APOLLO MISSION REPORT

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ABSTRACT

The purpose of this report is to convince Congress to fund and defend the Apollo mission's future to reach the Moon. Calculations have been done to show the gravitational pull and gravitational potential energy of both the Earth and the Moon to show how Saturn V will be affected during flight. The report includes how far the Saturn V rocket carrying the Apollo Command Module will reach before burnout of Stage 1. The success of the Apollo Missions pave the way to the future of space exploration and opportunities for new technology that may aid us all in the coming years.

I. Introduction

Earth and Moon systems are both controlled by one the fundamental forces of nature, Gravity. This force is what keeps us orbiting the sun and keeps everything down to Earth. Apollo Mission control is planning to counteract this force to be able to reach the Moon and create a landmark in history to be the first on the Moon. To be able to achieve this we require the assistance of congress to fund the Apollo Mission to reach the Moon and make the United States of America the first to reach the Moon and beyond. This is the purpose of the Apollo Mission.

Overcoming Earth's gravitational pull requires a rocket with enough fuel to leave the orbit and fly towards the Moon, this will be done using the planned Saturn V rocket which will use the fuel within its first stage to reach escape velocity from earth's surface. Once in orbit of the Earth the Saturn V rocket will attempt to reach Lunar orbit and attempt to land the first humans on the Moon. To make sure this plan works, our team ran calculations to imitate the pull of the Earth and Moon system and how this affects Saturn V in flight from the Earth to the Moon.

II. The Gravitational Potential of the Earth-Moon System

Using plotting technology such as *matplotlib* which allows for the plotting of data, we projected how the gravitational potential energy from the Earth-Moon system affects any surrounding object in the vicinity of their gravitational pull, this is known as gravitational potential energy and it determines how much energy it takes to move something due to gravity.

Gravitational potential energy is described in an equation as:

$$\Phi(r) = -\frac{GM}{r} \tag{1}$$

Where G is a gravitational constant, M is the mass of an object, and r is the distance from that object. This was used to produce the following graph that shows how this energy changes over the distance from earth.

Figure 1 shows how the gravitational potential energy changes as distance from Earth changes.

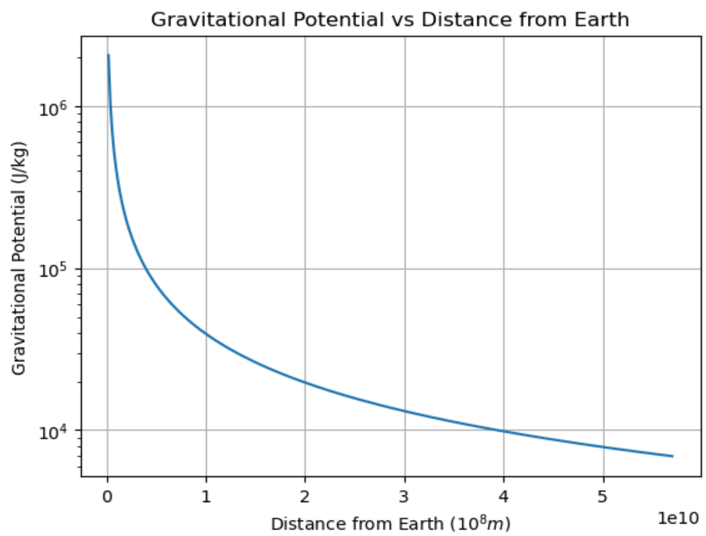

Figure 1: Gravitational Potential per Distance from Earth

The y-axis shows the energy in J/kg, the x-axis shows the change in the distance from Earth. This combined shows how it is easier to move something further away from Earth as the energy decreases than closer to it when the energy increases. Once outside Earth's gravitational pull it will be easier to move the rocket towards the Moon. Where it will be pulled in by the Moon's gravitational pull.

Thus we can then model how the Earth and Moon system affect the gravity throughout the system.

