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Gravity

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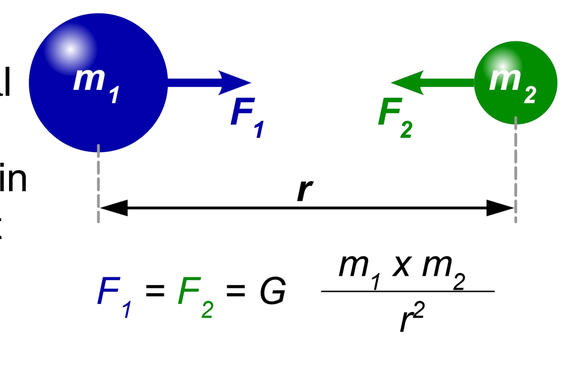
Three Standard Models of Gravity

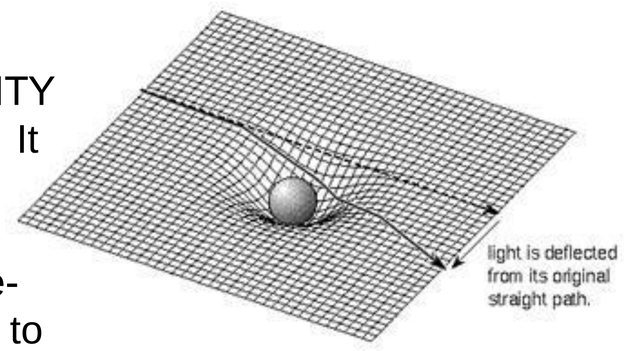
Gravity is familiar yet enigmatic. It makes us “fall to the ground,” but what exactly is going on?

CLASSICAL ANTIQUITY: ‘Logos’ keeps the cosmos ordered, moving all things. The nature of elements, such as water and earth, cause them to move towers the center of the (geocentric) universe.

NEWTONIAN PHYSICS: The synthesis of centuries of work in the laws of motion (F=ma) and universal gravitation unites the physics of falling bodies with keeping “planets in their orbs.” While accounting a vast range of observations, it does not account for how “action at a distance” works. “Invisible, intangible, and not mechanical” are not pleasing attributes of physical models.



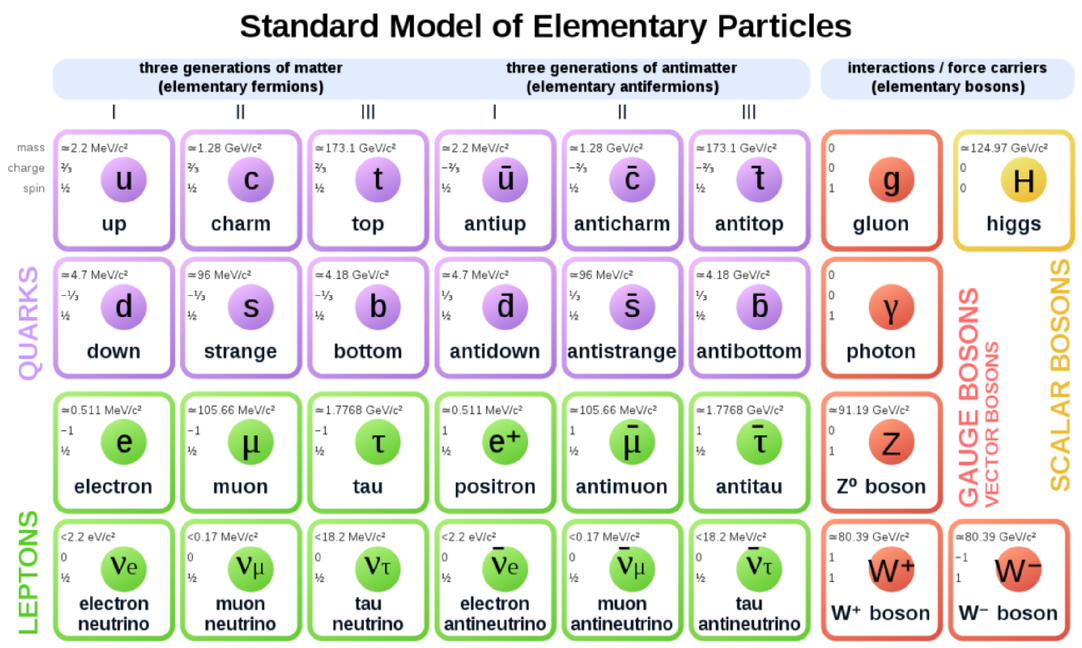
EINSTEIN’S GENERAL RELATIVITY describes space-time as a metric. It enjoys regular confirmation of its detailed and precise predictions. Interacting with the fabric of space-time, a mass tells how space-time to bend, and bent space-time tells things how to move.



Experimental Quantum Gravity

PROBLEM: Quantum Mechanics (the other pillar of modern physics) and General Relativity are difficult to reconcile.

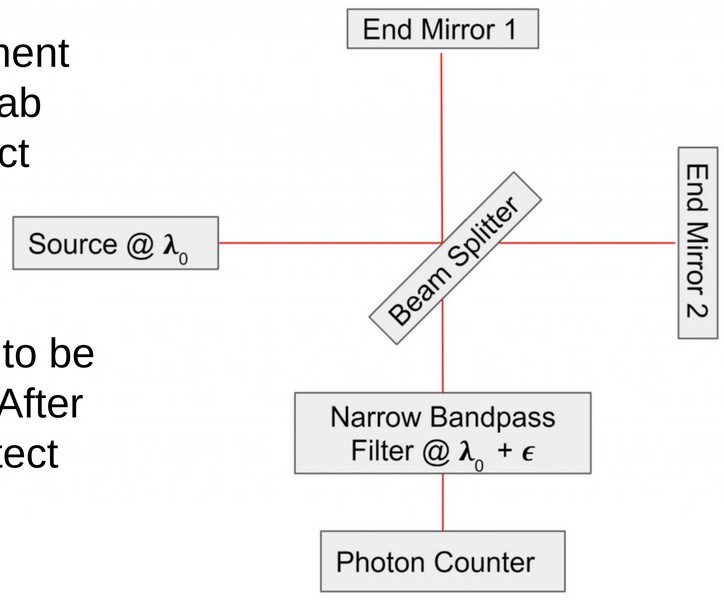
Quantum field theories describe the standard model of particle physics, the forces and fields the account for properties of fundamental particles, yielding the most precise agreement between model prediction and experimental measurement in all physical sciences.



Gravity is conspicuous by its absence. This is not due to lack of interest or ability. Decades of theoretical work to “quantize gravity” as has been done for the standard model have not produced a consistent description of gravity at the quantum level.

VERLINDE-ZUREK: A new approach (PRB 882 (2021) arXiv 1902.08207) describes quantum fluctuations of the metric. In addition to giving rise to General Relativity, it also predicts unique side effects: subtle changes in the behavior or Michelson interferometers.

GQUEST(Gravity from the Quantum Entanglement of Space Time) is under development at Fermilab and Caltech. It will be sensitive to the side effect predicted by Verlinde-Zurek. This will be an experimental confirmation (or rejection) of this approach to quantum gravity. The metric fluctuations cause some of the source photons to be of slightly higher energy (shorter wavelength). After filtering out the original photons, we seek to detect individual photons at the shorter wavelength.



Details at:

https://gquest.fnal.gov

arXiv 2404.07524