ECE2 COVARIANT PRECESSION VERSUS THE EINSTEIN THEORY IN THE S2 STAR AND HULSE TAYLOR BINARY PULSAR.

by

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ABSTRACT

The ECE2 covariant theory is developed of any mass m orbiting any mass m on the non relativistic and relativistic levels. The relativistic, ECE2 covariant, lagrangian produces precession of the orbit without the need for Einsteinian general relativity. The ECE2 covariant theory is applied to the orbit of the S2 star around a massive object near Sagittarius B, and to the Hulse Taylor (HP) binary pulsar. The Einstein theory is shown to fail by two orders of magnitude in the HP system and to fail qualitatively to give retrograde precession in the S2 system.

Keywords: ECE2 relativity, the general two body orbit, S2 star system, Hulse Taylor binary pulsar.

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INTRODUCTION

In recent papers of this series {1 - 12}, various applications have been developed of ECE2 relativity, which is special relativity developed in a space with finite torsion and curvature. In section 2, ECE2 relativity is applied to the general orbit of any mass m_1 around any mass m_2, the general two body problem in gravitation. ECE2 relativity is applied to the orbit of the S2 star around a very massive object near Sagittarius B, and to the Hulse Taylor binary pulsar (HP). It is shown that the Einstein theory fails by eight orders of magnitude in the S2 star system, and by several orders of magnitude in the HP system. The ECE2 theory produces reasonable results.

This paper is a short synopsis of detailed calculations in notes accompanying UFT375 on combined sites (www.aias.us and www.upitec.org). Notes 375(1) and 375(2) discuss the equivalence of the Cartesian and plane polar coordinate systems in an ellipse. Note 375(3) discusses the relativistic lagrangian in Cartesian coordinates and is developed in Section 3 to show that the relativistic angular momentum is a constant of motion. Note 374(4) adds a term to the potential to produce a shrinking orbit as observed experimentally in HP. Notes 375(5) and 375(8) are first attempts to describe the final version in Note 375(10) of the lagrangian of the general two body problem. Note 375(10) is the basis of Section 2 of this paper. Note 375(6) defines the half right latitude and eccentricity of an ellipse. Note 375(7) is a comparison of experimental HP data from a Stanford site and Wikipedia. There are large discrepancies in the experimental data. This note shows that the Einstein theory is incorrect by several orders of magnitude. Note 375(9) gives the relevant experimental data for the S2 star system and shows that the Einstein theory is incorrect by eight orders of magnitude.

Section 3 summarizes computations and graphics of ECE2 relativity applied to HP and the S2 star system, and to the general two body gravitational problem.

2. ECE2 COVARIANCE IN THE GENERAL ORBIT

Consider the orbit of a mass m_1 around a mass m_2. The non relativistic lagrangian is:

$$\mathcal{L} = \frac{1}{2} m_1 \dot{\underline{r}}_1 \cdot \dot{\underline{r}}_1 + \frac{1}{2} m_2 \dot{\underline{r}}_2 \cdot \dot{\underline{r}}_2 + \frac{m_1 m_2 G}{r} \quad -(1)$$

where $\underline{r}_1$ is the vector from the centre of mass to mass m_1, and $\underline{r}_2$ is the vector from the centre of mass to m_2. Here G is Newton's constant and:

$$\underline{r} = \underline{r}_1 - \underline{r}_2 , \quad -(2)$$

$$r = |\underline{r}| = |\underline{r}_1 - \underline{r}_2| . \quad -(3)$$

The lagrangian can be developed as:

$$\mathcal{L} = \frac{1}{2} \frac{m_1 m_2}{m_1 + m_2} \dot{\underline{r}} \cdot \dot{\underline{r}} + m_1 m_2 G \frac{|\underline{r}|}{r^2} \quad -(4)$$

where:

$$|\underline{r}| = (\underline{r} \cdot \underline{r})^{1/2} . \quad -(5)$$

The Euler Lagrange equation is:

$$\frac{\partial \mathcal{L}}{\partial \underline{r}} = \frac{d}{dt} \frac{\partial \mathcal{L}}{\partial \dot{\underline{r}}} = \left(\frac{m_1 m_2}{m_1 + m_2} \right) \ddot{\underline{r}} = m_1 m_2 G \frac{\partial}{\partial \underline{r}} \left(\frac{1}{|\underline{r}|} \right) \quad -(6)$$

in which:

$$\frac{\partial}{\partial \underline{r}} \left(\frac{1}{|\underline{r}|} \right) = -\frac{1}{2} 2 \underline{r} \frac{1}{(\underline{r} \cdot \underline{r})^{3/2}} = -\frac{\underline{r}}{r^3} . \quad -(7)$$

Therefore:

$$\left(\frac{m_1 m_2}{m_1 + m_2} \right) \ddot{\underline{r}} = - m_1 m_2 G \frac{\underline{r}}{r^3} \quad -(8)$$

i..e.

$$\underline{\ddot{r}} = -(m_1+m_2)\, G\, \frac{\underline{r}}{r^3}. \quad -(9)$$

This equation is valid in any coordinate system in two and three dimensions and can be solved in Cartesian coordinates as in UFT374.

