Investigating how the Horava correction to the Newtonian potential itself affects the anomalistic orbital time of various celestial bodies.

John Spry, Devon Mcleod

Supervisors: Ioannis Haranas

Dept. of Physics and Computer Science,

Wilfrid Laurier University Science Building,

Waterloo, ON, N2L 3C5,

e-mail: Iharanas@wlu.ca, Spry9170@mylaurier.ca, Mcleod3290@mylaurier.ca

Abstract

Horava gravity is a theory of quantum gravity that solves problems related to different concepts of time in quantum field theory and general relativity by treating the quantum concept of space and time to be not equivalent at a high energy level. In this paper, we will investigate how the Horava correction to the Newtonian potential itself affects the anomalistic orbital time of various celestial bodies. For Mercury, Puslar PSR 1913+16, and Planet b of star HD 80606, we will use the Gaussian form of Lagrange equations to derive and calculate the anomalistic time rate of change as a function of the eccentric anomaly. The correction to Horava gravity that we are using is and using this equation with the Gaussian form of Lagrange equations, we will develop an expression for ΔT. ΔT will represent two integrals that show how Horava gravity effects ΔT.

Introduction

Horava gravity is a theory of quantum gravity proposed by Petr Horava in 2009. This theory was created to solve many problems related to different concepts of time in quantum field theory and general relativity. The quantum concepts as we know it is treated as the more fundamental concept so that space and time are not equivalent. Due to this, at high energy levels, space and time are not equal to each other. The Horava theory as opposed to Loop quantum gravity uses concepts from condensed matter physics such as quantum critical phenomena. Also, through Horava gravity, the speed of light has been discovered to approach infinity at high energies. Now, with every theory, there are inconsistencies. These inconsistencies include: while using Horava's initial formulation's, it was found that when comparing a spherical and non-spherical Sun, the results predicted were very different from those calculated. Since there are inconsistencies, many other scientists have modified his theory in hope to find a solid solution and there has been much progress. The theory is constructed using the full ADM metric: $ds^2 = N^2dt^2 - h_{ij}(dx^i + N^idt)(dx^j + N^jd)$, and it is invariant under foliation-preserving diffeomorphysms. In our investigation, we will investigate using our own correction: .

Anomalistic time rate of change as a function of the eccentric anomaly

Using the Gaussian form of Lagrange equations, we determined the function of anomalistic time rate of change as a function of the eccentric anomaly.

$$\frac{dT}{dE} = \frac{1-ecosE}{n}[-\frac{(1-e^2)}{n^2ae}\frac{(cosE-e)R}{(1-ecosE)} + \frac{2ea(1-ecosE)}{n^2a^2e}R],$$

where e is the eccentricity of the celestial body, n is the mean motion, a is the semi-major axis, and E is the anomaly, and R is the radius of the body.

After much derivations and simplifications, the final expression we come to is:

$$\Delta T = -\frac{12\pi n^5a^6(4+e)}{\psi c^6(1-e^2)^{5/2}} + \frac{\pi(2+e^2)n^5a^6}{\psi c^6(1-e)^3(1+e)^{5/2)}}$$

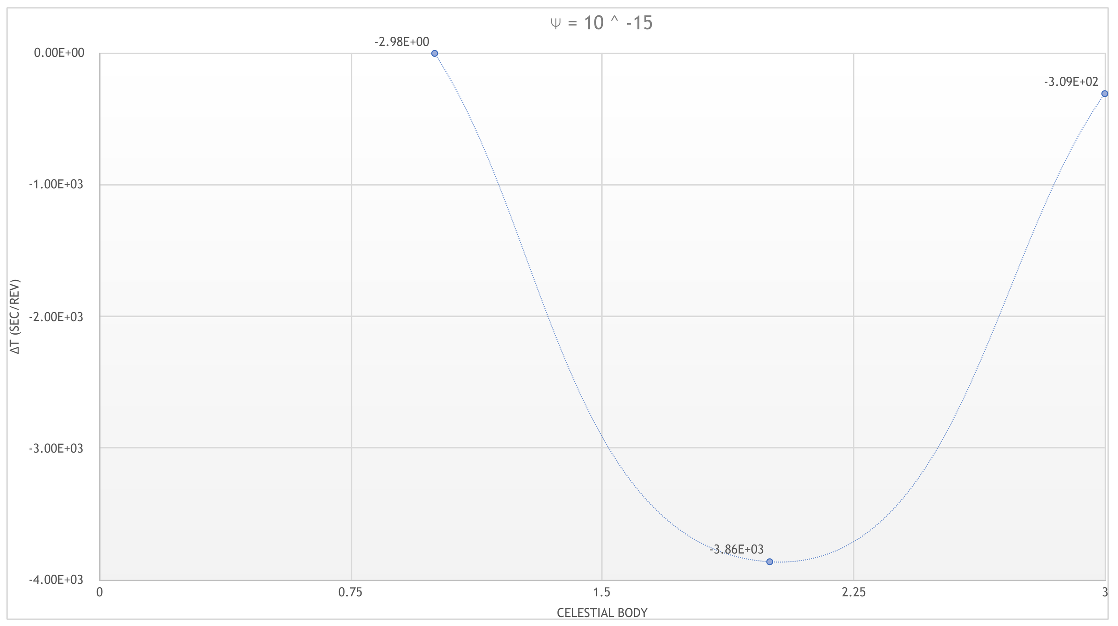
Numerical Results

Celestial Body in Space	ΔT (s/rev)	ψ
Mercury	-2.9830419	10^(-15)
Pulsar PSR 1913+16	-3,861.7	10^(-15)
Planet b of Star HD 80606	-308.6204	10^(-15)

