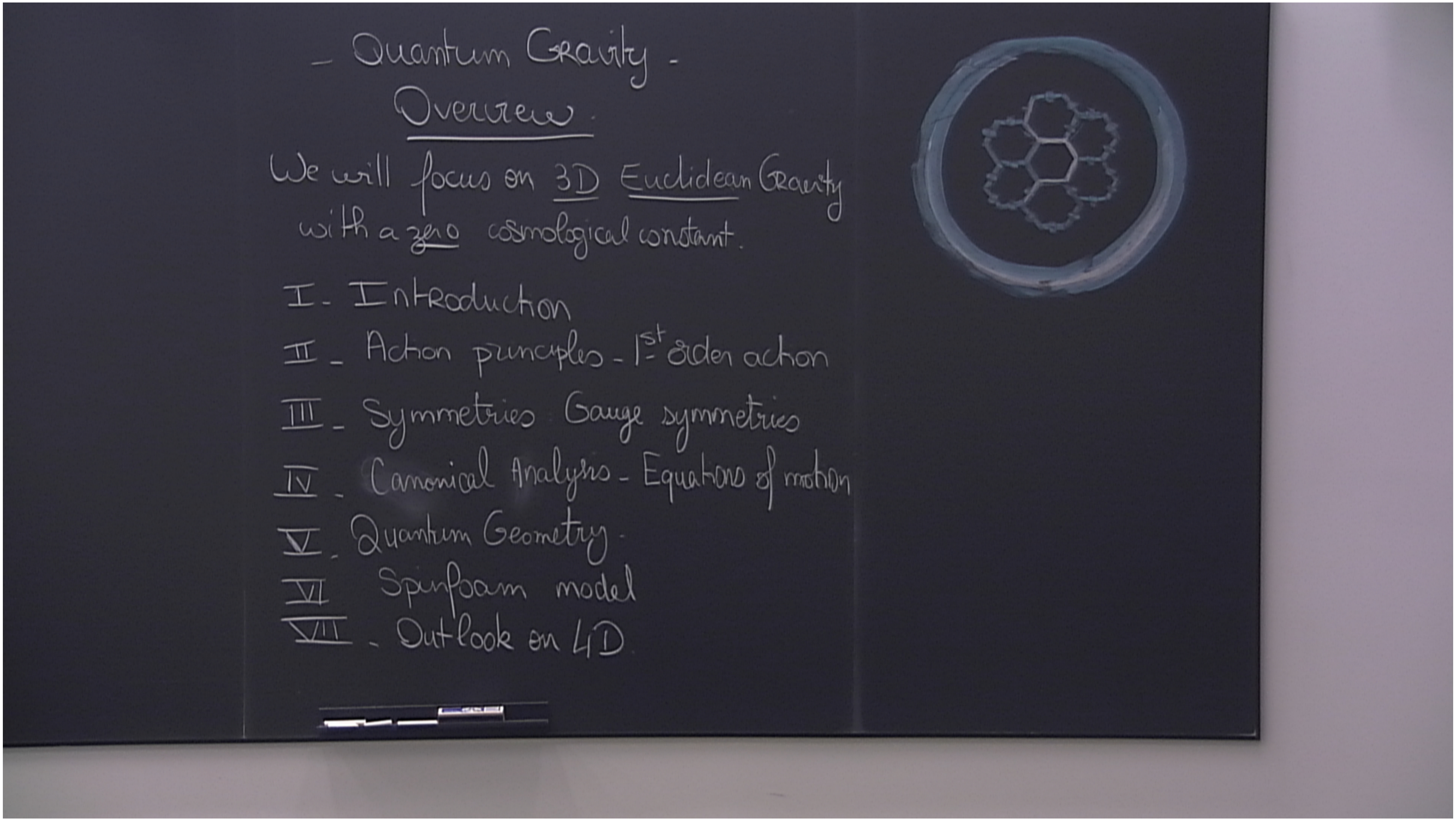
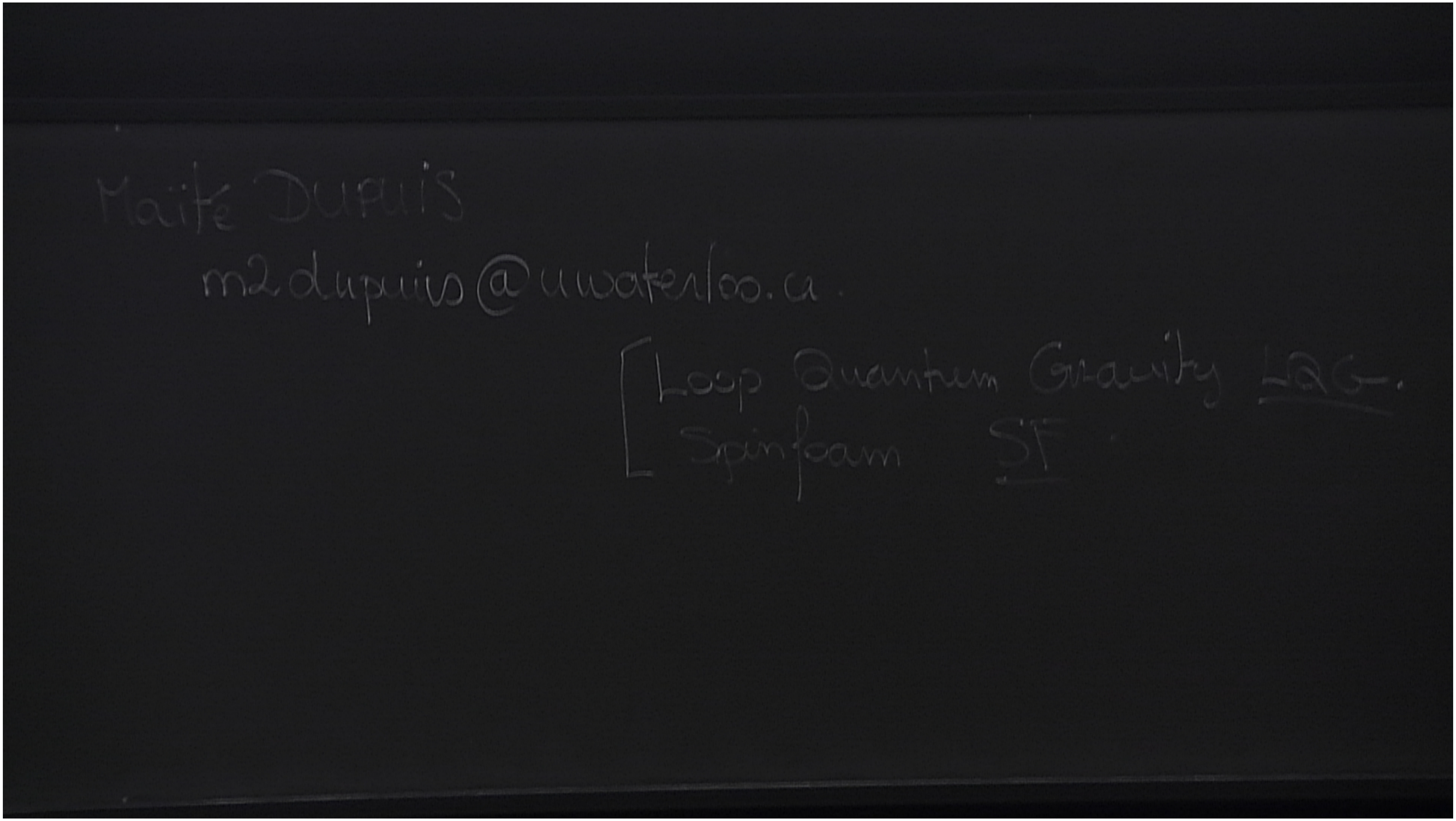
Title: PSI 2015/2016 Quantum Gravity - Lecture 1

