Behaviour of a pitiable rocket flying near to the Earth

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Abstract

Nowadays many people know that if one jumps thoughtlesly high, he can get a bump. But they all have never thought that tiny rockets feel the same! Imagine that you're a tiny ricket and you want to change your direction using our planet. Everything goes well until you meet our skrewdy atmosphere: it slows you down and you fall and explode! That's a pity. In this work we will discuss what tiny rockets can do in such situations.

Introduction

The process of turning around our rocket is explored in this research. The theoretical model includes **Newton's law of universal gravitation** and **Barometric formula**. This is enough because other things are left as self-evident. This was implemented in **Python** program which calculates what would happen under initial conditions like coordinate, velocity and impact parameter.

Theoretical model

As it was already mentioned, was used **Newton's law of universal gravitation**:

$$\mathbf{F} = G \cdot \frac{m_1 \cdot m_2}{r^3} \cdot \mathbf{r} \tag{1}$$

Where F is Newton force, m_1 is the rocket mass, m_2 is the Earth mass and r is a distance between the rocket and the Earth.
And **Barometric formula** (used when the rocket is in the atmosphere):

$$\rho = \rho_0 \cdot exp\left[\frac{-g \cdot m \cdot H}{k \cdot T}\right] \tag{2}$$

Where ρ is the density of atmosphere, ρ_0 is the density near the surface, g is the gravitational acceleration, m is mass of an air molecule, H is the height above the Earth, k is Boltzmann constant and T is temperature.
Also the **friction force** acts upon the rocket (when the rocket is in the atmpsphere):

$$\mathbf{F} = -\frac{1}{2} \cdot c \cdot S \cdot v^2 \cdot \frac{\mathbf{v}}{v} \tag{3}$$

Where F is the friction force, c is the drag coefficient, S is the effective square v is the velocity of the rocket.

Methods

To model such situation **Python** code was written. You should use `main.py`. There are two functions to use: `sign_graph.show()` and `sign_graph.test()`. They take two arguments. The first one `impact_parameter` is a required positional argument representing the impact parameter (it is measured in the Earth radius), another one which represents the absolute value of the initial velocity is a keyword argument with the default value 15 pixel per second and is referred to as `speed`. Function `sign_graph.show()` shows how it happens, function `sign_graph.test()` finds the optimal *impact parameter* in $O_{0.1}(impact\_parameter)$.

Results

Here are the findings of the study. The optimal value of the *impact parameter* is $2.276 \cdot R_{Earth}$ if the influence of the atmosphere is taken into account and $2.2748 \cdot R_{Earth}$ otherwise.

Conclusion

As it can be seen, the influence of the atmosphere is not that significant ($\approx 0.05\%$). Nevertheless, since that moment all tiny rockets can use this project to fly happily and not be confused.