by:

$$a = \frac{L}{mc}, \quad b = \frac{Lc}{E} \quad - (7)$$

Here  $E$  is the total energy and  $L$  the total angular momentum, both of which are constants of motion, and  $m$  (not to be confused with  $m(r)$ ) is the mass of the attracted object (a planet for example). So:

$$r^2 \left( \frac{1}{b^2} - m(r) \left( \frac{1}{a^2} + \frac{1}{r^2} \right) \right)^{1/2} = \frac{x\epsilon}{d} \sin(x\theta) \quad - (8)$$

and the correct  $m$  function in the solar system is therefore:

$$m(r) = \left( \frac{1}{b^2} - \left( \frac{x\epsilon}{d} \right)^2 + \left( \frac{x\epsilon}{d} \right)^2 \left( 1 - \frac{d}{r} \right)^2 \right) \left( \frac{1}{a^2} + \frac{1}{r^2} \right)^{-1} \quad - (9)$$

where we have used:

$$\cos(x\theta) = \frac{1}{\epsilon} \left( \frac{d}{r} - 1 \right) \quad - (10)$$

The standard model uses the incorrect function:

$$m(r) = ? \cdot 1 - \frac{r_0}{r} \quad - (11)$$

in which:

$$r_0 = \frac{2MG}{c^2} \quad - (12)$$

Here  $G$  is Newton's constant,  $M$  is the mass of the attracting object and  $c$  the vacuum speed of light. The function ( 11 ) is incorrectly attributed to K. Schwarzschild. This attribution is not true. On 22<sup>nd</sup> Dec. 1915 Schwarzschild proposed (13):

$$m(R) = 1 - \frac{\gamma}{(R^3 + r_0^3)^{1/3}} \quad - (13)$$

where  $\gamma$  is a constant and  $R$  is different from  $r$ . Clearly, the function ( 11 ) is not the same as the function ( 9 ) obtained directly from a precessing ellipse. This is enough to show that the standard model is nonsense. Another way of showing this is by using Eq. ( 11 ) in Eq. ( 6 ):

$$ds^2 = c^2 d\tau^2 = ? \left( 1 - \frac{r_0}{r} \right) c^2 dt^2 - \left( 1 - \frac{r_0}{r} \right)^{-1} dr^2 - r^2 d\theta^2 \quad - (14)$$

Comparison with Eq. ( 5 ) gives:

$$\frac{x \in \sin(x\theta)}{d} = \left( \frac{1}{b^2} - \left( 1 - \frac{r_0}{r} \right) \left( \frac{1}{a^2} + \frac{1}{r^2} \right) \right)^{1/2} \quad - (15)$$

which is a polynomial in  $r$ . The roots of this polynomial are constants, a result which has no meaning because it implies that Eq. ( 11 ) is true only at the roots of the polynomial ( 15 ), and not otherwise. On a logical plane it is difficult to see why such arrant nonsense has lasted

for more than ninety years. The claim to "precision testing" of such nonsense is deception on a large scale, and Einstein himself is suspected {11, 12} of obfuscation.

In the limit:

$$r \rightarrow \infty \quad - (16)$$

the  $m$  function behaves as follows:

$$m(r) \xrightarrow{r \rightarrow \infty} a^2 \left( \frac{1}{b^2} - \left( \frac{x\epsilon}{a} \right)^2 + \left( \frac{x}{a} \right)^2 \right) \quad - (17)$$

For the planet Earth for example the observed perihelion precession is:

$$5.0 \pm 1.2 \text{ arcsecond / century} \quad - (18)$$

In a revolution of  $2\pi$  radians (a year):

$$x\theta \rightarrow x\theta + 2\pi x \quad - (19)$$

If an initial measurement is made at some point in the orbit, the earth advances by:

$$x\theta \rightarrow x\theta + \left( 2\pi + \frac{0.05}{3600} \right) \quad - (20)$$

in radians. So:

$$2\pi x = 2\pi + \frac{0.05}{3600} \quad - (21)$$

and:

$$x - 1 = 2.21 \times 10^{-6} \quad - (22)$$

Therefore  $x$  is very close to unity. The eccentricity of the Earth's orbit is:

$$\epsilon = 0.01671123 \quad - (23)$$

Its aphelion and perihelion are respectively:

$$\left. \begin{aligned} r_{\max} &= 1.52098232 \times 10^{12} \text{ m}, \\ r_{\min} &= 1.47098290 \times 10^{12} \text{ m}. \end{aligned} \right\} - (24)$$

