Title: Ontology of the quantum state: wavefunction vs. spacetime state realism

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Abstract: TBA

Plan:

- Presenting wavefunction realism
  - Configuration vs Physical space
- Challenges to wavefn realism
- Against wavefn realism
- Spacetime State Realism

Wavefunction Realism

- Realist subdivision:
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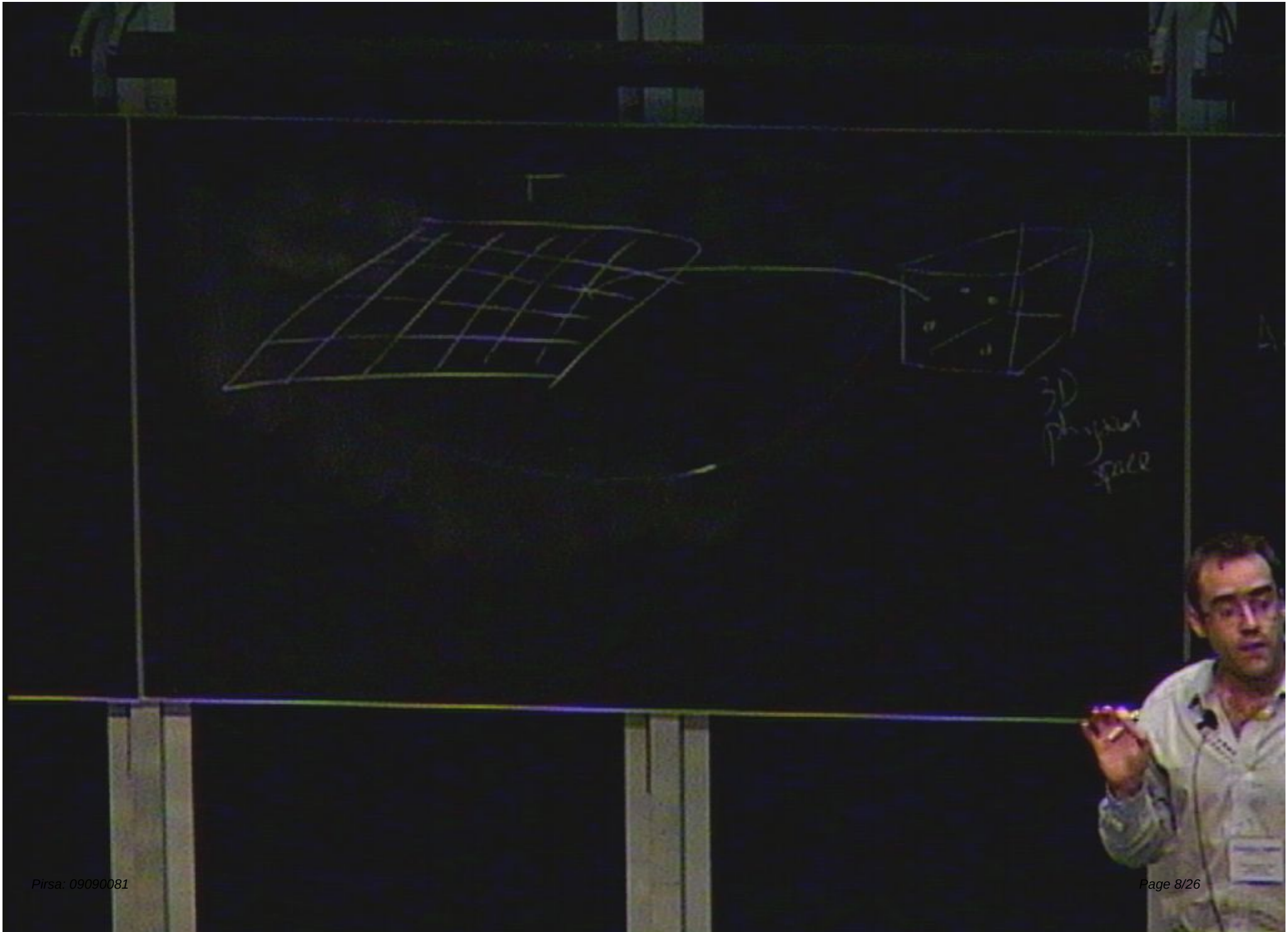
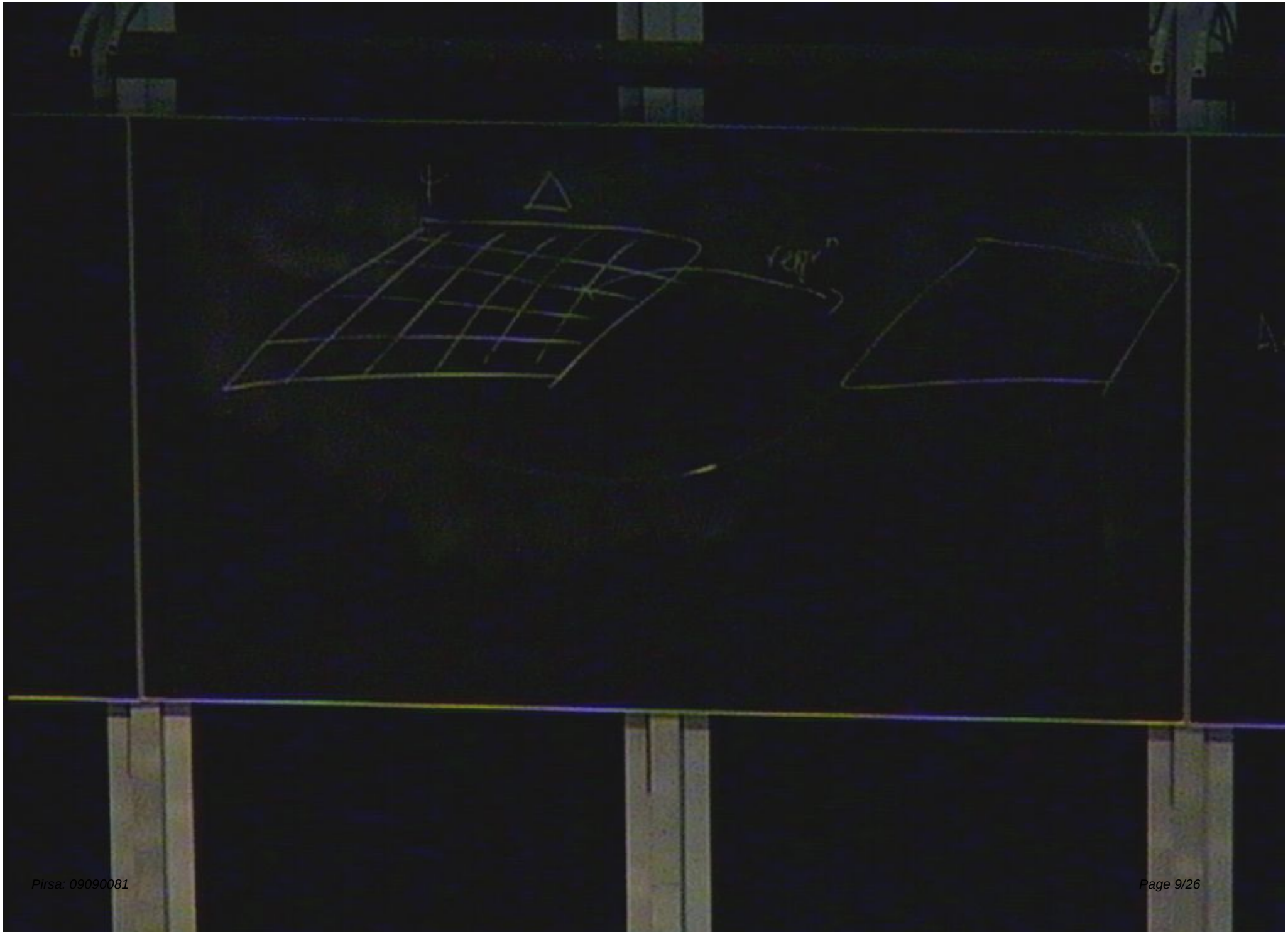
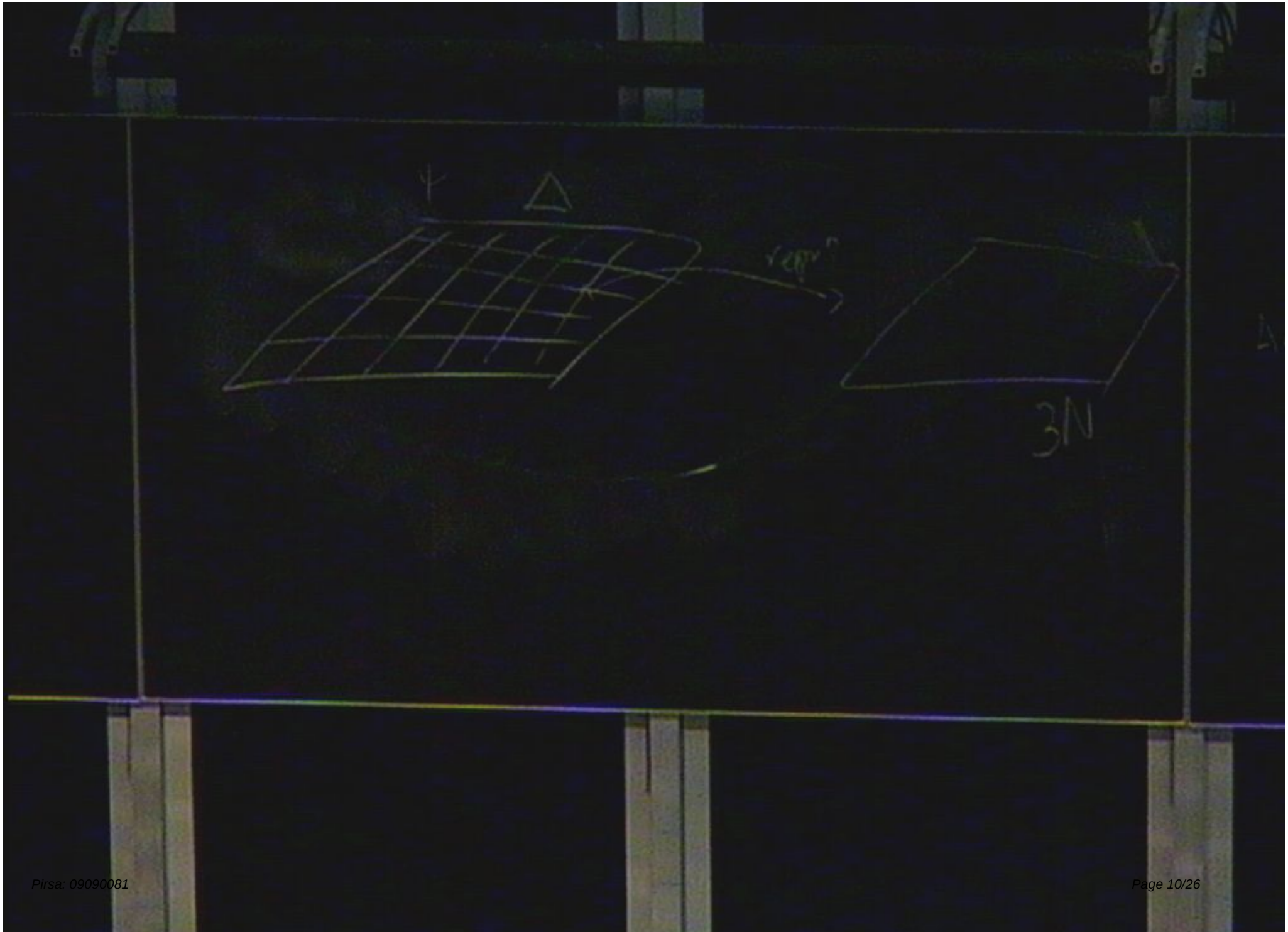
- Case of EM field