In the solar system and S2 star system:

$$m_2 \gg m_1 \quad -(10)$$

and

$$\underline{\ddot{r}} \sim -m_2 G \frac{\underline{r}}{r^3} \quad -(11)$$

but in the HP system:

$$m_1 \sim m_2. \quad -(12)$$

The centre of mass is defined by:

$$m_1 \underline{r}_1 + m_2 \underline{r}_2 = \underline{0} \quad -(13)$$

so:

$$\underline{r}_1 = \frac{m_2}{m_1+m_2}\, \underline{r}, \quad -(14)$$

$$\underline{r}_2 = \frac{-m_1}{m_1+m_2}\, \underline{r}. \quad -(15)$$

From these equations, Note 375(10) shows that there are three equations of motion in the general two body gravitational problem:

$$\underline{\ddot{r}} = -(m_1+m_2)\, G\, \underline{r} / r^3 \quad -(16)$$

$$\ddot{\underline{r}}_1 = -(m_1+m_2) G \underline{r}_1 / r^3 \quad -(17)$$

$$\ddot{\underline{r}}_2 = -(m_1+m_2) G \underline{r}_2 / r^3 \quad -(18)$$

Eq. (16) gives a Newtonian ellipse with mass:

$$M = m_1 + m_2 . \quad -(19)$$

Eqs. (17) and (18) are simultaneous differential equations:

$$\ddot{\underline{r}}_1 = -MG\, \underline{r}_1 / \left(| \underline{r}_1 - \underline{r}_2 |^3 \right) \quad -(20)$$

$$\ddot{\underline{r}}_2 = -MG\, \underline{r}_2 / \left(| \underline{r}_1 - \underline{r}_2 |^3 \right) \quad -(21)$$

which must be solved numerically for any coordinate system, for example the Cartesian system of Section 3.

The ECE2 covariant lagrangian in its relativistic form is:

$$\mathcal{L} = -m_1 c^2 \left(1 - \frac{\dot{\underline{r}}_1 \cdot \dot{\underline{r}}_1}{c^2} \right)^{1/2} - m_2 c^2 \left(1 - \frac{\dot{\underline{r}}_2 \cdot \dot{\underline{r}}_2}{c^2} \right)^{1/2} + \frac{m_1 m_2 G}{| \underline{r}_1 - \underline{r}_2 |} . \quad -(22)$$

Using Eqs. (13), (14) and (15), Eq. (22) reduces to:

$$\mathcal{L} = -m_1 c^2 \left(1 - \left(\frac{m_2}{m_1+m_2} \right)^2 \frac{\dot{\underline{r}} \cdot \dot{\underline{r}}}{c^2} \right)^{1/2} - m_2 c^2 \left(1 - \left(\frac{m_1}{m_1+m_2} \right)^2 \frac{\dot{\underline{r}} \cdot \dot{\underline{r}}}{c^2} \right)^{1/2} + \frac{m_1 m_2 G}{r} \quad -(23)$$

which can be solved with the Euler Lagrange equation (6) to give a precessing orbit entirely without use of the Einsteinian general relativity (EGR) {1 - 12}.

Some astronomical data for the HP system are summarized in Note 375(7) from Wikipedia and a Stanford University site www.large.stanford.edu/courses/2007/ph210/ There is severe self inconsistency of data as summarized in Note 375(7). EGR gives the well known result:

known result:

$$\Delta \phi = \frac{6\pi M G}{c^2 a (1-\epsilon^2)} \quad -(24)$$

for the precession of the orbit of the pulsar. Eq. (24) is derived in the weak gravitational limit of EGR as is well known. Here M is the mass of the attracting object, G is Newton's constant, c is the speed of light, a is the semimajor axis, and ϵ is the eccentricity. Using the Stanford data it gives:

$$\Delta \phi = 0.16^\circ \text{ per earth year} \quad -(25)$$

in degrees per earth year, and using the Wikipedia data it gives:

$$\Delta \phi = 0.11^\circ \text{ per earth year} \quad -(26)$$

in degrees per earth year. The experimental result form both sites is about 4.2° per earth year. So EGR is wildly incorrect for weak gravitation, and the two sites give wildly inconsistent results.

It is unlikely that a small metric adjustment for strong field gravitation can ever give a precise match to experimental data as so often claimed uncritically by protagonists of EGR.