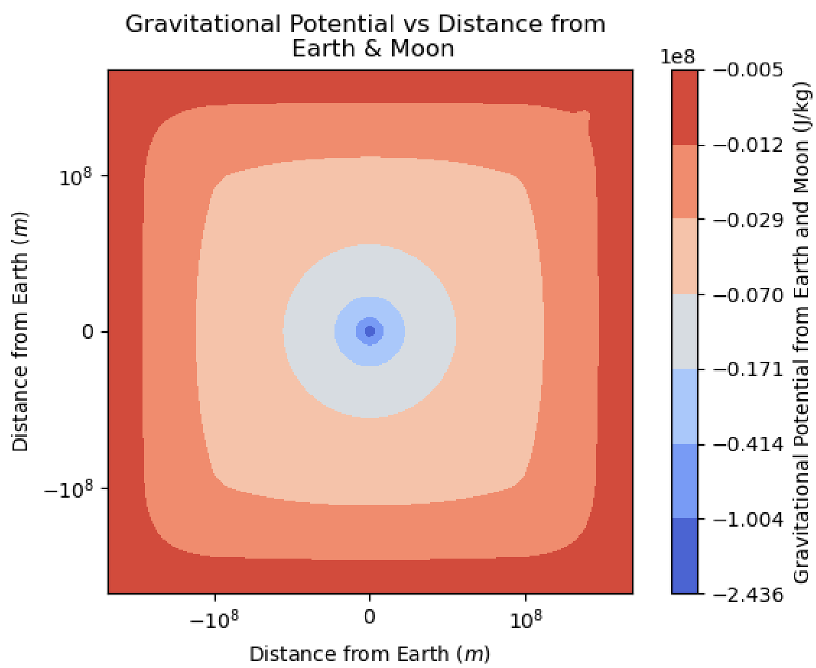

Figure 2: Gravitational Potential per Distance from Earth and Moon

Figure 2 suggests that in addition to the Moon's gravitational pull, there would not be much difference in the overall uniform change in gravitational energy as Saturn V moves away from Earth, but there is a significant difference near the Moon's surface where gravity is higher and can pull Saturn V in for a safe landing.

III. The Gravitational Force of the Earth-Moon System

Following the Gravitational Potential Energy, our team calculated the Gravitational Force that Saturn V will experience throughout its trajectory. The force exerted by both systems affect how Saturn V will move throughout its journey to the Moon.

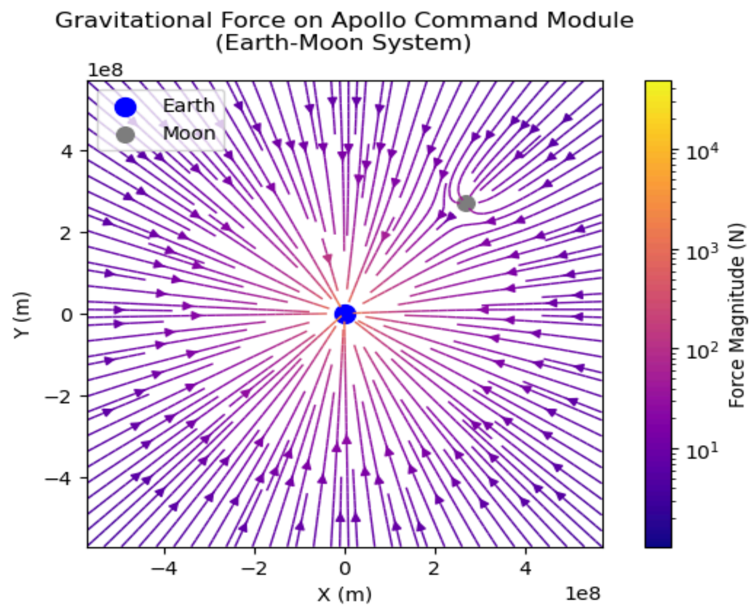

Figure 3: Gravitational Force per Distance from Earth and Moon

Figure 3 shows how the Gravity of the Earth pulls towards its surface and models the expected weakness of the force the further away the Apollo Command Module is from the Earth, and the figure also shows how the Moon will pull the Apollo Command Module towards its surface as well. Using these well modeled force trajectories we can predict where the Saturn V rocket will go and how we can make sure it will reach the Moon.

IV. Projected Performance of Saturn V Stage 1

Saturn V performance has also been modeled and predicted on its performance for how far the rocket will reach before burnout of the first stage is reached. Projected velocity by burnout of stage 1 is projected to be 1600 meters per second which is more than enough to overcome Earth's escape velocity and reach orbit. The altitude Saturn V will reach by burnout is projected to be 74093 meters which is 74 km, this would leave the rocket at the mesosphere where it will continue its journey beyond.

V. Discussions and Future Work

Calculations above have had few assumptions made, especially with the performance of Saturn V, it was assumed that the Earth's gravity is constant throughout all of stage 1, this means that Saturn V will reach slightly higher altitudes and velocity but these assumptions are made because there isn't a significant change in gravity, these calculations will need some refinement for more realism in the future, currently NASA has ran tests and discovered that stage 1 burned for 160 seconds with an altitude of 70 km, the predicted calculations show that it burned for 157 seconds and reached an altitude of 75 km, this may be due to other factors such as air drag and shows that our calculations are a slight overestimate as we neglected drag in our calculations which can heavily impact the velocity of Saturn V.