# UNIVERSAL LAW OF GRAVITATION: CALCULATION OF ORBITAL DEFLECTION AND ILLUSTRATION OF NEW ORBITS.

by

M. W. Evans, H. Eckardt, R. Delaforce and G. J. Evans

Civil List and A.I.A.S.

(www.aias.us, www.webarchive.org.uk, www.upitec.org, www.atomicprecision.com, www.et3m.net)

ABSTRACT

A new universal law of gravitation is inferred from precessing planetary orbits and shown to be the same in structure as the potential function used in the Schroedinger equation. The law accounts for all known orbits on the classical level and produces an array of new orbits and conical sections of mathematics hitherto unknown. The law is applied to calculate the orbital deflection of a mass m by a mass M self consistently with orbital precession in a classical limit of ECE theory.

Keywords: ECE theory, universal law of gravitation, new conical seections.

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1. INTRODUCTION

In recent papers of this series {1 - 10} on the applications of ECE theory a new universal law of gravitation has been inferred from the observation of orbital precession in the solar system. The universal law of gravitation is able to describe all known orbits, not only in the solar system but in objects such as binary pulsars and whirlpool galaxies. It is a classical law whose gravitational potential can be identical in mathematical structure to the potential used in the Schroedinger equation in atomic and molecular spectroscopy. It is universal therefore on the macroscopic and microscopic levels. The law produces a vast array of orbits hitherto unknown and unclassified and is based on a simple yet profound generalization of the conical sections in mathematics through use of a precession factor x. In the first instance x is a constant. When x is very close to unity the well known orbital precession in the solar system is described, but when x is allowed to vary through its full range, an astonishing array of new results emerge. The force law of orbital precession is obtained straightforwardly using lagrangian dynamics as in the previous paper, and the potential law obtained from the force law. It is therefore possible to describe all known orbits in this classical limit of ECE theory, but the Einsteinian general relativity (EGR) is known to be erroneous and obsolete {1 - 10}.

In Section 2 the new law is applied to the well known problem of gravitational deflection of an orbit of a mass m by a mass M. In the obsolete EGR it was claimed erroneously that the deflection of light by gravitation could be explained using the ideas of general relativity. During the course of development of ECE theory {1 - 10} the ideas of EGR were gradually abandoned and replaced by correct mathematics. One of the clearest ways of demonstrating the complete incorrectness of EGR is its failure to produce planetary precession. This result can be proven easily using the equation for a precessing ellipse in mathematics. In addition, EGR produces an incorrect force law from Lagrangian dynamics.

These are elementary errors that have been perpetrated dogmatically. In recent work it was discovered that the correct equation of the precessing ellipse produces an astonishing array of orbits, some of which are illustrated in Sections 3 and 4 of this paper. In Section 3 it is shown that the precessing conical section can be transformed into the hyperbolic spiral type of orbit observed in whirlpool galaxies. Section 5 contains a discussion of the fact that the structure of the new universal potential of gravitation is the same for $x^2$ greater than unity as the potential used in the Schroedinger equation in atomic and molecular spectroscopy. There is therefore universality on the macroscopic and microscopic scales in nature.

## 2. CALCULATION OF ORBITAL DEFLECTION

The deflection is calculated from the new equation of the conical section:

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

in a plane. The plane polar coordinates are ( r, $\theta$ ), $\alpha$ is the half right latitude, $\epsilon$ is the eccentricity and x the precession factor. In the simplest case, x is a constant. The total deflection for a hyperbola ($x = 1, \epsilon > 1$) is $2\phi$, where:

$$\phi = \sin^{-1}\frac{1}{\epsilon} = \tan^{-1}\frac{a}{b} \quad -(2)$$

Therefore:

$$\Delta\phi = 2\phi = 2\sin^{-1}\frac{1}{\epsilon} \quad -(3)$$

where the eccentricity is defined by:

$$\epsilon = \left(1 + \frac{b^2}{a^2}\right)^{1/2}. \quad -(4)$$

The half right latitude is defined by:

$$d = \frac{b^2}{a}. \quad -(5)$$

At the distance of closest approach $R_0$ of m to M in a hyperbolic orbit:

$$\cos\theta = 1 \quad -(6)$$

so:

$$R_0 = \frac{d}{1+\epsilon}. \quad -(7)$$

For the precessing hyperbola these fundamental relations have to be examined anew using basic principles. They are not the same because a graphical analysis shows that the precessing hyperbola can look entirely different from the original hyperbola.