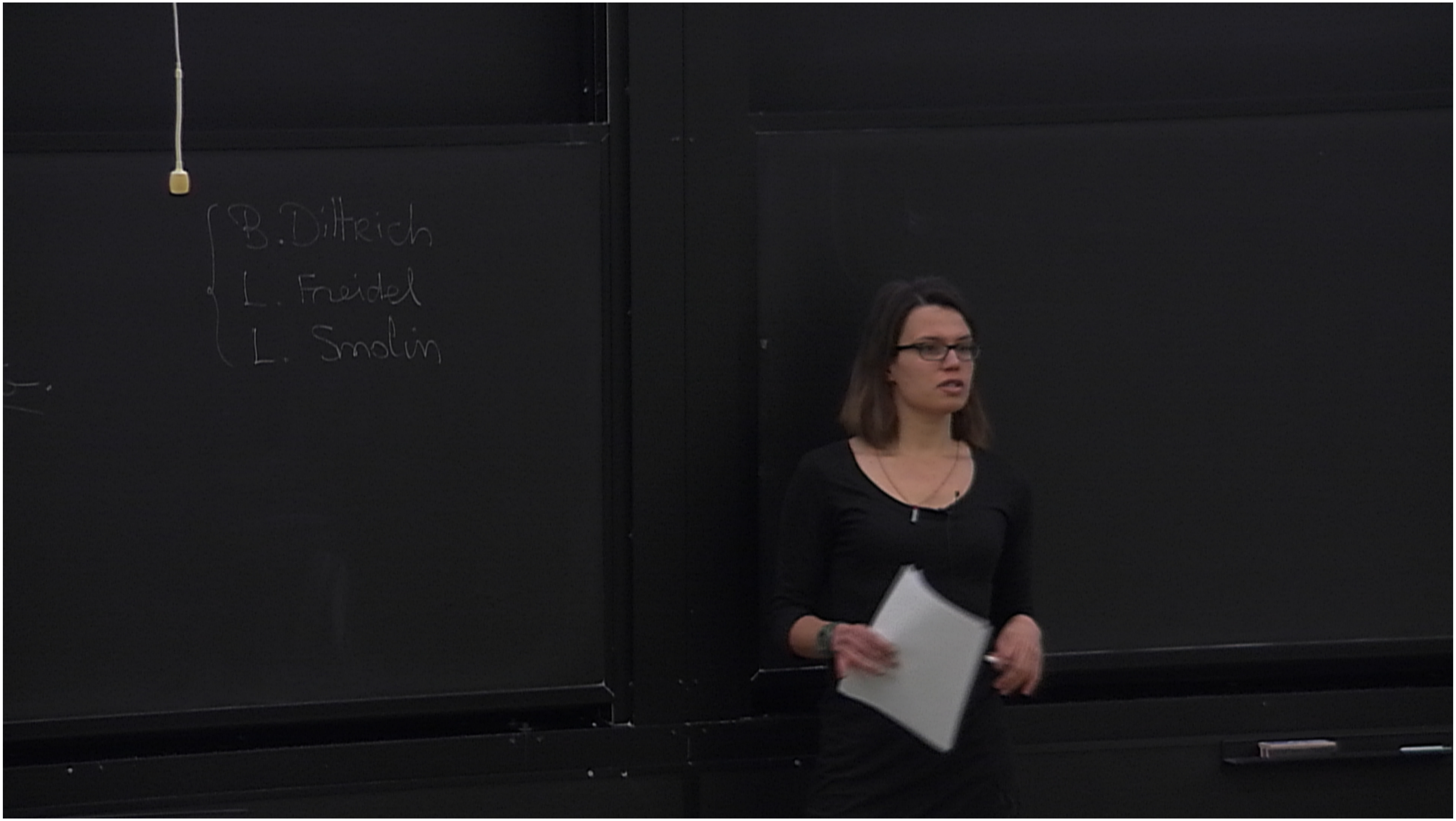
Date: Feb 22, 2016 10:15 AM

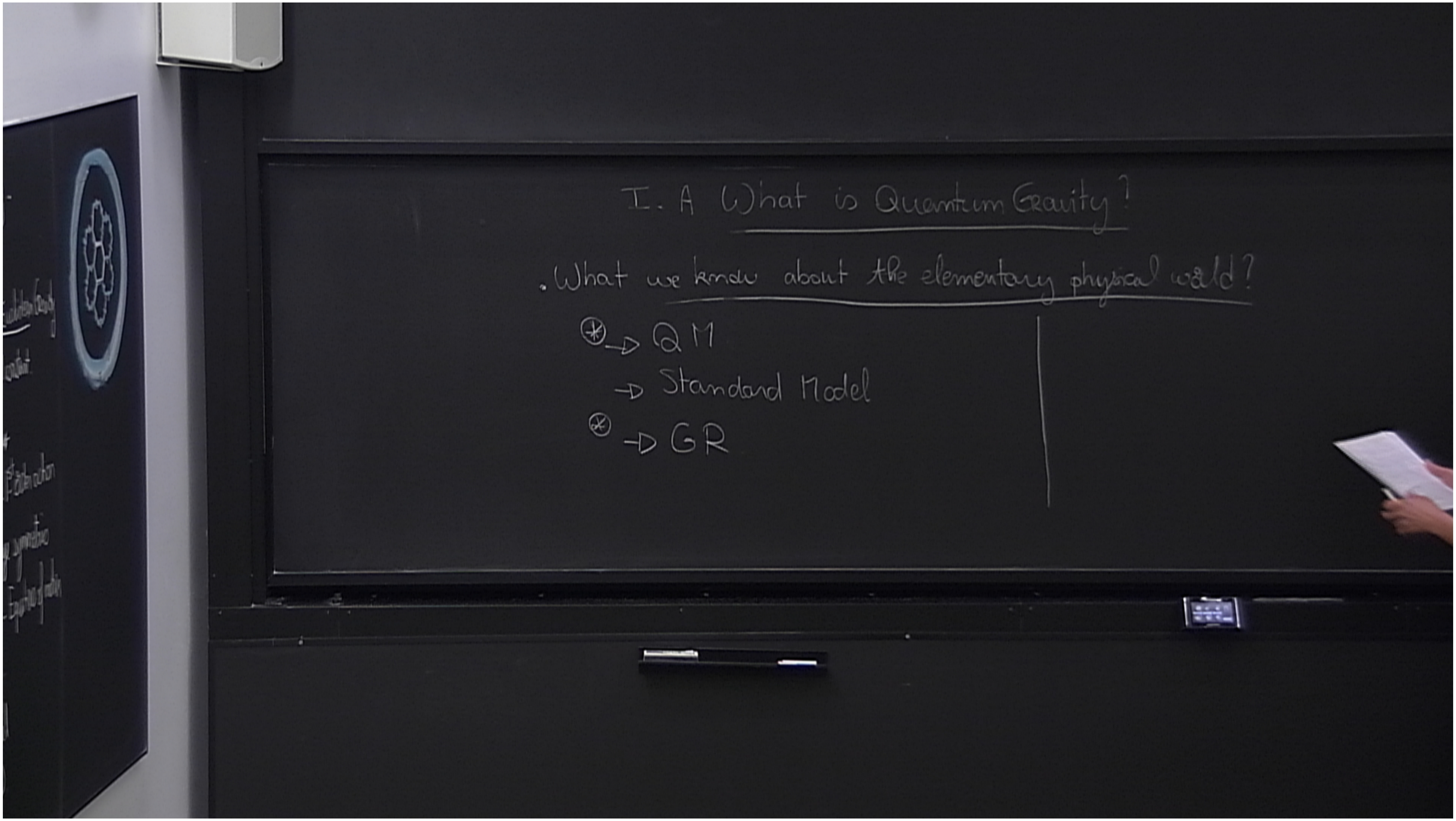
URL: http://pirsa.org/16020072

Abstract:


- Quantum Gravity -
Overview.
We will focus on 3D Euclidean Gravity
with a zero cosmological constant.
I - Introduction
II - Action principles - 1st order action
III - Symmetries Gauge symmetries
IV - Canonical Analysis - Equations of motion
V - Quantum Geometry.
VI Spinfoam model
VII - Outlook on 4D