In order to apply ECE2 gravitational theory the following data are used, taken from two sites in the literature:

$$m_1 = m_p = 2.824 \times 10^{30} \text{ kg} \quad -(27)$$

$$m_2 = m_c = 2.804 \times 10^{30} \text{ kg}. \quad -(28)$$

The perisastron is taken to be 1.1 solar radii, a value easily found by Google. This is

$$r(0) = 7.6527 \times 10^{8} \text{ m} \quad -(29)$$

in the required S. I. Units. The orbital velocity with respect to the centre of mass of the two neutron stars of the HP system is used as in the literature:

$$v(0) = 4.5 \times 10^{5} \, m s^{-1} \quad -(30)$$

Therefore $r(0)$ and $v(0)$ can be used as initial conditions for the computations of Section 3. However, there is such wild inconsistency in the astronomical data that the initial velocity can be used as an input parameter, and the effect on the computed orbits graphed.

As in Note 375(9) Eq. (24) can be applied with the following S2 data, easily found by Google and various sites:

$$\begin{aligned} M &= 7.956 \times 10^{36} \, kg \\ G &= 6.67408 \times 10^{-11} \, m^{3} kg^{-1} s^{-2} \\ c &= 2.99792458 \times 10^{8} \, m s^{-1} \\ a &= 1.4253 \times 10^{14} \, m \\ \epsilon &= 0.8831 \\ T &= 15.56 \text{ earth years} \end{aligned} \quad -(31)$$

All these data are given in the obscure, non S. I., units used in astronomy, and are given above in the required S. I. Units. EGR and Eq. (24) give:

$$\Delta\phi = 3.549 \times 10^{-3} \, rad . \quad -(32)$$

This is converted to degrees per orbital interval T of S2, (i.e. per orbit) using:

$$T = 15.56 \times 3.154 \times 10^{7} \text{ seconds} \quad -(33)$$

The result is:

$$\Delta\phi = 0.203^{\circ} \text{ per orbit} \quad (34)$$

The vague experimental claims vary from about -1 to 2 degrees per orbit. It is known that the orbit of S2 is nearly a Newtonian ellipse. The semimajor axis of this ellipse is:

$$a = 1.4253 \times 10^{14} \text{ m.} \quad (35)$$

So the S2 star is about a thousand times more distant from the central mass than the distance of the earth from the sun. The ratio of the mass of S2 to the central mass is roughly similar to the ratio of the mass of the earth to the sun.

So it is expected therefore that the weak gravitational limit is an excellent approximation for S2. Nevertheless EGR fails by an order of magnitude if the precession is taken to be 2° per orbit, and fails qualitatively if the precession is taken to be -1° per orbit. ECE2 has been shown {1 - 12} in many papers to be an acceptable theory of gravitation. In three hundred and seventy five UFT papers and books to date{1 - 12} it has been shown that EGR is riddled with errors, notably the neglect of torsion. The S2 data show clearly that it fails completely in that system. It also fails completely in whirlpool galaxies for which ECE gives an acceptable description.

SECTION 3: COMPUTATION AND GRAPHICS

ECE2 covariant precession versus the Einstein theory in the S2 star and Hulse Taylor pulsar

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3 Computation and graphics

3.1 Relativistic motion of star S2

3.1.1 The relativistic Lagrangian model

The star S2 orbits the centre of the our galaxy being a supermassive object of over 4.3 million solar masses. S2 is one of several stars orbiting the centre in few years, therefore their orbits are observable completely. Nevertheless, experimental data, given in Eqs. (31) of section 2, are not very precise.

The numerical calculation was executed with the relativistic 1-body equation

$$\ddot{\mathbf{r}} = \frac{\gamma M G}{r^3} \left(\frac{\dot{\mathbf{r}} \, (\dot{\mathbf{r}} \cdot \mathbf{r})}{c^2} - \mathbf{r} \right) \tag{36}$$

as obtained from the relativistic Lagrangian

$$\mathscr{L} = -\frac{mc^2}{\gamma} + \frac{m \, M \, G}{r} \tag{37}$$

where γ is the relativistic factor

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{1}{\sqrt{1 - \frac{\dot{X}^2 + \dot{Y}^2}{c^2}}}. \tag{38}$$

Calculations were carried out in Cartesian coordinates and in SI units. Although distances have magnitudes of several powers of 10, this is by far the clearest way to avoid obscure units used in astronomy. The minimum and maximum orbital radius (periastron and apastron) are derived from the experimental semi major axis a by

$$r_{\min} = \frac{a(1 - \epsilon^2)}{1 + \epsilon}, \tag{39}$$

$$r_{\max} = \frac{a(1 - \epsilon^2)}{1 - \epsilon}. \tag{40}$$

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v_0 [10^6 m/s]	T [yr]	$r_{\max}$ [10^{14} m]	ϵ	$\Delta\phi$ [rad]
7.73	13.45	2.52019	0.87595	$5.9385 \cdot 10^{-4}$
7.7466	14.88	2.70718	0.88402	$5.9130 \cdot 10^{-4}$
7.7529648	15.50	2.78609	0.88712	$5.9033 \cdot 10^{-4}$
7.77	17.38	3.02068	0.89543	$5.8774 \cdot 10^{-4}$
non-rel.:				
7.7529648	15.31	2.76156	0.88619	$< 8 \cdot 10^{-8}$
rel. fluid dyn. model:				
7.7529648	15.52	2.78821	0.88804	-0.0043065
experiment:				
7.7529648	15.56	2.68398	0.8831	-0.017...+0.035

Table 1: Parameters of S2 star orbit (various calculations and experiment).