However, the famous problem of light deflection (see accompanying notes to this paper, UFT216 on www.aias.us) deals with very small deflections, seconds of arc in magnitude. In this case x is close to unity and the above relations for the hyperbola hold approximately. The orbital velocity corresponding to the precessing conical section ( 1 ) was shown in UFT215 to be:

$$v^2 = \left(\frac{L}{md}\right)^2 \left(\frac{2x^2 d}{r} + x^2(\epsilon^2 - 1) - \left(\frac{d}{r}\right)^2 (x^2 - 1)\right) \quad -(8)$$

where L is the conserved total angular momentum, a constant of motion. At the disatnce of closest approach:

$$v^2 = \frac{L^2}{m^2 R_0}\left[\frac{x^2}{d}(1+\epsilon) - \frac{(x^2-1)}{R_0}\right] \quad -(9)$$

so this equation gives a relation between the angle $\phi$ and the velocity v of a mass m in orbit around a mass M and at closest approach to M. Eq. ( 7 ) can be used to eliminate $d$ and there are various ways of testing this new equation in astronomy. For small angles of deflection:

$$\sin\phi \sim \phi = \frac{1}{\epsilon} = \left[\frac{m^2 \alpha R_0}{x^2 L^2}\left(v^2 - \frac{L^2}{m^2}\left(\frac{x^2-1}{R_0^2}\right)\right) - 1\right]^{-1} \quad -(10)$$

It is seen that the mass m does not cancel out of this equation so it can be used to measure m if v is known experimentally. In the Newtonian limit:

$$x = 1 \quad -(11)$$

and the equation reduces to:

$$\sin\phi \sim \phi = \frac{1}{\epsilon} = \left[\frac{m^2 \alpha R_0 v^2}{L^2} - 1\right]^{-1} \quad -(12)$$

In the Newtonian limit the half right latitude is {11}:

$$\alpha = \frac{L^2}{m^2 M G} \quad -(13)$$

where G is Newton's constant. The usual "Newtonian" light deflection of a photon of mass m is obtained with:

$$\sin\phi \sim \phi = \frac{1}{\epsilon} = \left(\frac{R_0 v^2}{MG} - 1\right)^{-1} \quad -(14)$$

and m cancels out of the calculation. The square of c is sixteen orders greater than unity, so the Newtonian result for light deflection is:

$$\Delta\phi = 2\phi = \frac{2MG}{R_0 c^2} \quad -(15)$$

a well known result. It is claimed that the experimental result is twice this value, but there are many criticisms of the experimental methods, criticisms which appear in refereed journal articles and on reputable websites. The claim of EGR to have obtained twice the Newtonian value is clearly erroneous and is rejected as repeated dogma. Accepting the experimental claims uncritically, then the observed deflection of light can be expressed in terms of photon mass using Eq. ( 10 ) and some calculations are given in the notes accompanying this paper.

It is clear that only the observed Eq. ( 1 ) can be used to calculate the deflection of light due to gravitation. The calculation requires an estimate of the constants of motion E, the total energy, and L, the total angular momentum. $\quad -(16)$

The new universal potential law is:

$$U(r) = -\frac{kx^2}{r} + \frac{(x^2-1)k\alpha}{2r^2}$$

where k is a constant. As in UFT215 this law can be calculated directly from the precessing conical section ( 1 ) for all x using Lagrangian dynamics. For:

$$x^2 > 1 \quad -(17)$$

the new potential law of gravitation has the same structure as the well known potential of the Schroedinger equation in atomic and molecular spectroscopy:

$$u(r) = -\frac{e^2}{4\pi\epsilon_0 r} + \frac{l(l+1)\hbar^2}{2mr^2} \quad -(18)$$

where - e is the charge on the electron, $\epsilon_0$ the vacuum permittivity, l orbital angular momentum quantum number, $\hbar$ the reduced Planck constant, m the electron mass. Both laws have the same structure:

$$U(r) = -\frac{A}{r} + \frac{B}{2r^2} \quad -(19)$$

This is discussed further in Section 5. So under the condition ( 17 ), the new gravitational potential has an attractive and repulsive component as in the Schroedinger equation. In the old Newton Hooke gravitational potential there was only an attraction part. So the new gravitation is qualitatively different, and this may have many implications for astronomy. In the area of counter gravitational technology, a repulsive gravitation is of basic interest. In fundamental physics, gravitation has hitherto been thought to be attractive only. The same law is able to describe the outlines of galactic dynamics, because under the condition:

$$\theta = 1 + \epsilon \cos(x\theta) \quad (20)$$

the precessing hyperbola becomes the hyperbolic spiral, and stars in the arms of a whirlpool galaxy are arranged on a hyperbolic spiral. This result is discussed in Section 3. In Section 4 some of the astonishing array of orbits possible from Eq. ( 1 ) are classified and discussed, and finally in Section 5, Eq. ( 19) is discussed.