Maïté Dupuis
m2dupuis@uwaterloo.ca
Loop Quantum Gravity LQG.
Spinfoam SF


B. Dittrich
L. Freidel
L. Smolin

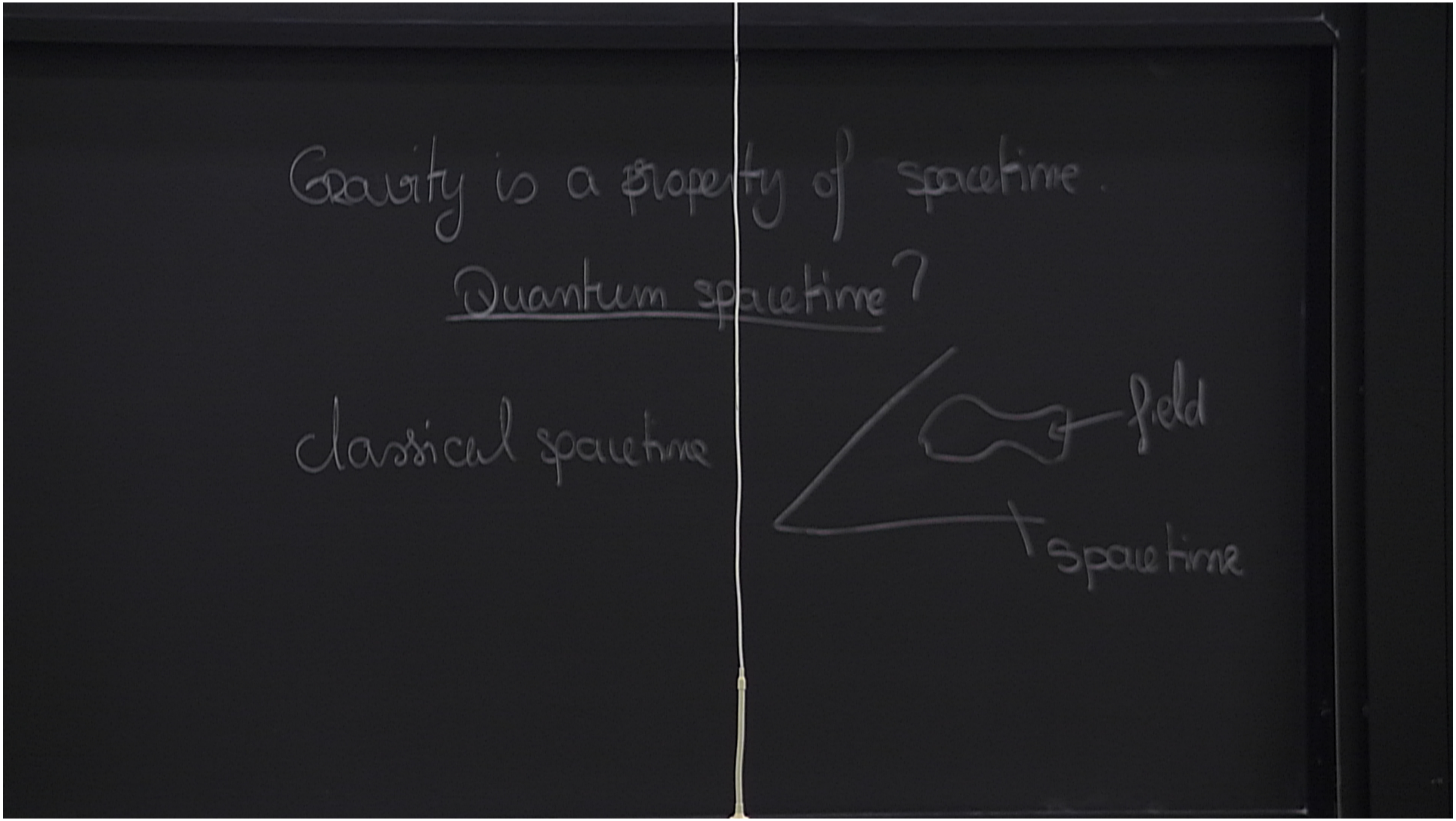

I. A What is Quantum Gravity?
. What we know about the elementary physical world?
QM
Standard Model
GR

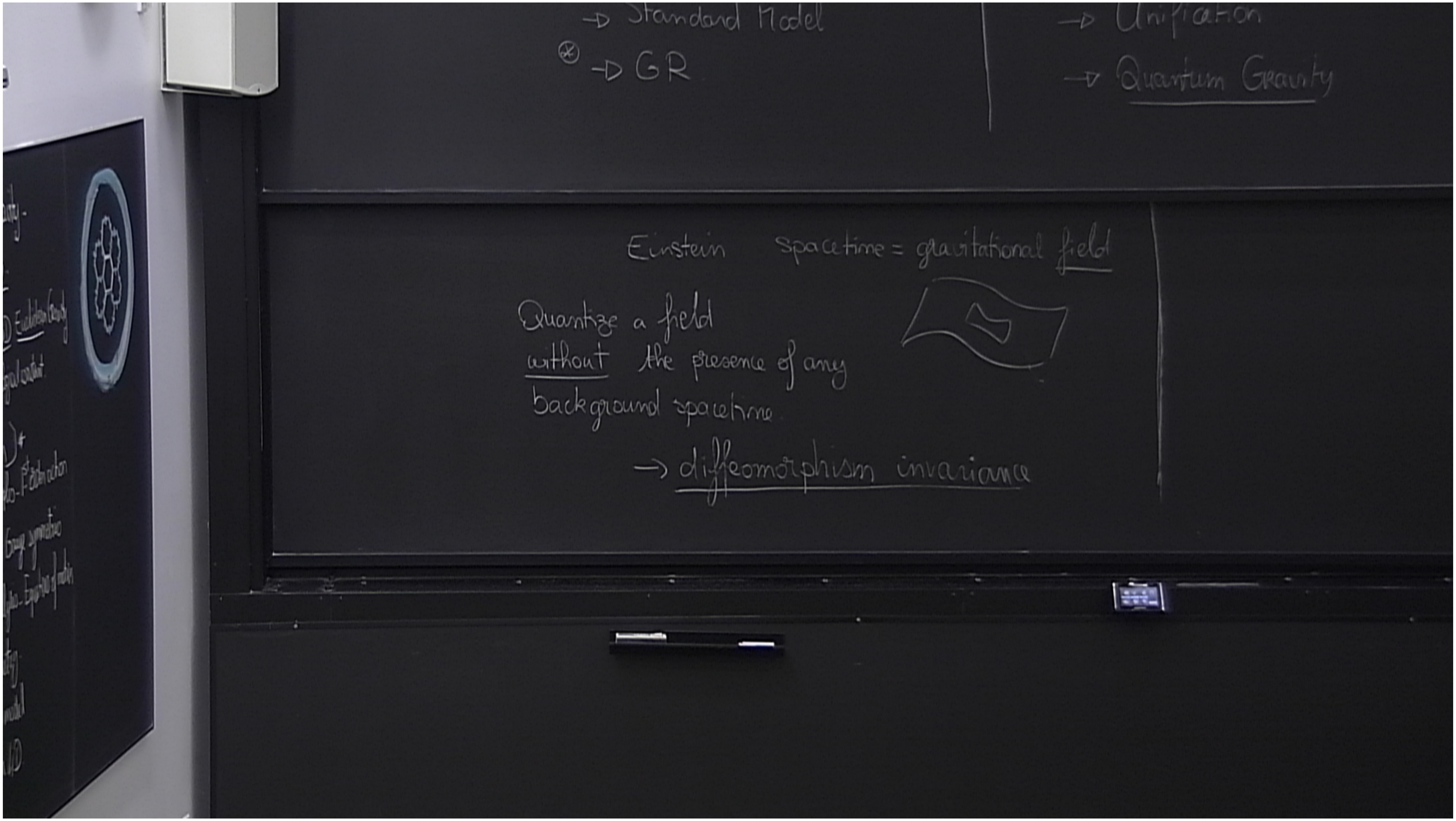
I. A What is Quantum Gravity?