The experimental periastron has been taken as initial point for orbital calculation. The initial velocity is in non-relativistic approximation:

$$v_0 = \dot{Y}(0) = \sqrt{\frac{M\ G}{a}(3 + 2\epsilon - \epsilon^2)}. \tag{41}$$

Test runs showed that the orbit period T is sensitive to the initial velocity. Therefore we selected four values of v_0 (see Table 1) and extracted the orbit period from the numerical solution. The third value is nearest to the experimental value of $T = 15.56$ years and was chosen as reference value. It is not possible to bring both T and the apastron $r_{\max}$ in coincidence with the experimental values by the same v_0.

The trajectories $X(t)$ and $Y(t)$ of the S2 star are graphed in Fig. 1. Because of the high ellipticity, the orbital velocity at periastron is much higher than at apastron and the X trajectory changes direction sharply. The same can be observed from the graph of velocity components (Fig. 2) where both $\dot{X}$ and $\dot{Y}$ have sharp peaks at periastron. The relativistic angular momentum is in Z direction and given by

$$L_{Z,\mathrm{rel}} = \gamma m |\mathbf{r} \times \mathbf{v}|_Z = \gamma m (X\dot{Y} - Y\dot{X}) \tag{42}$$

where m is the mass of S2 of 15 solar masses. The non-relativistic angular momentum is Eq. (42) without the γ factor. Both are graphed in Fig. 3. It is seen that the relativistic angular momentum is constant as it should be. The non-relativistic counterpart is lower in regions where the orbital velocity is high, i.e. at periastron. The absolute differences however are very small. The γ factor is plotted separately in Fig. 4. Its maximal deviation from unity is 4/10 000, indicating that relativistic effects are small and the S2 orbit, in spite of the large masses involved, is nearly Newtonian. Nearly the same results are obtained from a calculation with the non-relativistic Lagrangian that are also presented as a line in Table 1. All parameters (except orbital precession) are very close to the relativistic calculation.

The numerical calculation only needs initial coordinates and velocity. All orbit parameters have to be extracted from the calculation. We used a simple detection of changes in coordinate signs to find $r_{\rm max}$ and determined ϵ by

$$\epsilon = \sqrt{1 - \frac{b^2}{a^2}} = \sqrt{1 - \frac{Y_{\rm max}^2}{((|X_{\rm min}| + |X_{\rm max}|)/2)^2}}. \tag{43}$$

While $r_{\rm max}$ depends visibly on the initial velocity $v_0 = \dot{Y}(0)$, the eccentricity ϵ is not very sensitive on v_0. We particularly emphasise that the orbital precession has been calculated carefully. Since the radius at apastron takes a flat maximum, we used an interpolation procedure to obtain its exact value and the corresponding angle. We took three points nearest to the maximum and made a parabolic interpolation as follows:

The orbital angle is given from Cartesian coordinates by

$$\phi = \mathrm{atan}\frac{Y}{X}. \tag{44}$$

The radius function $r_i(\phi_i)$ at points (X_i, Y_i) is interpolated by the formula

$$r_i = c_1\phi_i^2 + c_2\phi_i + c_3 \tag{45}$$

with coefficients c_1, c_2, c_3. These can be determined by selecting three points (i values) around the maximum, giving three equations:

$$r_{i-1} = c_1\phi_{i-1}^2 + c_2\phi_{i-1} + c_3, \tag{46}$$

$$r_i = c_1\phi_i^2 + c_2\phi_i + c_3, \tag{47}$$

$$r_{i+1} = c_1\phi_{i+1}^2 + c_2\phi_{i+1} + c_3. \tag{48}$$

After having found the solution for the coefficients, the angle ϕ at the maximum is determined by

$$\frac{dr}{d\phi} = 2\, c_1\phi + c_2 = 0 \tag{49}$$

giving

$$\phi_{\rm max} = -\frac{c_2}{2\, c_1}, \tag{50}$$

and finally we obtain for the precession angle:

$$\Delta\phi = \phi_{\rm max} - \pi. \tag{51}$$

The results for the numerical solutions are listed in Table 1. $\Delta\phi$ is not very sensitive to orbital changes and is about 0.034 degrees per orbit. This is in the experimental range between -1 and +2 degrees per orbit. Obviously there is no consensus among the astronomers even about the sign of precession.

