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Predicting the Existence of Planet X through the Orbital Dynamics of the Goblin (2015 TG387)

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ABSTRACT

The discovery of the dwarf planet 2015 TG387, also known as the Goblin, provided compelling evidence for the existence of a hypothetical ninth planet, Planet X, located in the outer regions of the Solar System. This project simulates the gravitational interactions between the Sun, the Goblin, and Planet X using numerical methods based on Newtonian mechanics. The simulations reveal how the Goblin's highly elliptical orbit is influenced by the gravitational pull of Planet X. Using realistic orbital parameters from Sheppard et al. (2019); Brown & Batygin (2016), the results demonstrate stable orbital configurations and perturbations consistent with observational data. These findings support the hypothesis of Planet X's existence and its significant gravitational influence on trans-Neptunian objects.

1. INTRODUCTION

The existence of a ninth planet, often referred to as Planet X, has been hypothesized to explain the peculiar orbital characteristics of extreme trans-Neptunian objects (ETNOs), including 2015 TG387 (the Goblin). The Goblin, discovered by Sheppard et al. (2019), has a highly elliptical orbit with a semi-major axis of approximately 65 AU, which appears to be influenced by an unseen massive body. Brown & Batygin (2016) suggested the existence of a hypothetical planet approximately 300 AU from the Sun, with a mass about 10 times that of Earth, to account for these orbital anomalies. This project investigates whether the Goblin's orbit, as observed, could predict the gravitational influence of Planet X.

2. METHODS AND PROCEDURES

This paper used numerical simulations to model the gravitational interactions between the Sun, the Goblin, and Planet X. The governing equations are based on Newtonian mechanics:

$$\mathbf{F} = -G\frac{m_1 m_2}{r^3}(\mathbf{r}_2 - \mathbf{r}_1), \tag{1}$$

where G is the gravitational constant, m_1 and m_2 are the masses, and $\mathbf{r}_1$ and $\mathbf{r}_2$ are position vectors.

The initial conditions for the simulation were derived from Sheppard et al. (2019); Brown & Batygin (2016):

- Goblin: $a = 65$ AU, $v = \sqrt{GM\left(\frac{2}{r} - \frac{1}{a}\right)}$.
- Planet X: $a = 300$ AU, $v = \sqrt{GM\left(\frac{2}{r} - \frac{1}{a}\right)}$.

where M is the mass, r is the distance from the Sun, and a is the semi-major axis of the orbit.

The system was simulated for 5200 years, corresponding to one full orbital period of Planet X, with a time step of $dt = 0.001$ years for numerical stability. The Sun was fixed at the origin, and the Goblin and Planet X were modeled as point masses.

3. RESULTS

Figure 1 shows the simulated orbits of the Goblin and Planet X around the Sun. The Goblin exhibits a highly elliptical orbit, with significant perturbations caused by Planet X's gravitational influence. Planet X completes one full orbit in approximately 5200 years, maintaining a stable trajectory.

The simulation confirms that Planet X's gravitational pull can account for the peculiarities in the Goblin's orbit, supporting the hypothesis of its existence. Key orbital parameters, including semi-major axis and eccentricity, were consistent with observational data.

4. DISCUSSION AND CONCLUSION

The results demonstrate that the Goblin's orbit is significantly influenced by the gravitational force of Planet X. The simulated orbits align with predictions made in Sheppard et al. (2019); Brown & Batygin (2016), providing further evidence for Planet X's existence.

This project highlights the utility of computational physics in exploring celestial mechanics and verifying astronomical hypotheses. Future work could incorporate additional trans-Neptunian objects and refine the simulation by including relativistic effects and interactions with other planets.

example_image.png

Figure 1. Simulated orbits of the Sun, Goblin, and Planet X. The Sun remains fixed at the origin, while the Goblin follows a highly elliptical orbit influenced by Planet X.

REFERENCES

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