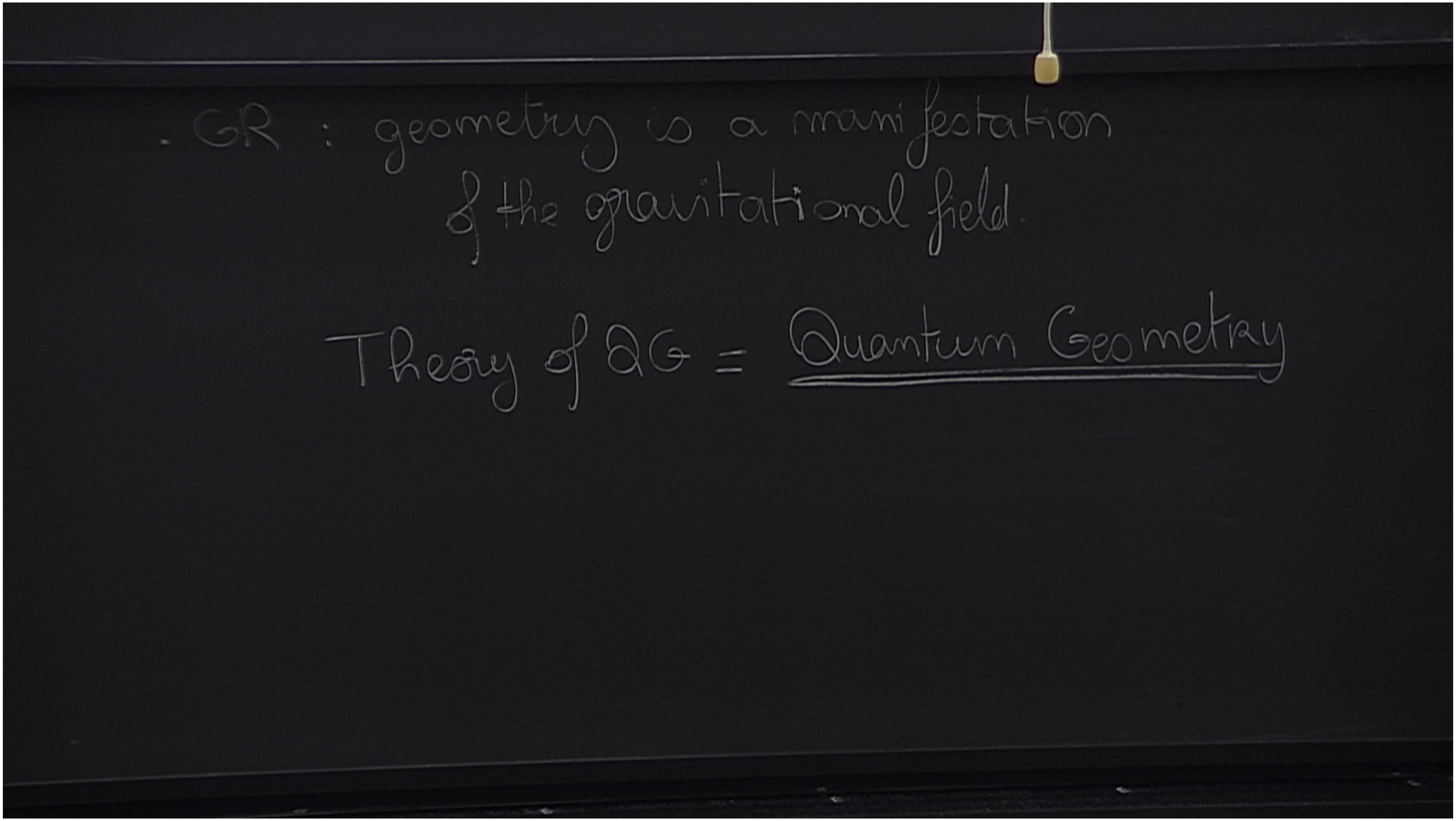
. What we know about the elementary physical world?