Therefore:

$$d = (1 + \epsilon)r_{\min} = (1 - \epsilon)r_{\max} = 1.4956 \times 10^{12} \text{ m}. - (25)$$

So to an excellent approximation:

$$m(r) = \left( \frac{E}{mc^2} \right)^2 \left( \frac{1}{1 + \left( \frac{L}{mcr} \right)^2} \right) - (26)$$

because:

$$\frac{v}{c} \ll 1, \quad \frac{v}{c} \ll 1, \quad - (27)$$

$$v = 1.$$

The earth's orbit is nearly circular so to an excellent approximation:

$$L = m r^2 \omega - (28)$$

where the angular velocity is

$$\omega = \frac{d\theta}{dt} - (29)$$

so  $m$  is a simple function:

$$m(r) = \left( \frac{E}{mc^2} \right)^2 \left( \frac{1}{1 + \left( \frac{\omega r}{c} \right)^2} \right) - (30)$$

Obviously this is not Eq. ( 11 ). In Section 3 the characteristics of the correct solar system  $m$  function are evaluated by computer.

The standard model of physics must be discarded in favour of science. For

example the following method is suggested for calculating  $x$ , effectively the precession of the perihelion. The semiminor and semimajor axes of the ellipse are defined respectively by:

$$r_1 = \frac{d}{(1-\epsilon^2)^{1/2}}, \quad r_2 = \frac{d}{1-\epsilon^2} \quad - (31)$$

From Eq. ( 4 ):

$$\Delta\theta = \theta_2 - \theta_1 = \frac{1}{x} \left[ \cos^{-1} \left( \frac{d}{r_2} - 1 \right) - \cos^{-1} \left( \frac{d}{r_1} - 1 \right) \right] \quad - (32)$$

and from Eq. ( 6 ):

$$\Delta\theta = \int_{r_1}^{r_2} \frac{1}{r^2} \left( \frac{1}{b^2} - m(r) \left( \frac{1}{a^2} + \frac{1}{r^2} \right) \right)^{-1/2} dr \quad - (33)$$

Therefore:

$$\cos^{-1} \left( \frac{d}{r_2} - 1 \right) - \cos^{-1} \left( \frac{d}{r_1} - 1 \right) = x \int_{r_1}^{r_2} \frac{1}{r^2} \left( \frac{1}{b^2} - m(r) \left( \frac{1}{a^2} + \frac{1}{r^2} \right) \right)^{-1/2} dr \quad - (34)$$

in which:

$$m(r) = \left( \frac{1}{b^2} - \left( \frac{x\epsilon}{d} \right)^2 + \left( \frac{x}{d} \right)^2 \left( 1 - \frac{d}{r} \right)^2 \right) \left( \frac{1}{a^2} + \frac{1}{r^2} \right)^{-1} \quad - (35)$$

The distances  $r_1$  and  $r_2$  have been observed since ancient times, so  $x$  can be calculated from Eq. ( 34 ) by computer to machine precision. It should be the same as the experimental value ( 18 ). If not then general relativity itself fails or the spacetime cannot be considered to be spherically symmetric. As can be seen from an inspection of Eq. ( 34 ) the method based on the perihelion precession is a very poor one in the solar system. It is far simpler to deduce  $m$  from the angular velocity { 1 - 10 }:



$$\omega = \frac{d\theta}{dt} = \left( \frac{Lc^2}{E} \right) \frac{m(r)}{r^2} \quad - (36)$$

Although much simpler than perihelion precession, this method seems never to have been used.

In a whirlpool galaxy the stars are observed to be distributed in a logarithmic spiral:

$$r = r_0 \exp(\gamma \theta) \quad - (37)$$

in which  $\gamma$  is the pitch (UFT 190 on [www.ajias.us](http://www.ajias.us)). It has been known for half a century that the Einsteinian general relativity fails completely to describe the velocity curve of a whirlpool galaxy. From Eq. (37):

$$\frac{dr}{d\theta} = \gamma r \quad - (38)$$

so

$$m(r) = \left( \frac{1}{b^2} - \frac{\gamma^2}{r^2} \right) \left( \frac{1}{a^2} + \frac{1}{r^2} \right)^{-1} \quad - (39)$$

which is a simple well behaved function with no singularity graphed in Section 3. Both Eqs. (26) and (39) can be parameterized and fitted to the general Eq. (3) as in Section 3.