A check of the numerical method of determining $\Delta\phi$ is the non-relativistic calculation. The result should be exactly zero. We obtained a value of about four orders of magnitude smaller than for the relativistic calculation (Table 1). This proves that our results are reliable, although the small precession value was obtained from relatively large radius numbers. The time interval of Runge-Kutta integration was 10^5 s that came out to be small enough compared to the orbit period of 15.5 years = $4.89 \cdot 10^8$ s.

3.1.2 A model with fluid dynamics effects

In an approach similar to that in UFT374, we added an external velocity of fluid spacetime to the calculation. The kinetic energy of the relativistic Lagrangian

$$\mathscr{L} = -\frac{mc^2}{\gamma} + \frac{m\,M\,G}{r} \tag{52}$$

was altered in a way that velocity terms v_{fX}, v_{fY} were added to the orbital velocity components $\dot{X}, \dot{Y}$. The justification of this procedure will be explained in a future paper. The γ factor then reads

$$\gamma = \frac{1}{\sqrt{1 - \frac{(\dot{X} - v_{fX}(X,Y))^2 + (\dot{Y} - v_{fX}(X,Y))^2}{c^2}}}. \tag{53}$$

This leads to highly complicated Euler-Lagrange equations that are not shown here. For the calculation we used a fluid velocity model with a velocity rotating around the central mass:

$$\mathbf{v}_f = \omega_0 \begin{bmatrix} Y \\ -X \end{bmatrix} \tag{54}$$

where ω_0 is an angular rotation velocity. With $\omega_0 = 10^{-11}$/s a retrograde precession (negative $\Delta\phi$) is obtained, see orbit graphed in Fig. 5. The precession is $\Delta\phi = -0.25$ degrees which is within the experimental uncertainties. The direction of velocity rotation is in direction of negative precession angles, therefore the spacetime fluid has the effect of pushing the orbiting mass in its flow direction. This effect is larger than the "natural" positive precession. This external action violates energy and momentum conservation of the gravitating system, making it an open system. The angular momentum of the orbiting mass has been graphed in Fig. 6. There is a much stronger effect than the difference between relativistic and non-relativistic calculation in Fig. 4 (notice the different scales on the y axis).

The result of retrograde precession gives rise to the supposition that processes in the universe are impacted by floating spacetime, they are not fully explainable if such effects are neglected or excluded a priori.

The rotating vector field $\mathbf{v}_f$ is a model for a rotating rigid "spacetime disk" around the central mass. This is a non-relativistic approach, but we checked the disk's tangential velocity at the apastron of the S2 star. With $\omega_0 = 10^{-11}$/s, $X = r_{\max}$ we obtain $v_f = 2.68 \cdot 10^3$ m/s which is far below the speed of light. The rotational angular velocity period is

$$T = \frac{2\pi}{\omega_0} = 19\ 900 \text{ yr}. \tag{55}$$

It may be that this is the rotation speed of the central mass, generating this spacetime velocity effect. A more conclusive calculation would have to respect the propagation speed of light (for example Lense-Thirring effect). In the extremal case

$$\dot{\mathbf{r}} = \mathbf{v}_f \tag{56}$$

the kinetic energy goes to zero, we have a body at rest according to Newtonian theory. This means that spacetime flow can be considered as an absolute frame of reference.

3.2 Relativistic 2-body solution for the Hulse-Taylor pulsar

The Hulse-Taylor double-star system consists of a pulsar and a neutron star of nearly equal mass. Experimental values from Stanford are listed in Table 2, as well as some derived quantities like apastron radius and radius factor for the centre of mass coordinate r. The latter is required for the relativistic calculation with the covariant Lagrangian (23). Working out the Euler-Lagrange equations from (23) gives very complicated equations that are not shown here. Using SI units leads to very high differences in the exponents of floating point numbers so that the number of mantissa elements of arithmetic is exceeded. Therefore we have to introduce reduced units to avoid this problem, similar as is done in quantum mechanics by introducing atomic units. We choose a length unit of 10^{-9} m, solar masses as mass units and years as time units. Then all quantities containing a combination of these units have to be re-scaled appropriately, see Table 3. In particular the gravitational constant comes out to a handy value of about 991.

The results of the calculations are displayed in Table 4. As in the S2 case, we had to alter the periastron velocity significantly to obtain the experimental orbit period of 7.75 hours. This overestimates the maximum (apastron) radius and ellipticity. The experimental precession of 4.226 degrees per earth year has been recalculated to a value per single orbit which is in the order of 10^{-5} rad. This is an order of magnitude higher than the values of our calculation which are quite insensitive to changes of v_0. Perhaps additional fluid gravitation effects have to be taken into account as obviously is the case for the S2 star. The orbits of the Hulse-Taylor pulsar and its partner are graphed in Fig. 7. The ellipse of the neutron star is a bit larger because masses of both stars are not totally equal.