Section 3 by Horst Eckardt, Section 4 by Ray Delaforce, Section 5 by Gareth Evans.

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# Universal law of gravitation: calculation of orbital deflection and illustration of new orbits

M. W. Evans[*], H. Eckardt[†], R. Delaforce and G. J. Evans
Civil List, A.I.A.S. and UPITEC

(www.webarchive.org.uk, www.aias.us,
www.atomicprecision.com, www.upitec.org)

## 3 The hyperbolic spiral

The orbital equation (1) describes the classical conical sections for $x = 1$ but more general fractal structures for $x \neq 1$. In the most general case $x$ may vary with $r$ or $\theta$, leading to arbitrary orbital structures. In this section we will show that hyperbolic spirals, as they are observed for spiral galaxies, are possible orbits.

We start with equating the orbital equation (1) with a $r(\theta)$ of a hyperbolic spiral:

$$r = \frac{\alpha}{\theta}, \tag{21}$$

$$\frac{\alpha}{\theta} = \frac{\alpha}{\epsilon \cos(\theta\, x) + 1}. \tag{22}$$

Solving this equation for $x$ gives

$$x = \frac{1}{\theta} \operatorname{acos}\left(\frac{\theta}{\epsilon} - \frac{1}{\epsilon}\right). \tag{23}$$

From Eq.(21) we can replace $\theta$ by $r$, leading to the alternative expression

$$x = \frac{r}{\alpha} \left(\operatorname{acos}\left(\frac{r-\alpha}{\epsilon\, r}\right) - \pi\right). \tag{24}$$

This function $x(r)$ is graphed in Fig. 1. It can be seen that $x$ drops to zero for a certain minimal $r$, then becomes imaginary for smaller $r$'s. Alternatively, $x(r)$ can be plotted in polar coordinates as done in Fig. 2. It is nicely seen that $x$ goes to zero like a hyperbola and starts off again as a spiral. The hyperbolic spiral of the orbit $r(\theta)$ is shown for comparison. In this way a plethora of new orbital forms can be expected. Astronomers could find out if these are observable anywhere in the universe.

[*]email: emyrone@aol.com
[†]email: horsteck@aol.com

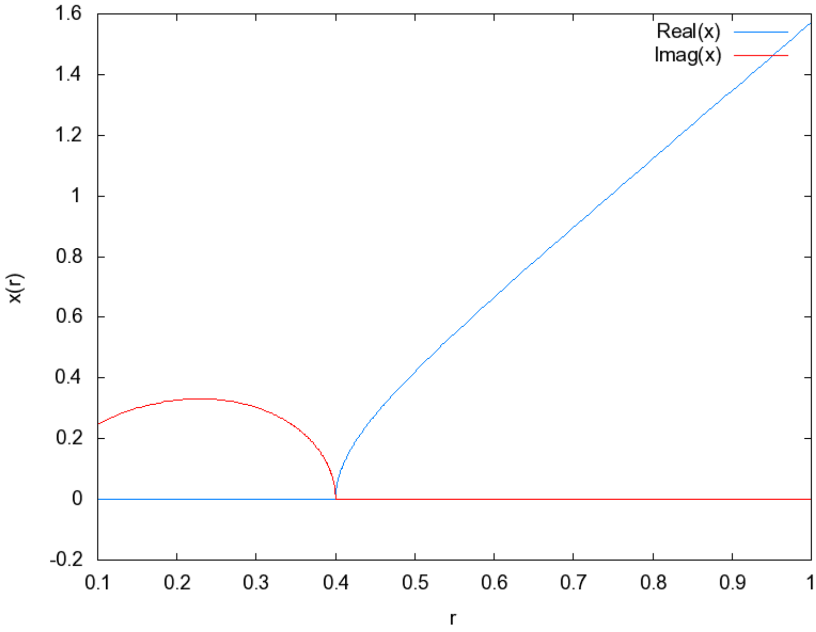


Figure 1: $x(r)$ for a hyperbolic orbit with $\epsilon = 1.5,\ \alpha = 1$.