This means that a new self consistent cosmology has been developed because the same m function method has been used for both the solar system and the whirlpool galaxy. The binary pulsar can be modelled by the analytical function:

$$r = e^{\gamma \theta} \frac{d}{1 + f \cos(x\theta)} \quad - (40)$$

which is a product of that of the spiral and precessing ellipse. In this case simple differentiation gives:

$$\frac{dr}{d\theta} = \gamma r + e^{\gamma \theta} \frac{x d \sin(x\theta)}{(1 + f \cos(x\theta))^2} \quad - (41)$$

and the binary pulsar is described simply by its characteristic  $m$  function. In the standard model the whirlpool galaxy led to the recession into mediaeval dark matter, and the binary pulsar was incorrectly described by the function ( 11 ) plus gravitational radiation arising from the wholly incorrect Einstein field equation.

Finally in this section a new approach to Newtonian dynamics is suggested as follows by starting with the infinitesimal line element:

$$ds^2 = c^2 d\tau^2 = m(r) c^2 dt^2 - \frac{dr^2}{m(r)} - r^2 d\theta^2 \quad - (42)$$

In the solar system:

$$m(r) = \left( \frac{1}{b^2} - \left( \frac{x}{d} \right)^2 + \left( \frac{x}{d} \right)^2 \left( 1 - \frac{d}{r} \right)^2 \right) \left( \frac{1}{a^2} + \frac{1}{r^2} \right)^{-1} \quad - (43)$$

which gives the precessing ellipse:

$$r = \frac{d}{1 + \epsilon \cos(x\theta)} \quad - (44)$$

When

$$x = \frac{1}{\epsilon} \quad - (45)$$

Eq. ( 44 ) reduces to the static Newtonian ellipse:

$$r = \frac{d}{1 + \epsilon \cos \theta} \quad - (46)$$

which from Euler Lagrange analysis is a solution of:

$$\frac{d^2 u}{d\theta^2} + u = - \frac{m}{L^2 u^2} F(u) \quad - (47)$$

where

$$u = \frac{1}{r} \quad - (48)$$

and  $F$  is the inverse square law of universal gravitation:

$$F = -\frac{mMg}{r^2} \quad - (49)$$

incorrectly attributed to Isaac Newton. In historical fact, Robert Hooke suggested this law to Isaac Newton who developed it (John Aubrey, "Brief Lives").

### SECTION 3: COMPUTER ANALYSIS AND ORBITAL SCHEMATICS.

Section by Horst Eckardt & Robert Cheshire.

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# Towards an ECE cosmology: precession of the perihelion, whirlpool galaxies and binary pulsars

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## Abstract

Keywords:

## 1 Introduction

## 2 The $m$ function for the solar system, whirlpool galaxies and binary pulsars

## 3 Computer analysis and orbital schematics

In this section the function  $m(r)$  is evaluated. In order to give physical meaningful values, the limit

$$m(r \rightarrow \infty) = 1 \tag{50}$$

has to be fulfilled in all cases. This means that there is an additional relation between the parameters of  $m$ . We work this out for precessing orbits in the form of ellipses, logarithmic spirals and ellipses with shrinking diameter.

### 3.1 $m$ functions for the solar system

The general form of  $m(r)$  for precessing elliptic orbits was derived in Eq. (9) by equating the angular derivative of radius (Eq. (5)) with the general form of this

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expression (Eq. (6)) obtained from the infinitesimal line element. The limit of this function for  $r \rightarrow \infty$  is

$$\lim_{r \rightarrow \infty} m(r) = -\frac{a^2 (b^2 \epsilon^2 x^2 - b^2 x^2 - \alpha^2)}{\alpha^2 b^2}. \quad (51)$$

Setting this expression to 1, computer algebra gives the relation

$$\epsilon = \frac{\sqrt{a^2 b^2 x^2 - \alpha^2 b^2 + a^2 \alpha^2}}{a b x} \quad (52)$$

(actually we used the positive solution of a square root). This expression can be inserted in Eq. (9):

$$m(r) = -\frac{(2 a^2 r - a^2 \alpha) x^2 - \alpha r^2}{\alpha r^2 + a^2 \alpha}. \quad (53)$$

This is a simplified form of  $m$  where  $\epsilon$  has been eliminated. Note that also the parameter  $b$  does not occur anymore, giving a dependence only from  $a, \alpha$  and  $x$ . The curve is graphed in Fig. 1. The factor  $x$  determines the direction of precession of the ellipse.  $x > 1$  means in direction of  $\theta$ ,  $x < 1$  gives a rotation in the opposite direction. In the latter case,  $m$  remains in the positive range, meaning that there are no singularities in the metric.

