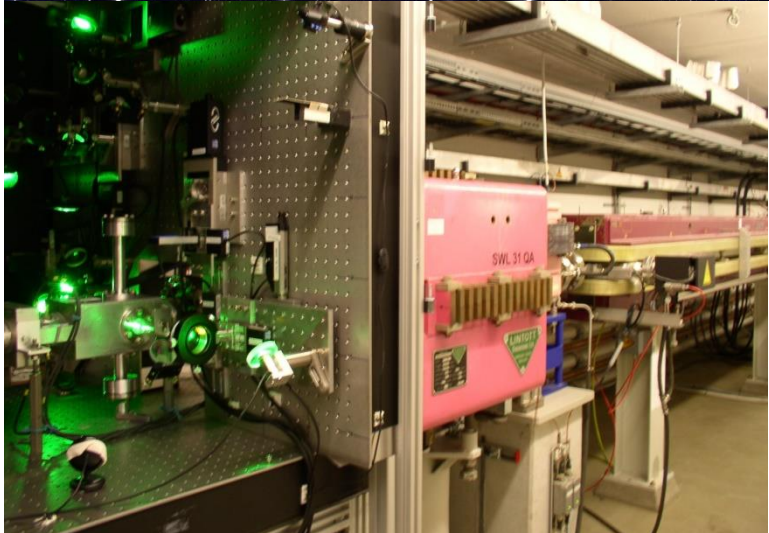


From Beam Diagnostics to Cosmology

Explaining the Universe with gravitation dependent quantum vacuum

Vahagn Gharibyan / DESY 16.06.20

Observation	Cosmological Interpretation	
	(Big Bang) Λ CDM	gravitation dependent quantum vacuum
 Refshifts of the galaxies	Space Expansion (SE)	Variable constants $c_z / h_z = (1+z) c / h$
Cosmic microwave background	Big Bang remnants	Vacuum Decay products
Non-luminous gravitating masses	Dark Matter	Polarized quantum vacuum
Anomalous dimness of type Ia supernovae	Accelerating SE, Dark Energy	$G_{Fz} > G_F$ $c_z / c < h_z^3 / h^3$

Explaining the Universe with gravitation dependent quantum vacuum

- Gravitation in accelerator laboratory
- Testing gravity with lepton beam and laser
- Observed results
- Quantum vacuum and physical constants
- Cosmological observations
 - Redshifts of the galaxies
 - Anomalous dimness of type Ia supernovae
 - Cosmic microwave background
 - Non-luminous gravitating masses

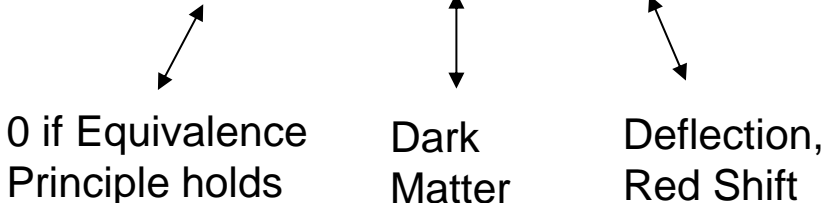
Gravitational fields at laboratory

Gravitational effects are induced by

$$U(R, M, G) = -\frac{GM}{R}$$

potential change

$$\Delta U(G, M, R) = U \frac{\Delta G}{G} + U \frac{\Delta M}{M} - U \frac{\Delta R}{R}$$



Gravitational Potential	Source			
	Earth	Sun	Galaxy	Virgo supercluster
U/c^2	7×10^{-10}	9×10^{-9}	3×10^{-7}	3×10^{-5}
$(1\text{m}/R) * U/c^2$	10^{-16}	7×10^{-29}	10^{-27}	10^{-36}

Relativistic particles in the Earth's gravity

$$\Delta U = -U \frac{\Delta R}{R}$$

Cosmic rays



Time / Energy

Highest energy Gravitational redshift

$$\frac{\Delta E}{E} = \frac{GM_{\oplus}}{c^2 R_{\oplus}^2} H \approx 10^{-13} / km$$

has been measured for keV
Mossbauer energies.

Accelerators



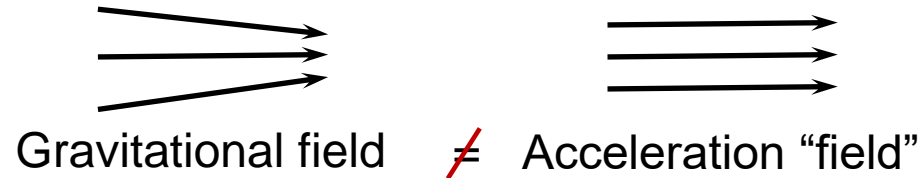
Space / Momentum

Gravitational deflection

$$\frac{2GM_{\oplus}}{c^2 R_{\oplus}} \frac{L}{\sqrt{L^2 + R_{\oplus}^2}} = 0.2 \text{ pm} / \text{km}$$

Space gravitational fields

Only the equivalence principle violating effects

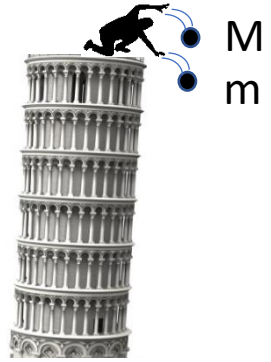


Lunar Tides affecting the LEP lepton energy detected by
laser Compton polarimeter

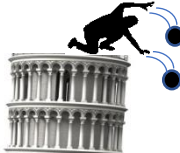
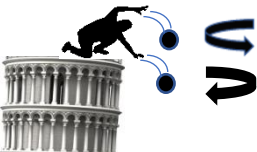
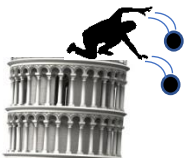


*“Effects of terrestrial tides on the LEP beam energy”
L. Arnaudon et al NIM A357 (1995)*

Discrete symmetries in gravity



The (weak) equivalence principle or universality of free fall discovered by Galileo

Continue with	Discrete Symmetries	Limits on $U\Delta G/G$	Method
	C - charge parity	$< 10^{-7}$	Pendulum analysis
	P - parity	$< 10^{-7}$	Spin polarized Pendulum
	energy-matter	$< 10^{-3}$	Light deflection

*D. S. M. Alves, M. Jankowiak and P. Saraswat, arXiv:0907.4110
 . E. Moody and F. Wilczek, Phys. Rev. D 30 130 (1984).*

Vacuum modified by fields and matter

In quantum physics, the properties of the vacuum can be modified by fields and particles via vacuum polarization.

W. Heisenberg and H. Euler, Z. Phys. 98, 714 (1936)

Physical constants have dynamic nature shaped by quantum interactions in vacuum.

P. A. M. Dirac, Nature 139, 323 (1937)

Casimir plates
superluminal

$$\frac{\delta c}{c} = -\frac{11}{90^2} \frac{\alpha^2 \pi^2}{m^4 d^4}$$

Magnetic
field

$$\frac{\delta c}{c} = \frac{11}{45} \frac{\alpha e^2 B^2}{4\pi m^2} \sim 3 \times 10^{-21}$$

G. M. Shore, Nucl. Phys. B 633, 271 (2002)

The vacuum density depends on the imposed fields or conditions and defines the values of physical constants such as the speed of light and the elementary charge. Likewise the magnitude of Planck's constant h could be altered.

Conclusions

On a way of investigating HERA beam diagnostic systematics, I had to invoke gravitation. This opened a possibility to understand the main cosmological observations within a new simple physical model escaping exotics and deficiencies in the current Λ CDM theory.