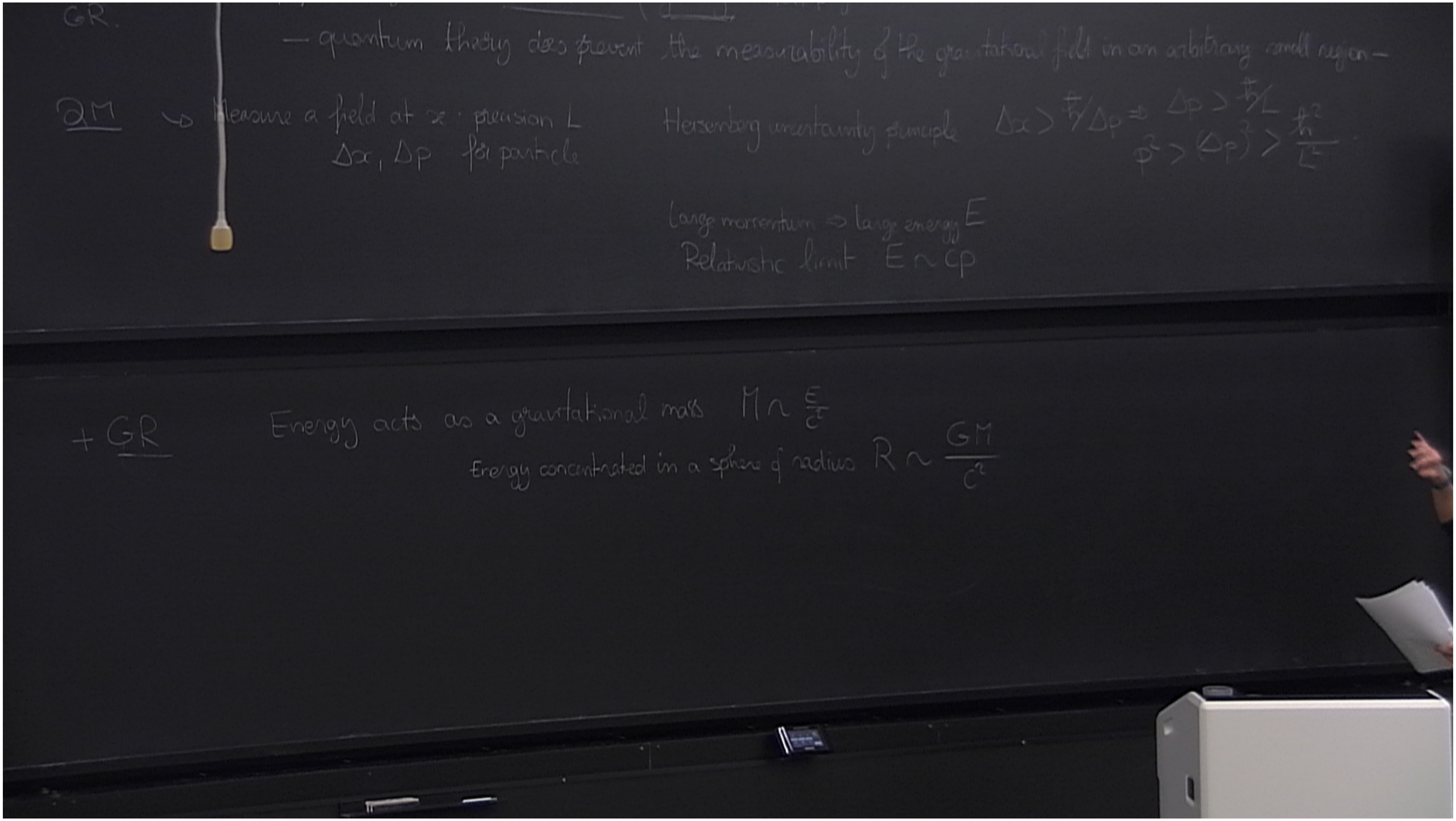
⊛ → QM	→ Dark matter.
→ Standard Model	→ Unification
⊛ → GR.	→ Quantum Gravity

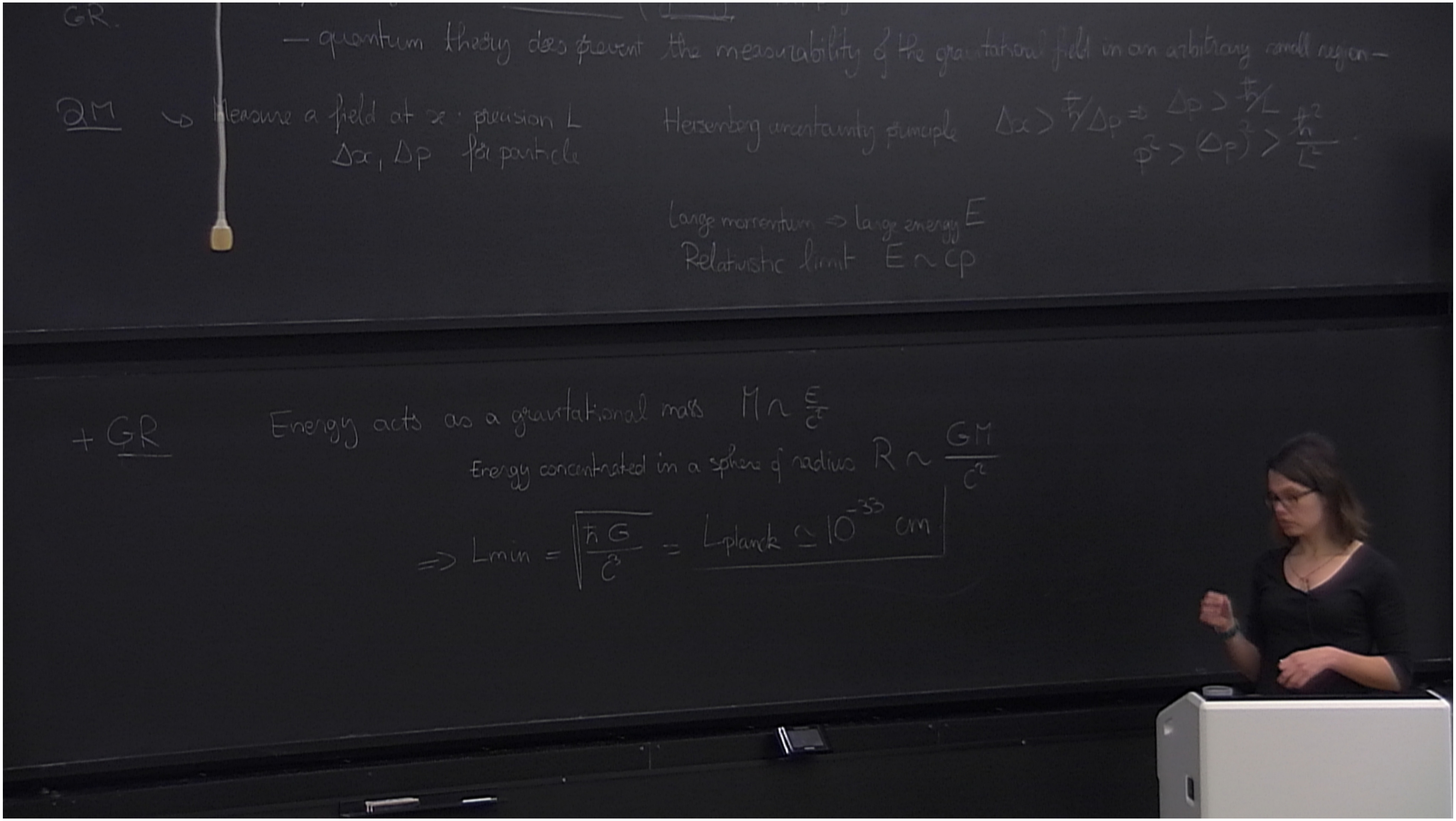
Einstein spacetime = gravitational field