Alternatively, the parameter  $x$  can be eliminated from Eq. (9) by using the limiting Eq. (51). This gives

$$x = \frac{\alpha \sqrt{b^2 - a^2}}{a b} \quad (54)$$

and the  $m$  function then takes the form

$$m(r) = \frac{(b^2 \epsilon^2 - b^2) r^2 + (2 \alpha b^2 - 2 a^2 \alpha) r - \alpha^2 b^2 + a^2 \alpha^2}{(b^2 \epsilon^2 - b^2) r^2 + a^2 b^2 \epsilon^2 - a^2 b^2}. \quad (55)$$

as an alternative to (53). The graph of this function is shown in Fig. 2 for three values of  $\epsilon$ . It must be noted that this function looks different compared to Fig. 1, it rises slightly beyond unity and approaches unity from above in the  $r$  limit.

### 3.2 $m$ functions for whirlpool galaxies

The  $m$  function takes a simple form in case of logarithmic spirals. The calculation in section 2 leads to the  $m$  function of Eq. (39):

$$m(r) = \left( \frac{1}{b^2} - \frac{\zeta^2}{r^2} \right) \left( \frac{1}{a^2} + \frac{1}{r^2} \right)^{-1}. \quad (56)$$

This has the simple limit

$$\lim_{r \rightarrow \infty} m(r) = \frac{a^2}{b^2} \quad (57)$$

which means that

$$a \approx b \quad (58)$$

in the limit of large  $r$ , i.e. The kinetic energy plays no role compared to the relativistic total energy. The function (56) has been plotted in Fig. 3 for three "pitch" values  $\zeta$ . There is no difference if  $\zeta$  is positive or negative because it appears in (39) in squared form only. In the case  $\zeta = 0$  the orbit is a circle which has a purely positive  $m$  function.

### 3.3 $m$ functions for binary pulsars

Massive cosmic objects in near distance to each other show a small permanent decrease of their average orbital radius. This was attributed to gravitational radiation losses prior to ECE theory. The orbits can be considered as a combination of an inward spiral with a precessing ellipse. The corresponding  $m$  function is given by Eq. (41). Applying the same limit calculation as before we obtain

$$\lim_{r \rightarrow \infty} m(r) = \frac{a^2 e^{-2\theta\zeta} (\alpha^2 e^{2\theta\zeta} - b^2 \epsilon^2 x^2 + b^2 x^2)}{\alpha^2 b^2} \quad (59)$$

which is somewhat more complex than Eq. (51). Equating the limit to unity gives

$$\epsilon = \frac{\sqrt{-\alpha^2 b^2 e^{2\theta\zeta} + a^2 \alpha^2 e^{2\theta\zeta} + a^2 b^2 x^2}}{a b x} \quad (60)$$

and inserting this in (41) leads to an even more complicated expression:

$$\begin{aligned} m(r) = & -\frac{1}{\alpha b (r^2 + a^2)} e^{-2\theta\zeta} \quad (61) \\ & \left( 2 a r \zeta e^{\theta\zeta} \sqrt{(a^2 \alpha^2 - \alpha^2 b^2) e^{2\theta\zeta} + a^2 b^2 x^2} \right. \\ & \cdot \sqrt{\frac{(\alpha^2 b^2 - a^2 \alpha^2) r^2 e^{2\theta\zeta} + (a^2 \alpha^2 b^2 - 2 a^2 \alpha b^2 r) x^2}{(\alpha^2 b^2 - a^2 \alpha^2) r^2 e^{2\theta\zeta} - a^2 b^2 r^2 x^2}} \\ & \left. + (a^2 \alpha b \zeta^2 - \alpha b r^2) e^{2\theta\zeta} + (2 a^2 b r - a^2 \alpha b) x^2 \right). \end{aligned}$$

This expression depends on  $\theta$  and has been graphed in Fig. 4 for a representative value of  $\theta$ . The effect of the pitch is a significant drop of the  $m$  function to negative values. The limit for large  $r$  is unity again.

