Title: Summer Undergrad 2020 - Path Integrals (M) - Lecture 1

Speakers: Dan Wohns

Collection: Summer Undergrad 2020 - Path Integrals

Date: May 26, 2020 - 8:15 AM

URL: http://pirsa.org/20050036

Abstract: Introduction to path integrals and the semi-classical limit


Path Integrals
Dan Wohns
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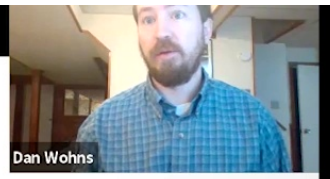

Dan Wohns
dwohns@perimeterinstitute.ca

- PSI Fellow – Perimeter Institute (2011-present)
- Adjunct Prof. – Univ. of Waterloo (2020-present)
- PhD – Cornell University (2011)

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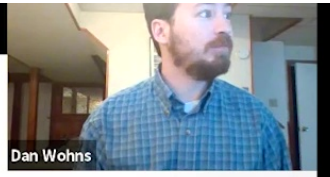

About me

Old World

New World

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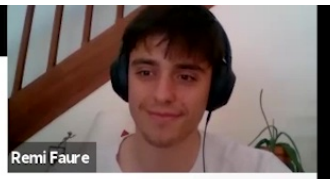

Remi Faure

- Teaching assistant
- Current PSI student
- Graduate of École Normale Supérieure

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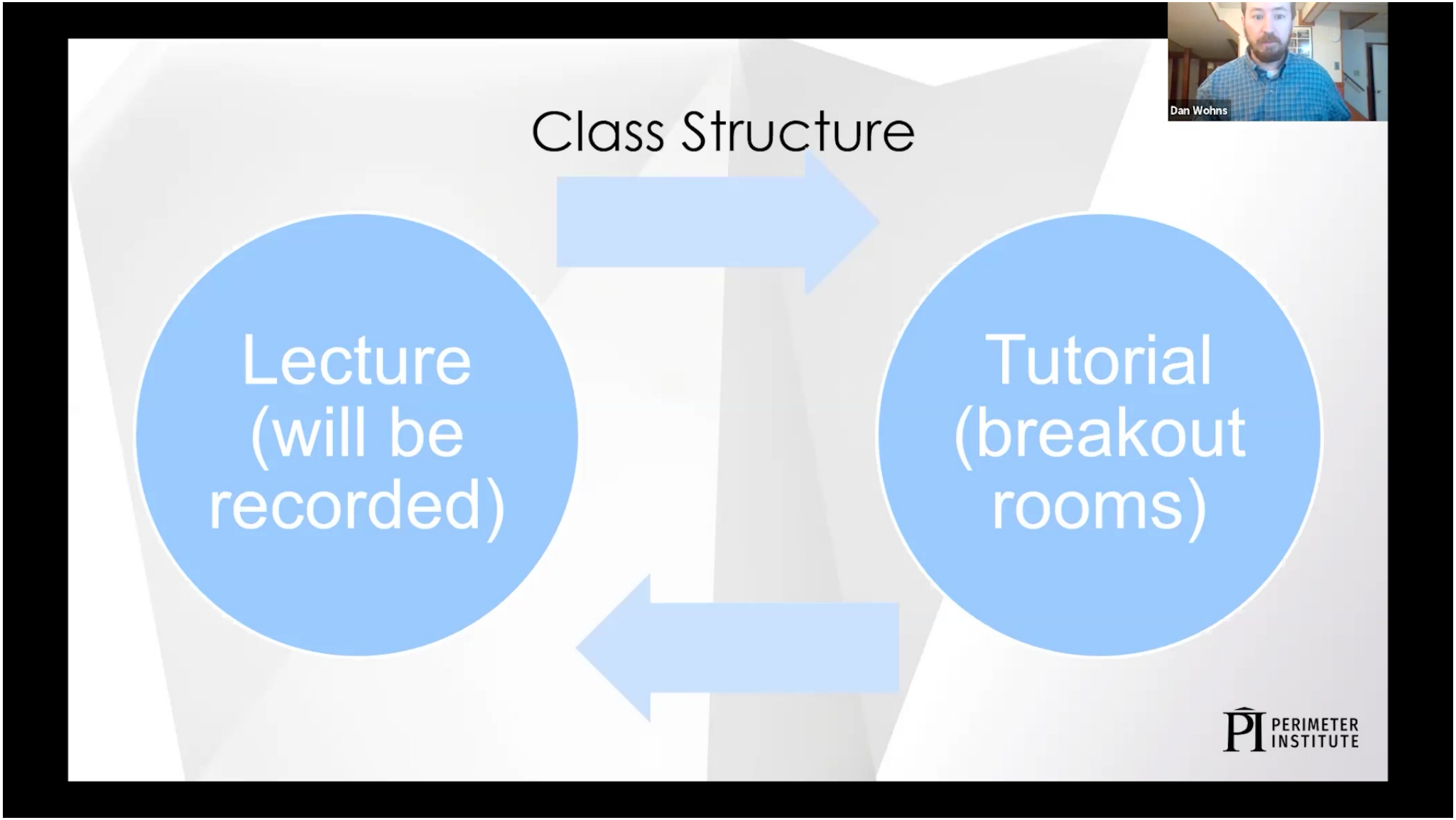
Dan Wohns
Class Structure
Lecture (will be recorded)
Tutorial (breakout rooms)
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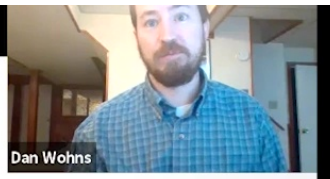