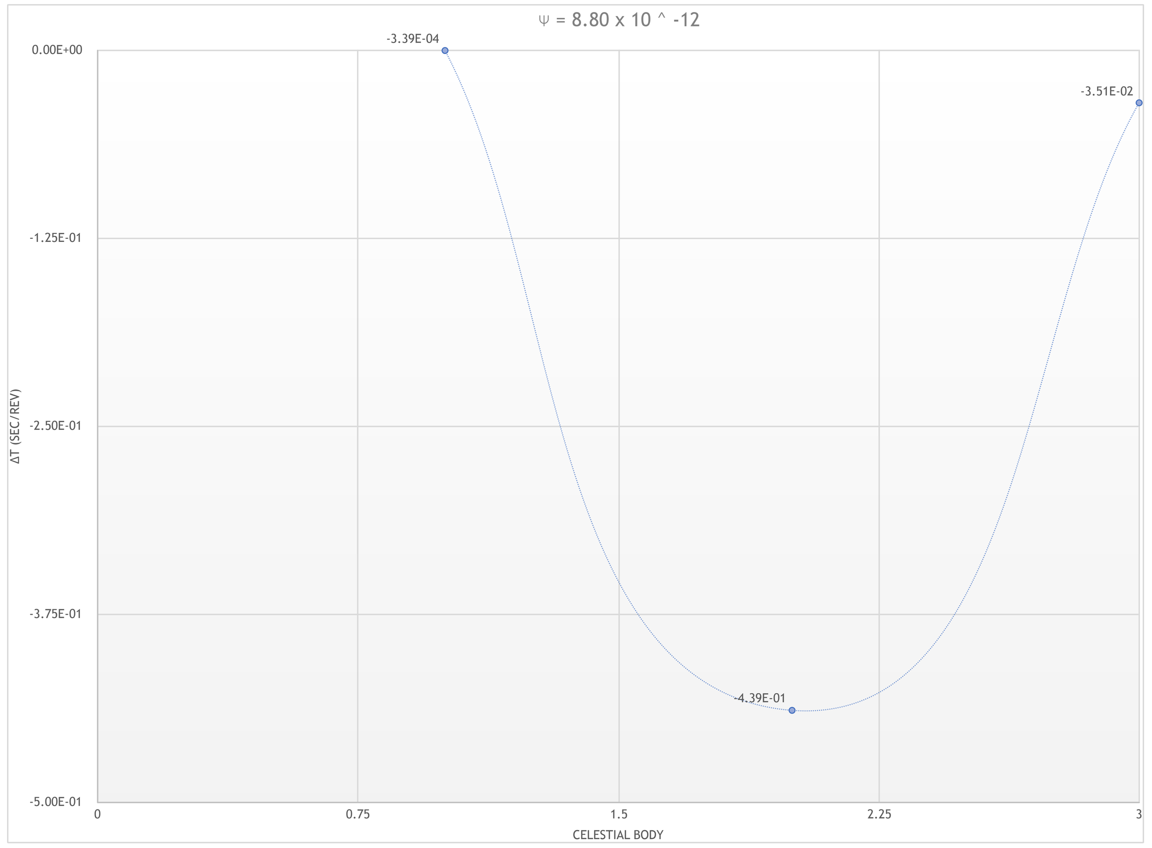
Table 2: Evaluating Delta T with ψ = 10^(-15)

Celestial Body in Space	ΔT (s/rev)	ψ
Mercury	$-3.38982*10^{-4}$	8.8 x 10^(-12)
Pulsar PSR 1913+16	$-4.3883*10^{-1}$	8.8 x 10^(-12)
Planet b of Star HD 80606	$-3.50705*10^{-2}$	8.8 x 10^(-12)

Table 3: Evaluating Delta T with ψ = 8.8x10^(-12)



Graph 2: Plotting Delta T with ψ = 10^(-15)



Graph 3: Plotting Delta T with ψ = 8.8 x 10^(-12)

Discussion

While investigating how the Horava correction to the Newtonian potential itself affects the anomalistic orbital time of various celestial bodies, we noticed that there are similarities within the data. According to the data shown, while ψ_0 increases, ΔT increases. This shows a trend within the data which is also shown throughout the graphs above. From this data, we can agree that while using the correction to Horava gravity, a multitude of ψ_0 values, and the gaussian form of Lagrange's equations, that ΔT will always be negative for any celestial body. This means that each celestial body's elliptical orbit will be ahead of their original and therefore will precess.

Conclusion

In conclusion, the data calculated predicts that as ψ_0 increases, ΔT increases. We can also conclude that while using various ψ_0 values with this new correction to the Newtonian potential itself, all of the ΔT data is negative. Since ΔT is negative, this represents that the elliptical orbit for each celestial body will be ahead of its original elliptical orbit and therefore will precess around the star that it is orbiting. While these calculations are accurate, it is still theory and therefore will not know its true anomalistic time rate of change until experimented upon.

References

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