Alternatively we can solve the limiting equation (59) for  $x$  as before:

$$x = \frac{\alpha \sqrt{b^2 - a^2} e^{\theta\zeta}}{a b}. \quad (62)$$

Inserting this into (41) gives a highly complicated expression again:

$$\begin{aligned} m(r) = & -\frac{1}{(b^2 \epsilon^2 - b^2) r^2 + a^2 b^2 \epsilon^2 - a^2 b^2} \left( (a^2 b^2 \epsilon^2 - a^2 b^2) \zeta^2 \quad (63) \right. \\ & + (2 a b \epsilon^2 - 2 a b) \sqrt{-\frac{b^2 - a^2}{\epsilon^2 - 1}} \sqrt{(\epsilon^2 - 1) r^2 + 2 \alpha r - a^2 \zeta} \\ & \left. + (b^2 - b^2 \epsilon^2) r^2 + (2 a^2 \alpha - 2 \alpha b^2) r + \alpha^2 b^2 - a^2 \alpha^2 \right). \end{aligned}$$

This expression has the benefit of not to dependent on  $\theta$ . However, the values are complex in a certain range of  $r$ . In that range no real values of  $m$  exist, as can be seen from Fig. 5. Occurrence of complex values can easily be seen from Eq. (62) where the condition  $a > b$  leads to a negative argument of the square root. Nevertheless the  $m$  functions looks more regular in overall than in Fig. 4. The same result can be drawn for the precessing ellipse of the solar system, see section 3.1, leading to a certain consistency of the results.

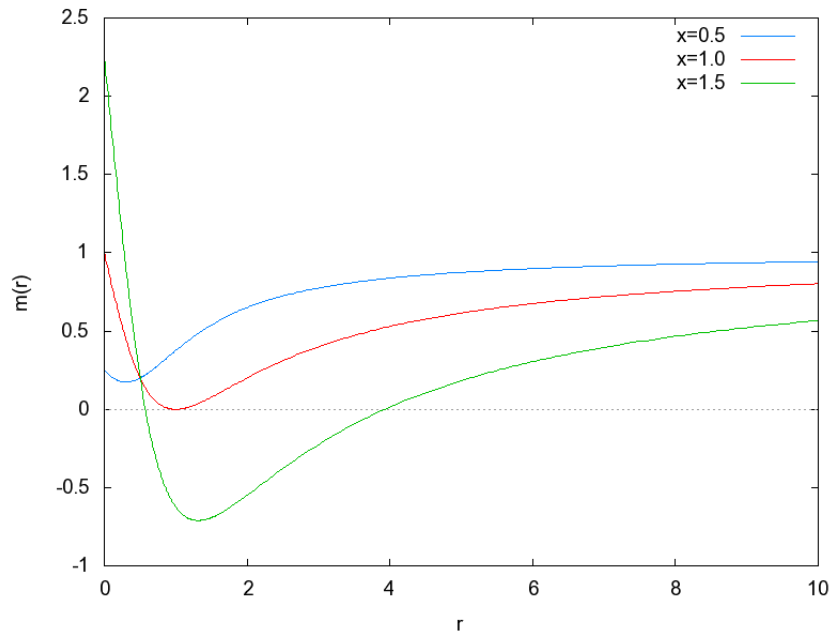


Figure 1:  $m(r)$  for precessing ellipses with parameters  $a = 1, \alpha = 1$ .

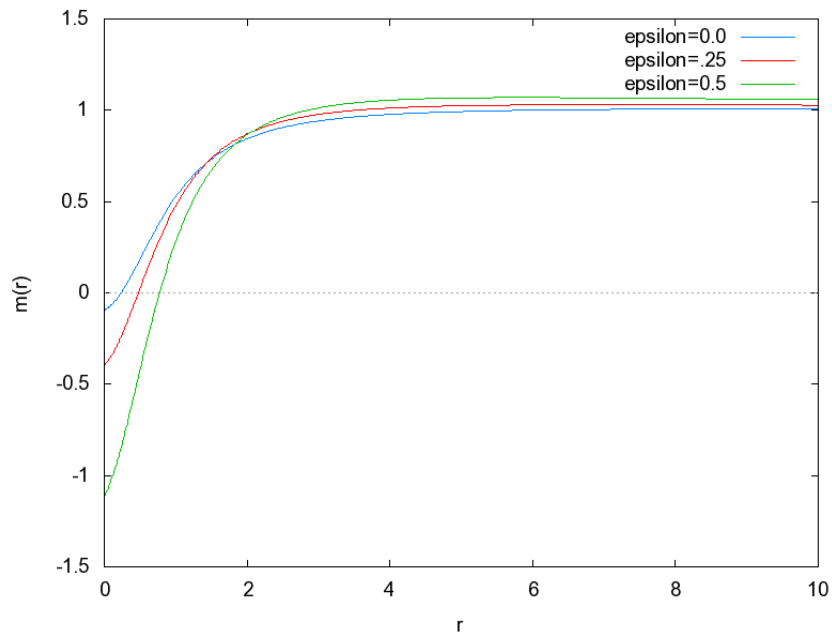


Figure 2:  $m(r)$  for precessing ellipses with parameters  $a = 1.05, b = 1, \alpha = 3$ .