Since the equations of motion are very complicated, we tried a simplification by approximating the gamma factor in the Lagrangian:

$$\sqrt{1-u} \approx 1 - \frac{u}{2} - \frac{u^2}{8} + \ldots \tag{57}$$

with

$$u = \frac{v^2}{c^2}. \tag{58}$$

The results of the quadratic approximation coincide exactly with the fully relativistic calculation, see corresponding line in Table 4. When restricting to the linear term, the non-relativistic result (9) follows. Doing a non-realtivistic calculation gives practically the same results (extra line in Table 4). This may appear astonishing because the Hulse-Taylor pulsar is considered as a source for gravitational waves. However, when we compare the v_0 value of 450 km/s with that of the S2 star (Table 1), we realize that v_0 of the Hulse-Taylor pulsar is smaller by an order of magnitude. This leads to a gamma factor deviating from unity by only an order of 10^{-6}. Therefore relativistic effects are very small in the Hulse-Taylor system, despite of the fact that two stars comparable to the sun come quite near to each other. The fast rotation of the pulsar of 17/s does not play a role in this type of gravitational theory, but it may be the reason for an energy loss which is observerd. This leads to a decrease of orbit period of

variable	alt. denom./def.	quantity
a		$8.6696 \cdot 10^8$ m
ϵ		0.617155
v_0		450 000 m/s
m_{pulsar}	m_1	$2.86625 \cdot 10^{30}$ kg
$m_{\text{neutron star}}$	m_2	$2.75812 \cdot 10^{30}$ kg
r_{pulsar}	$r_1 = \frac{m_2}{m_1+m_2}\ r$	$0.4903869\ r$
r	$\frac{m_1+m_2}{m_2}\ r_1$	$2.0392060\ r_1$
$r_{\text{periastron}}$	$\frac{a(1-\epsilon^2)}{1+\epsilon}$	$3.31916 \cdot 10^8$ m
r_{apastron}	$\frac{a(1-\epsilon^2)}{1-\epsilon}$	$1.40201 \cdot 10^9$ m

Table 2: Experimental data of Hulse-Taylor double star system (mostly Stanford).

property	units	factor SI $\rightarrow$ adopted units
length	m	10^{-9}
mass	kg	$5.0287898 \cdot 10^{-31}$
time	s	$1.1574074 \cdot 10^{-5}$
velocity	m/s	$8.64 \cdot 10^{-5}$
angul. mom.	kg m^2/s	$4.3448744 \cdot 10^{-44}$
grav. const.	m^3/(kg s^2)	$G = 990.69459$

Table 3: Definition of adopted units.

76.5 μs per year, corresponding to a decrease of the semi major axis by 3.5 m per year. The loss power is reported to be $7.35 \cdot 10^{24}$ W which corresponds to about $8 \cdot 10^7$ kg/s. This is far too low to account for the orbit decrease. Since the precession data give a hint fo fluid gravitation effects, this may also be a reason for the orbit shrinking. Another reason could be of electromagnetic type since the pulsar has a huge magnetic moment. Einsteinian general relativity is no more an adequate argument because of its incorrectness.

v_0 [m/s]	T [h]	$r_{\max}$ [10^9 m]	ϵ	$\Delta\phi$ [rad]
450 000	4.75	1.04648	0.51840	$3.1966 \cdot 10^{-6}$
466 863	7.17	1.48350	0.63433	$2.9697 \cdot 10^{-6}$
468 831	7.60	1.55474	0.64814	$2.9447 \cdot 10^{-6}$
469 526	7.76	1.58133	0.65303	$2.9360 \cdot 10^{-6}$
rel. approx. 2nd order:				
469 526	7.76	1.58133	0.65303	$2.9360 \cdot 10^{-6}$
non-rel.:				
469 526	7.76	1.58131	0.65303	$9.7865 \cdot 10^{-10}$
experiment:				
450 000	7.75	1.40201	0.617155	$6.5209 \cdot 10^{-5}$

Table 4: Parameters of Hulse-Taylor double star system (various calculations and experiment).

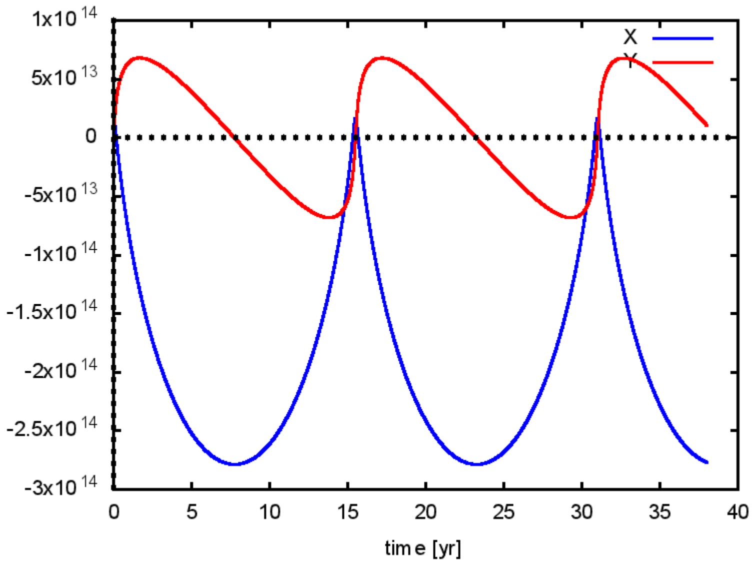

Figure 1: X and Y coordinate components of the S2 orbit (in m).

