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PHYS265

Apollo Rocket Performance Analysis

NASA was able to send humans to the moon, which marked the beginning of human space exploration. These missions needed expert understanding of gravitational forces, in order to eliminate potential dangers that astronauts encounter. The predictions and simulations of the rocket are necessary to ensure the success of Apollo missions. This report will examine and show the key analysis of gravitational forces on Earth, the Moon, and the rocket's performance.

II. The Gravitational Potential of the Earth-Moon System

The measure of energy a spacecraft experiences is the gravitational potential energy. Figure 1 shows this potential.

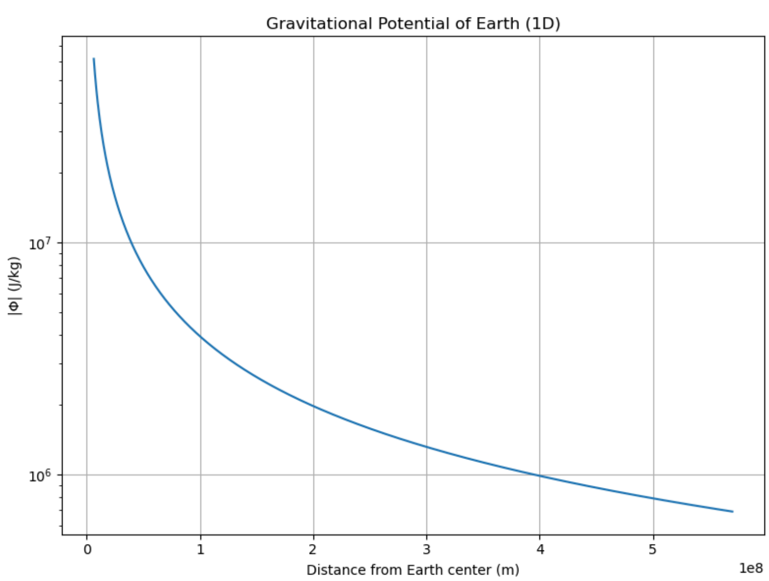

Figure 1

This graph demonstrates the decrease of potential energy when increasing the distance.

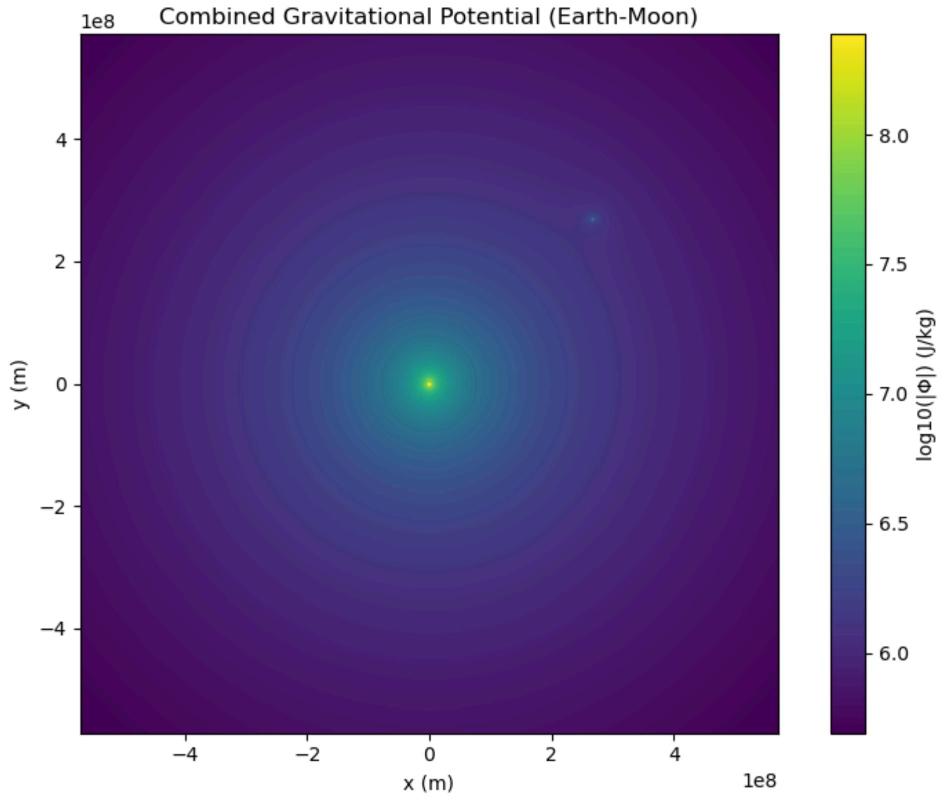

Figure 2

This figure provides a detailed visual representation of the gravitational field of the Earth and Moon. The regions around each body are clearly visible to have strong gravitational influence.

Both of the figures depict the influence of gravitational forces. Using these combined can show paths that the rocket can take to be the most fuel efficient.

III. The Gravitational Force of the Earth-Moon System

The force that acts on the Apollo 11 command module is simulated and illustrated by a stream plot. The gravitational field is shown with direction and strength that pulls on the command module within the Earth-Moon system (Figure 3). This shows the trajectories of spacecraft, used for precise travel in space and ensures crew safety.