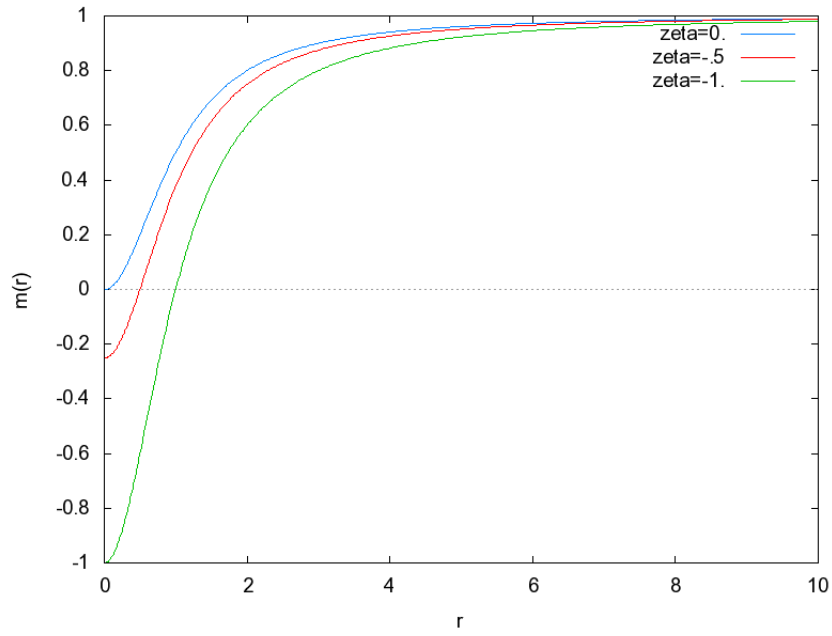


Figure 3:  $m(r)$  for logarithmic spirals with parameters  $a = b = 1$ .

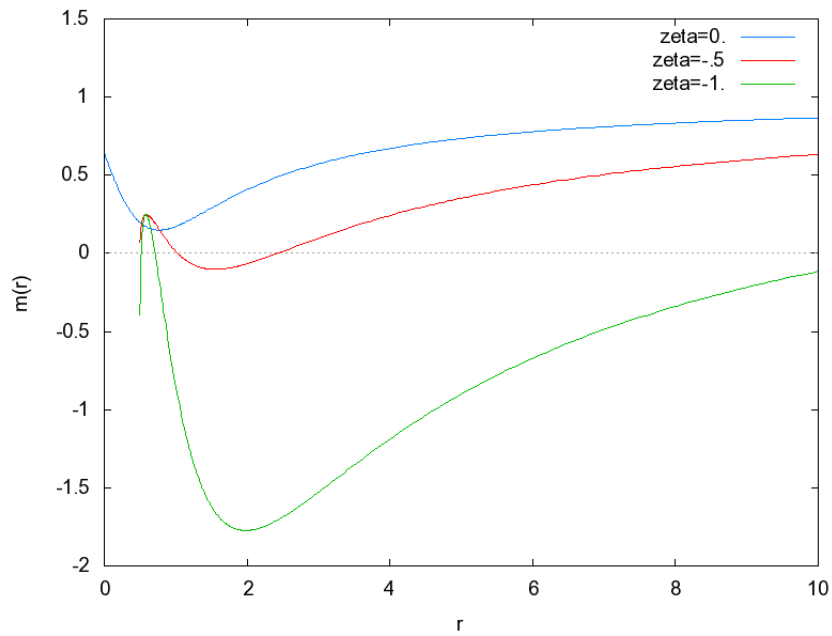


Figure 4:  $m(r)$  for shrinking precessing ellipses with parameters  $a = 1.01, b = 1, \alpha = 1, \zeta = -1, \theta = \pi/4$ .