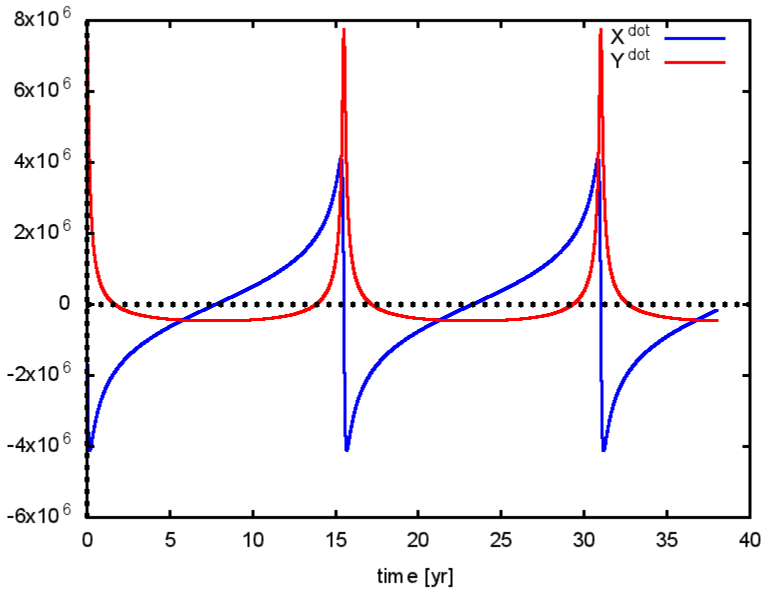

Figure 2: $\dot{X}$ and $\dot{Y}$ velocity components of the S2 orbit (in m/s).

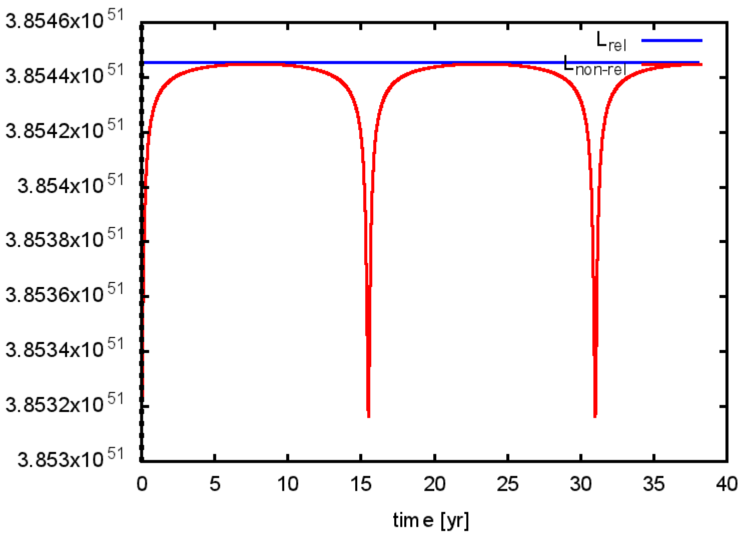

Figure 3: Angular momentum (relativistic and non-relativistic) of the S2 orbit.

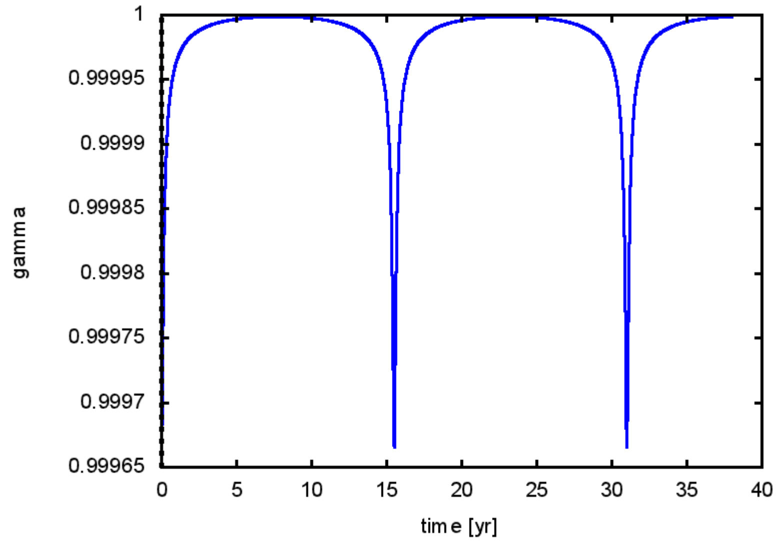

Figure 4: γ factor of the S2 orbit.