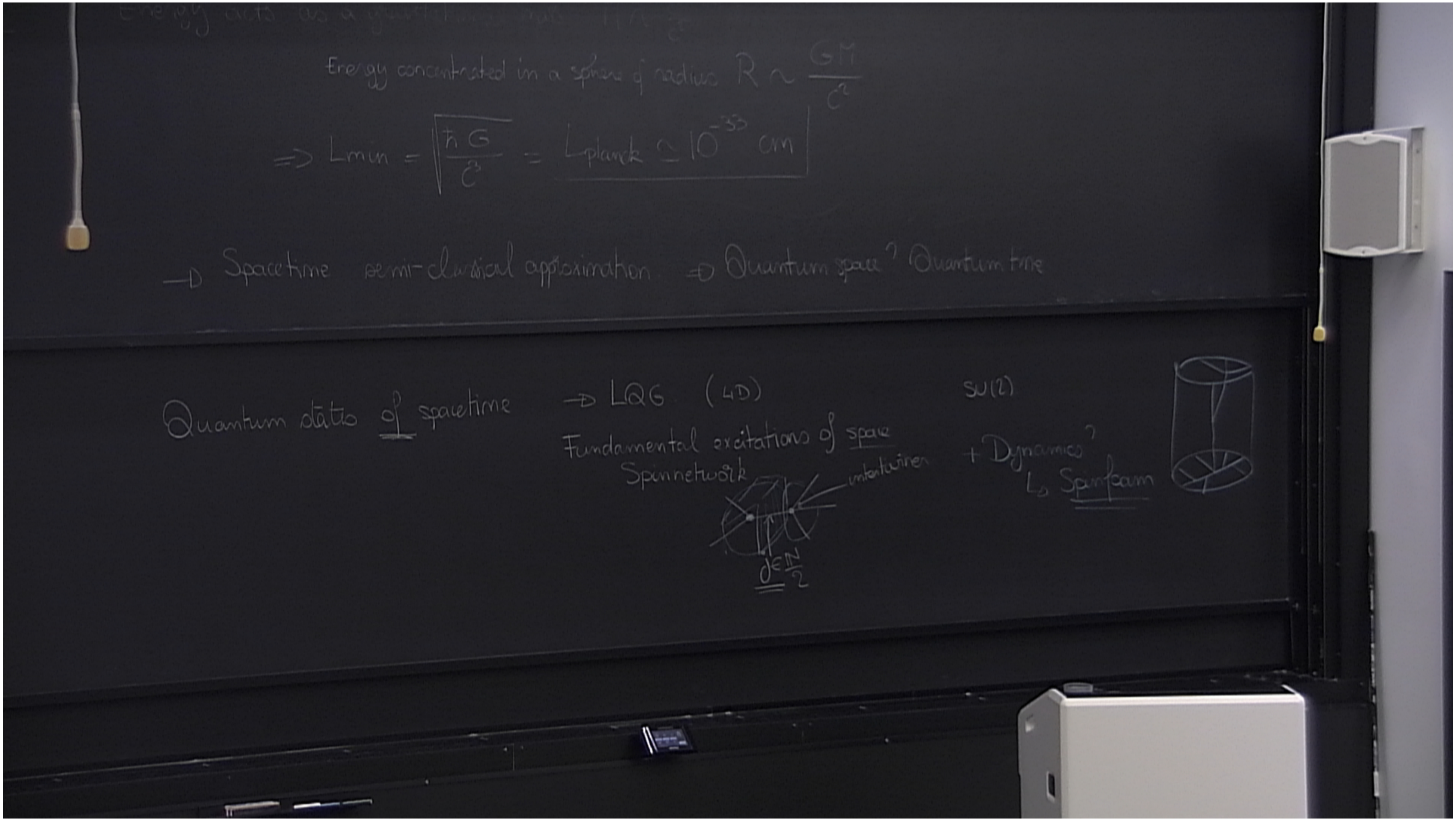

Gravity is a property of spacetime.
Quantum spacetime?
classical spacetime
field
spacetime


→ Standard Model
→ GR
→ Unification
→ Quantum Gravity
Einstein spacetime = gravitational field
Quantize a field
without the presence of any
background spacetime
→ diffeomorphism invariance


. GR : geometry is a manifestation
of the gravitational field.
Theory of QG = Quantum Geometry