Some distinctions:

- Representation and represented
  - Mathematical (representational) object vs Physical items (represented)
    - Mathematical: $\Psi(X,t)$, a fn defined on a (high D) space Δ
    - Physical: a field (*ψ-field*) living in a high D physical space
- Configuration space, Γ, vs Δ.
  - Γ: a representation of 3-D configurations;
  - Δ: a representation of positions in a 3N-D *physical* space



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Δ
3N

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- N.B. This is *realism*; the properties are not to be understood in terms of probabilities for measurement outcomes. They are *primitive* and *intrinsic*.
  - (Probs for measurement outcome will appear derivatively, following a *dynamical* analysis of measurement.)

Two kinds of problems:

1) Can we understand what the ψ-field is?

2) Is it possible to recover 3-D going's on?
(Monton, P. Lewis, Maudlin)

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ii) Don't just focus on the *space* and on the synchronic; ψ-field should be included (diachronically) in the supervenience base.

Against Wavefn Realism:

- **Unnatural**
  - A) to prefer pos^n repr^n
  - B) the Schrödinger form of dynamics
- What happens on move to QFT?
  - Particles not fundamental and their positions imprecisely defined; no decent notion of configuration space; variable particle number.
    - Field configurations? Non-unique.
  - Not taking role of spacetime sufficiently seriously

Spacetime State Realism

- Democracy: characterise state as a (+ve normalised) linear functional of dynamical variables: a density operator ρ
- But what are the property bearers?
  - The Universe as a whole?
  - Better: subsystems
  - The ρ assigned to a subsystem represents its *intrinsic properties*, understood as *primitive*.