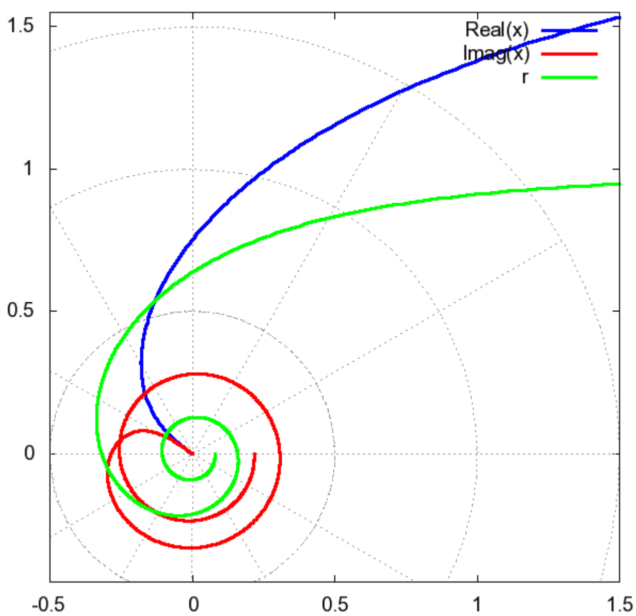


Figure 2: $x(\theta)$ and $r(\theta)$ for a hyperbolic orbit with $\epsilon = 1.5,\ \alpha = 1$.

# 4 Graphics of conical sections

# 5 The new universal gravitational potential and orbitals on the microscopic level

There may be important new implications of the universal gravitational potential on the microscopic scale. Schrödinger published his epoch making papers in 1926. Bohr had built up atoms by adding electrons one at a time to electron shells (or orbitals). Lennard-Jones believed that molecules could be built up in a similar way and his paper of 1929 laid the foundations of Molecular Orbital Theory. His approach implied that inner electrons remained in atomic orbitals and only valence electrons needed to be in molecular orbitals involving both nuclei.

The Lennard Jones potential is a 6-12 potential but the main characteristics are the same as the potential energy of the H atom. As mentioned in previous sections, the new universal law of gravitation, as inferred from precessing planetary orbits, has the same structure as the potential function used in the Schrödinger equation. The equation for the precessing elliptical orbit:

$$V = -\frac{kx^2}{r} + \frac{(x^2-1)k\alpha}{2r^2} \tag{25}$$

where

$$k = \frac{L^2}{\alpha m} \tag{26}$$

has the same structure as the well-known H atom potential for the Schrödinger equation:

$$V_{eff} = -\frac{e^2}{4\pi\epsilon_0 r} + \frac{l(l+1)\hbar^2}{2mr^2}. \tag{27}$$

In both equations there is the same functional dependence on $r$

$$U(r) = -\frac{A}{r} + \frac{B}{r^2}, \quad \text{provided } \; x > 1. \tag{28}$$

So, these are the gravitational and atomic counterparts with a seemingly new consistency introduced for the first time in physics at the macroscopic and microscopic levels. The new gravitational potential has an attractive and a repulsive component as in the Schroedinger equation. In the old Newton/Hooke approach gravitation was perceived as being attractive only. The new gravitation introduced in this paper is qualitatively different inferring a vast array of new and sometimes intricate orbits as discussed in previous sections.

There are two main types of orbits - open and closed. Closed orbits are either circular or elliptical (oval) in shape. A body on a closed orbit constantly travels around another, such as a planet orbiting the Sun or the Moon orbiting the Earth. An open orbit follows a mathematical shape: a parabola or a hyperbola. Both are sweeping curves that never join up. So, objects on open orbits simply fly by other (some spacecraft and comets follow open orbits). As discussed, all four classes of orbit are known as 'conic sections' because slicing a cylindrical cone in a different way can make each of their shapes. Closed orbits are achieved by cutting a cone from one side to another at different angles. Open orbits are achieved by slicing the cone from one side down through the base.

The new universal law of gravitation introduced in this paper describes closed and open orbits including those followed by objects such as binary pulsars and whirlpool galaxies. Likewise, the structure of this new "universal potential" may afford a new insight into microscopic (atomic and molecular) structure and behaviour. Atomic and molecular orbitals may likewise be a similar mix of open and closed orbitals. Closed orbitals, representing the inner-shells of atoms and molecules, are fixed as well described in standard teaching texts. These range from spherical s orbitals (or shells), to the characteristic dumb-bell shape p-orbitals and complex d and f-orbitals showing similar "petal-like structures" as for some of the closed gravitational orbits described in previous sections.

It now also becomes possible to think of "open orbitals" (a new concept as far as we are aware) describing the same sort of sweeping trajectories that never join up, as for orbits, on the microscopic (atomic and molecular) scale. This may provide a new way of describing the properties of metals (and other materials), for example, where electrons become de-localised moving "freely" (in open orbitals) throughout lattice structures. These ideas will be developed in following papers.

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