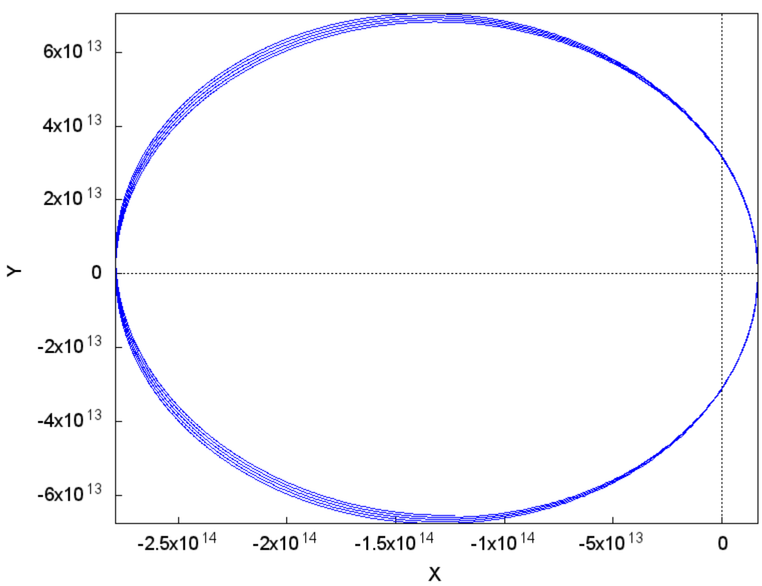

Figure 5: Retrograde precession orbit of the S2 fluid dynamics model (in m).

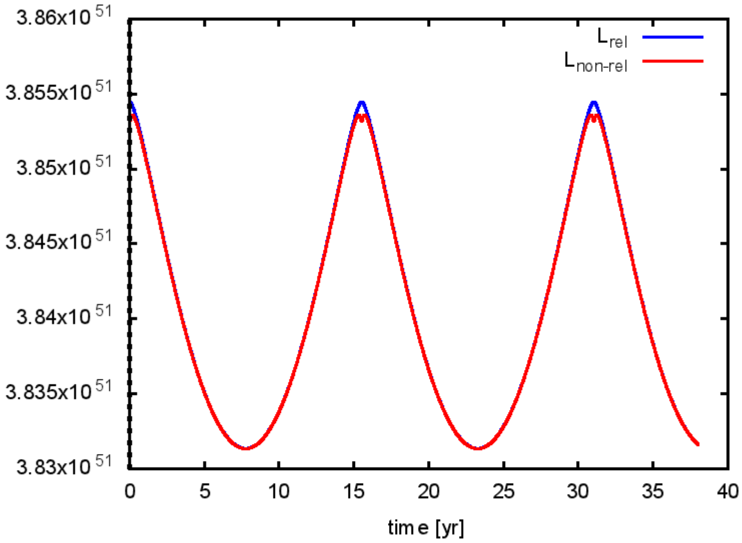

Figure 6: Angular momentum (relativistic and non-relativistic) of the S2 fluid dynamics model.

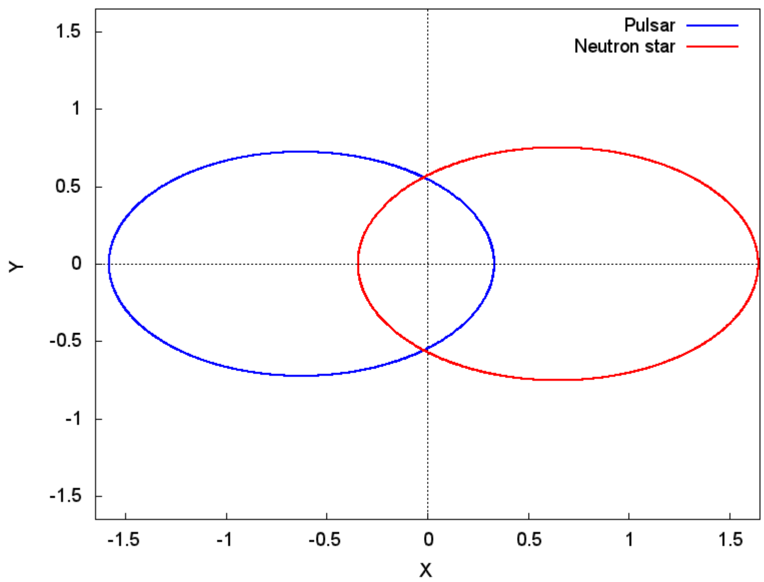

Figure 7: Orbit of Hulse-Taylor pulsar and its neutron star partner, (in 10^9 m).

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