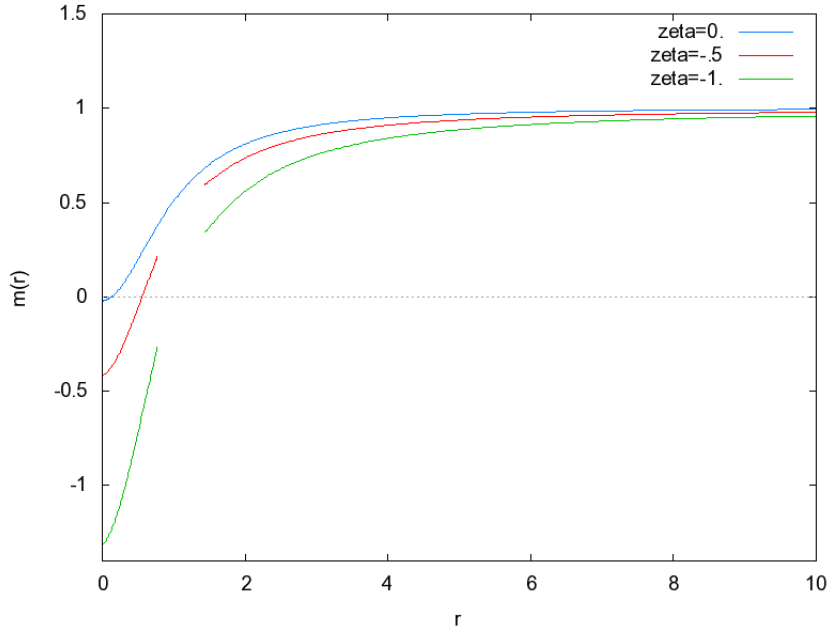


Figure 5:  $m(r)$  for shrinking precessing ellipses with parameters  $a = 1.01, b = 1, \alpha = 1, \epsilon = 0.3$ .

### 3.4 Graphical demonstration of elliptic orbits

Fig. 6: The Static Newtonian Elliptical Orbit describes an ellipse that, although non deviant, has a spiral connection in that all quadrants of the ellipse trace are almost exactly logarithmically spiral.

Fig. 7: The Precessing Elliptical Orbit trace can appear to produce spiralling "arms" from its rotating perihelion in both directions. Its rotation has slightly opened or closed the Newtonian, 360 degree, elliptical symmetry and so is now in spiralling elliptical orbit. The rotation of the orbit must depict a reduction or increase in the 360 degrees of the Newtonian Static ellipse's symmetry. So, more than 360 degrees of elliptical orbit gives a clockwise precession or vice versa if less than that (assuming a clockwise elliptical orbit).

Fig. 8: The Shrinking Precessing Elliptical Orbit trace is now seen to also spiral inward. There are many periods of orbit as there are precession rates. Therefore any one of these Figures shown may take up to millions of years to complete in reality.

Fig. 9: The Shrinking orbit continues toward M, its focus, possibly increasing in velocity, leading eventually to collision, diversion, or other uncertainty. A spiralling Galaxy can be depicted as a group of expanding precessing elliptical orbits that merely have a differing - much faster graphical spiral development.

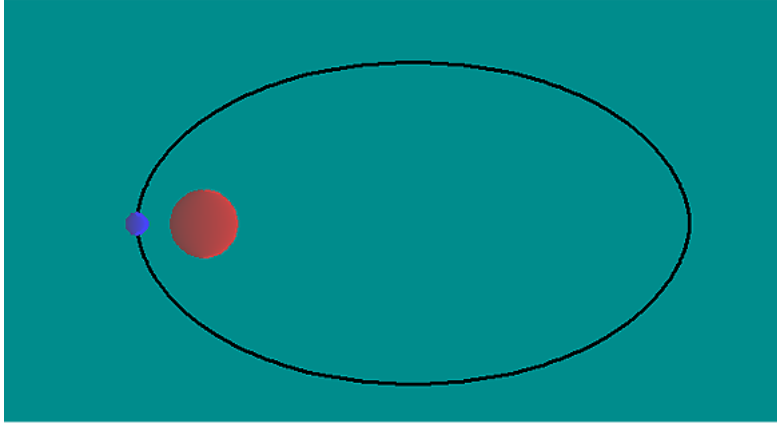


Figure 6: Newtonian elliptical orbit.

