Hunting for the chameleon particle: an update on an ambitious experiment on dark energy

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The hypothetical chameleon interaction could be a possible explanation for dark energy accounting for 68% of the total energy in our universe. We are following a novel idea [2] to measure this interaction in a table-top setup - the CANNEX experiment.

Introduction

The 1st hurdle: vibrations

Problem: required force sensitivity of 0.1 pN between DC and 1 Hz requires excellent damping of seismic and acoustic vibrations.

Solution: two-directional anti-vibration stage consisting of a geometrical anti-spring (GAS) filter (Fig.a) [3], a double pendulum (Fig.b), eddy current dampers, and a two-stage vacuum chamber (Fig.c).

1st hurdle: vibrations

- Measure forces between two parallel plates
- Inject gas and vary pressure p
- If the Chameleon exists, the force decreases, otherwise it increases with p

Aim: limit to the interaction strength or proof of existence

2nd hurdle: force sensitivity

- Required sensitivity: 0.1 pN
- Interaction distance: 10 μm
- Interaction area: 1 cm²

Achievable sensitivity

First sensitivity 1.5 pN
- Achievable with current setup

Second sensitivity 0.3 pN
- Upgrading the detection system

Third sensitivity 0.1 pN
- Upgrading the force sensor design

… to the next hurdles

- Augment the passive anti-vibration stage by active H∞ feedback
- Demonstrate capability to keep parallelism between three surfaces
- Demonstrate force sensitivity

Interested? Stay tuned on cannex.vu.nl!

References: