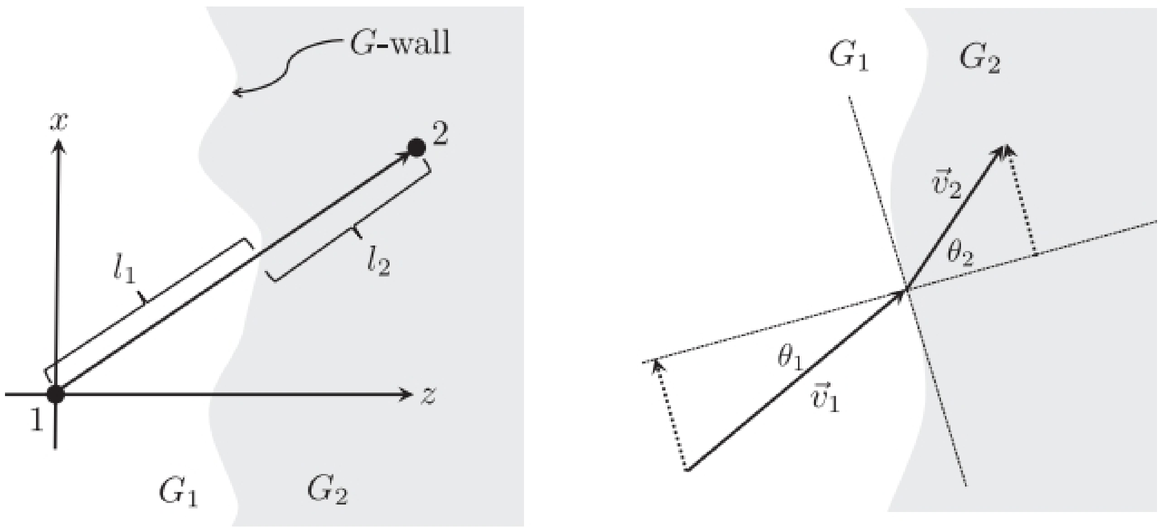
WHY IS NEWTON’S CONSTANT SO SMALL?

The [CECs Theoretical Physics Lab’s](#) researchers published a theoretical model that considers Newton’s gravitational constant as a dynamic variable that can take on different values in different regions of the universe, separated by domain walls called ***“G-walls”*** *. The spontaneous materialization of G-Walls could explain why the gravitational interaction is so weak compared to the rest of the interactions.*



From the elementary particles physics viewpoint, Newton’s constant is extremely small. The gravitational forces between the atom’s proton and electron, for example, is 39 orders of magnitude weaker than the electromagnetic force that keeps them together. This strange gap between the coupling of two fundamental theories led Paul Dirac in 1937 to question if the gravitational constant value may have evolved throughout the history of the universe, maybe in a remote past it had a commensurable value with the microscopic scales and it slowly decayed until it reached the minimal value observed today.

In this work, published by the ***Physical Review D*** [1] by the researchers of the CECs Theoretical Physics Lab, Claudio Bunster and Andrés Gomberoff, propose a mechanism that implements this decay. It’s based on the introduction of new fields that make that the constant gravitation ceases to be a universal constant to become an integration constant, in such a way that it can take on different values in different regions of the universe. These regions are separated by a new class of dominion walls that researchers have called ***G-wall***.

G-walls can materialize spontaneously due to quantum or thermal fluctuations. These would be closed walls: bubbles that show up with a certain probability in space. In the quantum case, Newton’s constant will decrease inside the bubble and after its formation it will grow to accommodate universe regions that are in constant growth. This process can repeat many times, leading to Newton’s constant to continue decaying. This will continue indefinitely, but the probability of creating a new bubble will decrease in each step, allowing a small residual value when the probability is sufficiently small. This is similar to what Brown and Teitelboim [2] did for the cosmological constant in 1987.

The possibility exists for one of this dominion walls to be absorbed by a black hole and the change in Newton’s constant implies a decrease in the entropy associated to the black hole. This phenomenon strictly restricts the form of the theory that couples the *G-walls* with the rest of the fields if we demand that the second law of thermodynamics is preserved.

In Andrés Gomberoff's words: “The fact that the gravitational constant is spectacularly small compared with the rest of the interactions is a very relevant theoretical problem. It’s hard to think in a unified theory that includes gravitation and the rest of the interactions, and is capable of predicting a number as such. The calculations that physics make don’t usually deliver numbers such as these. That’s why the Dirac’s idea is so attractive. These numbers are a reflection of the time that has gone by. Just like erosion is capable of changing geography in a radical way, although very slowly, Newton’s constant may have had a great value and it may have slowly decreased until reaching the actual value. With this work we show a mechanism capable of implementing this slow erosion”.

Ref.:

[1] Gravitational domain walls and the dynamics of the gravitational constant G. Phys. Rev. D 96, 025013 (2017) DOI: https://doi.org/10.1103/PhysRevD.96.025013

[2] J. D. Brown and C. Teitelboim, Neutralization of the cosmological constant by membrane creation, Nucl. Phys. B297, 787 (1988). https://doi.org/10.1016/0550-3213(88)90559-7