GR.
— quantum theory does prevent the measurability of the gravitational field in an arbitrary small region —
QM → Measure a field at x : precision L
Δx, Δp for particle
Heisenberg uncertainty principle Δx > ħ/Δp ⇒ Δp > ħ/L
p² > (Δp)² > ħ²/L²
Large momentum ⇒ large energy E
Relativistic limit E ~ cp
+ GR
Energy acts as a gravitational mass M ~ E/c²
Energy concentrated in a sphere of radius R ~ GM/c²

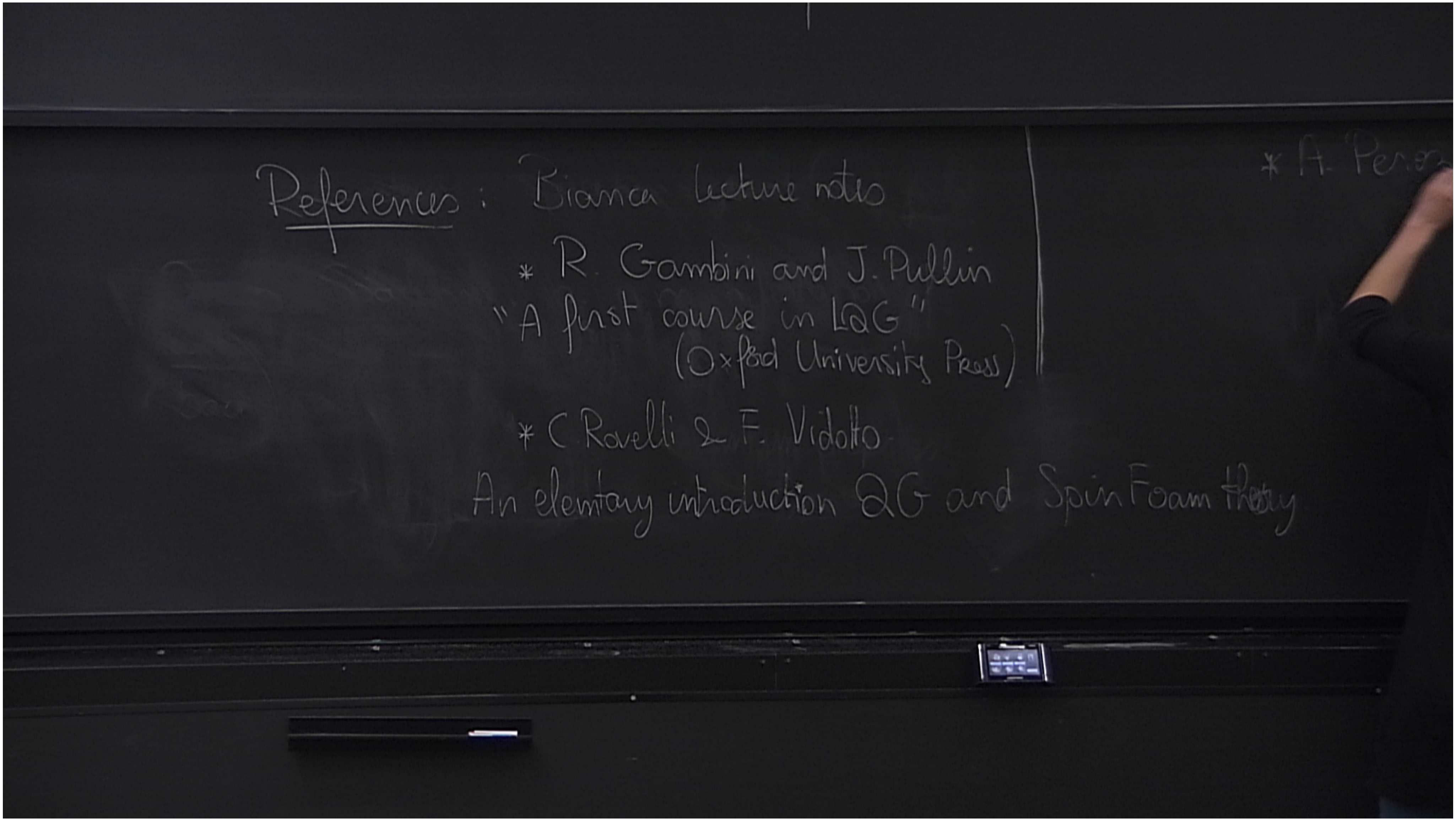

GR.
— quantum theory does prevent the measurability of the gravitational field in an arbitrary small region —
QM
Measure a field at x : precision L
Δx, Δp for particle
Heisenberg uncertainty principle Δx > ħ/Δp ⇒ Δp > ħ/L
p² > (Δp)² > ħ²/L²
Large momentum ⇒ Large energy E
Relativistic limit E ~ cp
+ GR
Energy acts as a gravitational mass M ~ E/c²
Energy concentrated in a sphere of radius R ~ GM/c²
⇒ Lmin = √(ħG/c³) = Lplanck ≃ 10⁻³³ cm


Energy concentrated in a sphere of radius R ~ GM/c²
=> Lmin = √(ħG/c³) = Lplanck ≃ 10⁻³³ cm
-> Spacetime semi-classical approximation => Quantum space? Quantum time
Quantum states of spacetime
-> LQG (4D)
SU(2)
Fundamental excitations of space
Spinnetwork
intertwiner
j ∈ N/2
+ Dynamics?
↳ Spinfoam

I.B Why QG?

→ no calls from experimentally accessible situations.

$$\frac{F_{grav}}{F_{electr}} \text{(proton-electron)} = 10^{-40}.$$


References: Bianca lecture notes
* R. Gambini and J. Pullin
"A first course in LQG"
(Oxford University Press)
* C Rovelli & F. Vidotto
An elementary introduction QG and Spin Foam theory
* A. Pere