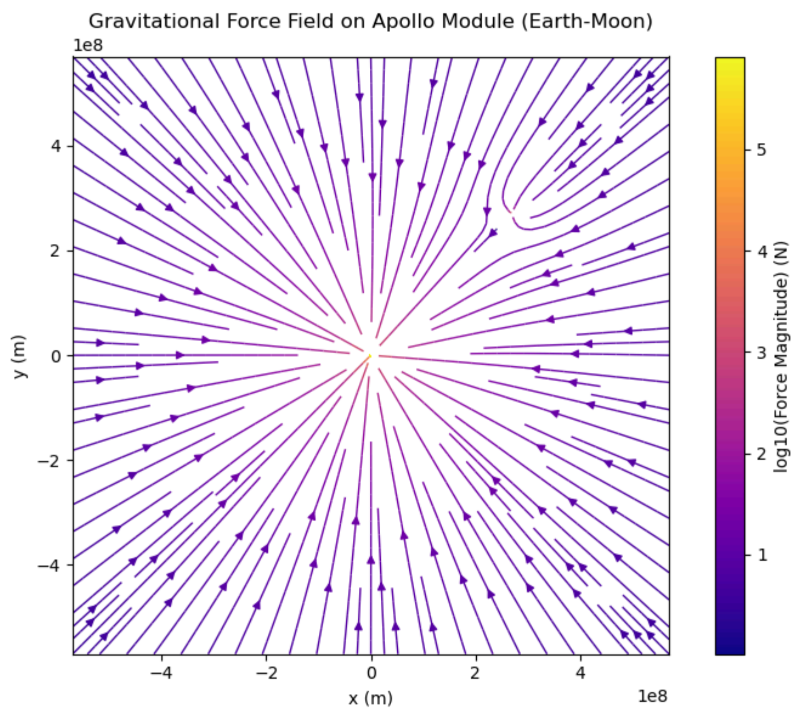

Figure 3

IV. Projected Performance of the Saturn V

The rocket performance is calculated through the rocket equation. It calculates the burn time based on its initial mass and fuel consumption. After calculating the burn time, 157.69 seconds is found, which is close to NASA's measured value of 160 seconds (Figure 4). The calculation of altitude is greater than the tested 70 km altitude because air resistance and other factors are neglected.

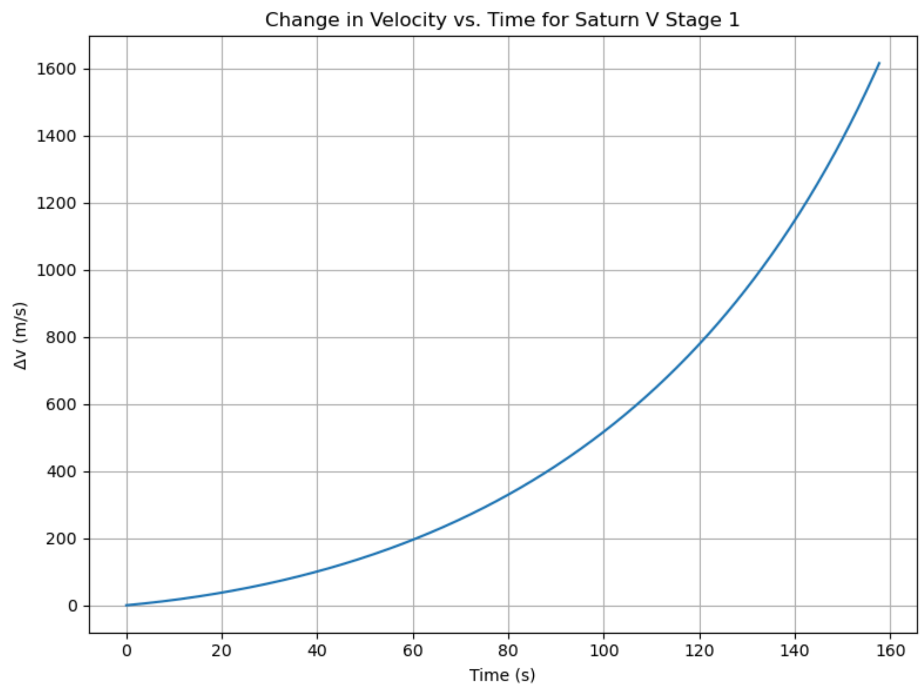

Figure 4

V. Discussion and Future Work

Simplifications were made by treating the large celestial bodies as point masses, neglecting atmospheric drag, calculating using a constant fuel burn rate, ignoring possibility of multistage rockets, and ignoring gravitational forces from other bodies such as the sun.

In future works, simplifications should be addressed by developing models that are more detailed for the mass of the Earth and Moon, calculating forces for a multistage rocket, add variable fuel consumption into the calculation, and including drag into trajectory calculations to simulate a more realistic model.

Compared to the NASA tests, the importance of incorporating these points are highlighted. By incorporating these points, we can improve the accuracy and reliability of future models.