# Can NASA Measure the Acceleration of Centrifugal Acceleration?

## 1. Introduction

The Lunar Laser Ranging (LLR) experiment has provided high-precision measurements of the Earth-Moon distance, leading to constraints on the time variation of Newton’s gravitational constant (G). The paper under discussion suggests that the relationship between the lunar orbit and G variation is given by:  
 𝑎̇/𝑎 = 𝑑𝐺/𝐺  
  
where the centrifugal acceleration of the Moon is:  
 𝑎 = 2.72 × 10⁻³ m/s²  
  
The question at hand is whether NASA can directly measure this small acceleration change per year to validate the claim that 𝑑𝐺/𝐺 is small.

## 2. Breakdown of the Required Measurement Precision

From the equation 𝑎̇/𝑎 = 𝑑𝐺/𝐺 and the constraint from the LLR paper:  
 𝑑𝐺/𝐺 = (-4 ± 9) × 10⁻¹³ yr⁻¹  
  
The expected annual change in acceleration is given by:  
 𝑎̇ = 𝑎 × (𝑑𝐺/𝐺)  
  
Substituting the values:  
 𝑎̇ = 2.72 × 10⁻³ × 10⁻¹²  
 𝑎̇ = 1.926 × 10⁻¹⁵ m/s² per year  
  
This is an extremely small acceleration change.

## 3. Can NASA Measure This?

- \*\*Current LLR Precision:\*\*  
 - LLR can measure the Earth-Moon distance with an uncertainty of ~2 cm per measurement.  
 - Over decades, integrated uncertainties can reach the millimeter level in range measurements.  
  
- \*\*Acceleration Sensitivity:\*\*  
 - NASA’s best tracking of planetary bodies using Doppler and ranging techniques (e.g., Cassini, LLR, VLBI) achieves acceleration sensitivities down to ~10⁻¹¹ to 10⁻¹² m/s².  
 - The required precision to measure 𝑎̇ ≈ 10⁻¹⁵ m/s² per year is three orders of magnitude smaller than current detection capabilities.

## 4. Implications

- NASA \*\*cannot currently measure\*\* this small acceleration variation.  
- The claim that LLR constrains 𝑑𝐺/𝐺 from lunar orbit changes \*\*relies on indirect assumptions\*\* rather than direct acceleration measurements.  
- This means that the \*\*paper’s conclusion about a small 𝑑𝐺/𝐺 might not be empirically justified\*\*, since the effect they claim to measure is far below current sensitivity.

## 5. Conclusion

Given the extreme precision required to directly measure a change in the Moon’s centrifugal acceleration at the level of 10⁻¹⁵ m/s² per year, it is currently \*\*beyond NASA’s capability\*\* to confirm the constraint on 𝑑𝐺/𝐺 derived in the paper. This suggests that the conclusion about a near-constant G is based on model-dependent assumptions rather than empirical direct detection of acceleration variations.