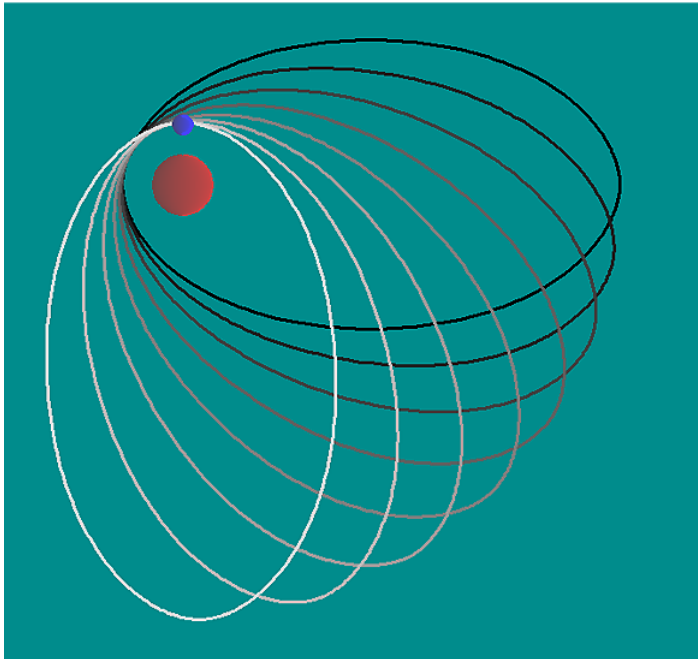


Figure 7: Precessing elliptical orbit.

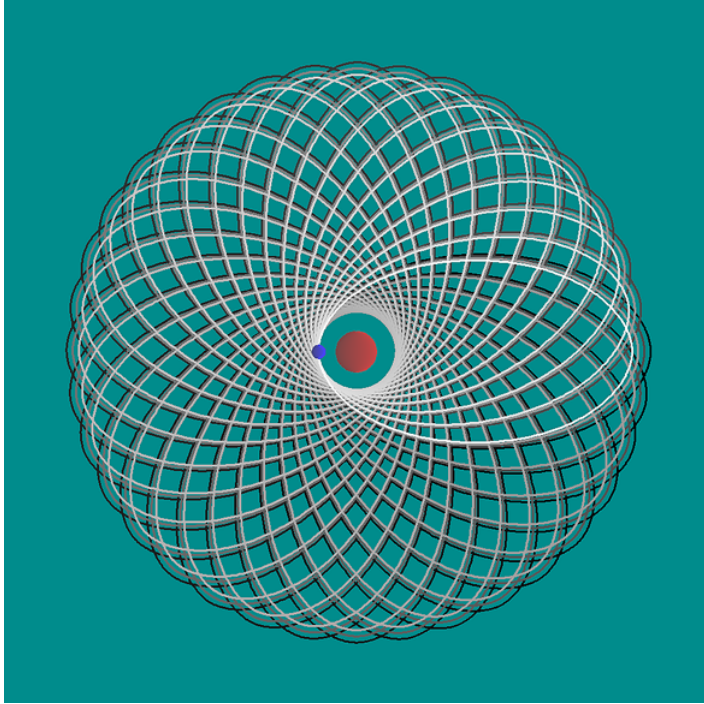


Figure 8: Precessing and shrinking elliptical orbit.

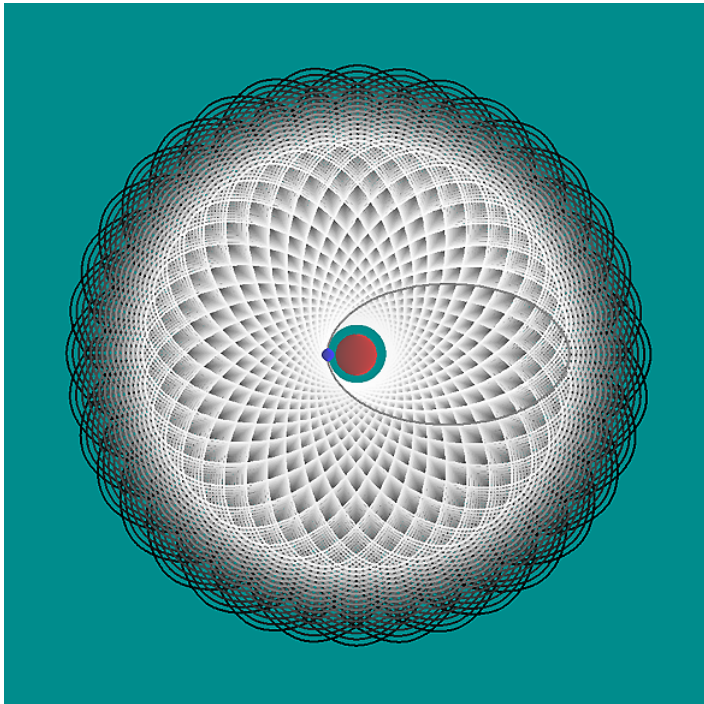


Figure 9: Precessing and shrinking elliptical orbit.