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PICTURE: non-separable field on spacetime; field values for regions specified by their ρ.

(link to experience: somewhat standard; decoherence)

Conclusions

- We can find intelligible property-bearers and properties to specify the ontology of the quantum state;
- Wavefn Realism: high-D physical space, separable field;
- Spacetime State Realism: physical arena is spacetime, a non-separable field.
- The latter is to be preferred: a univocal onotlogical picture across different quantum theories; natural role for spacetime; no unnatural preference for a particular set of dynamical variables.

References:

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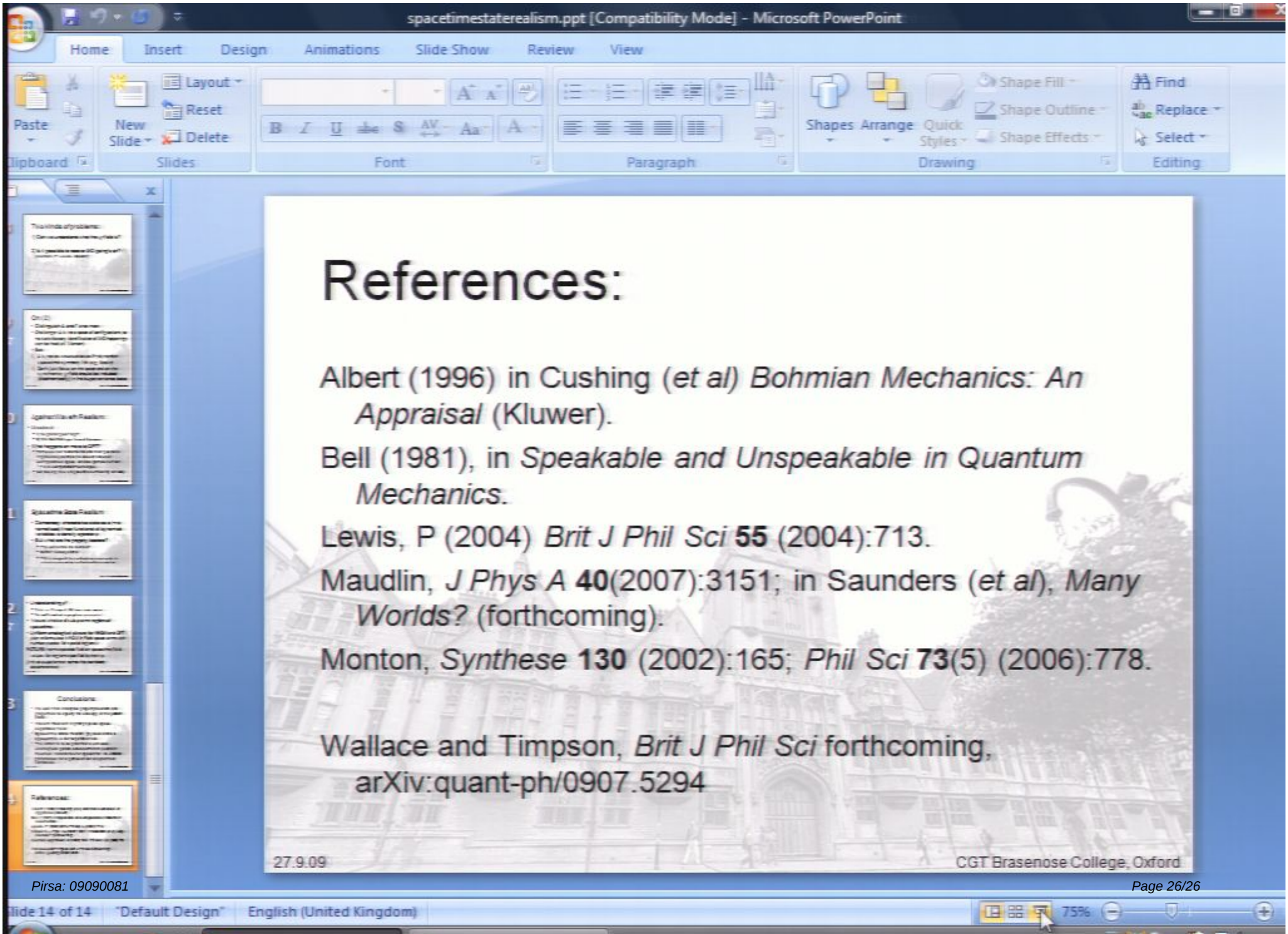
Wallace and Timpson, *Brit J Phil Sci* forthcoming, arXiv:quant-ph/0907.5294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