Zoom Classroom

- Use raise hand button
- Send anonymous questions to TA
- Suggestions?

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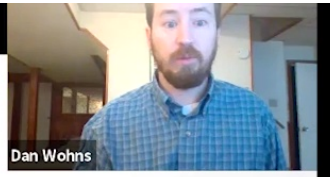
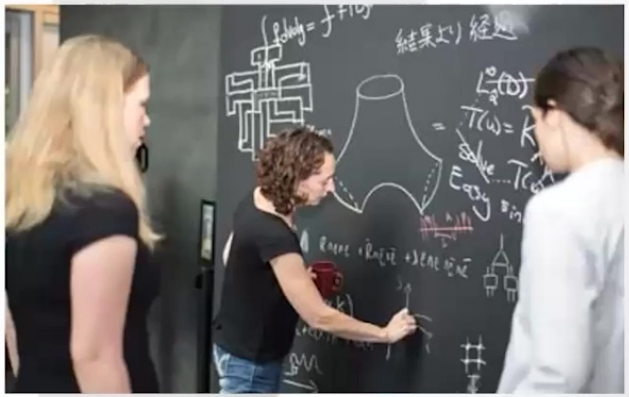


Breakout Room Discussions

- Sharing mathematical expressions
  - Zoom whiteboard
  - Other options in google drive
- Help button
- Suggestions?



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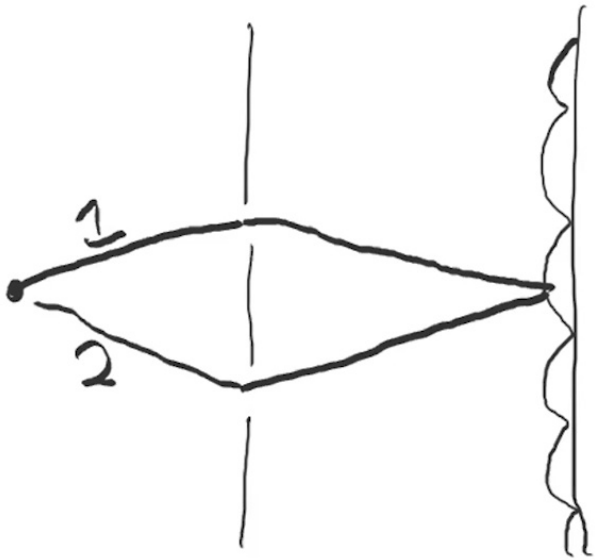
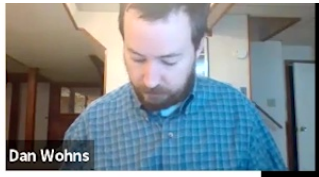
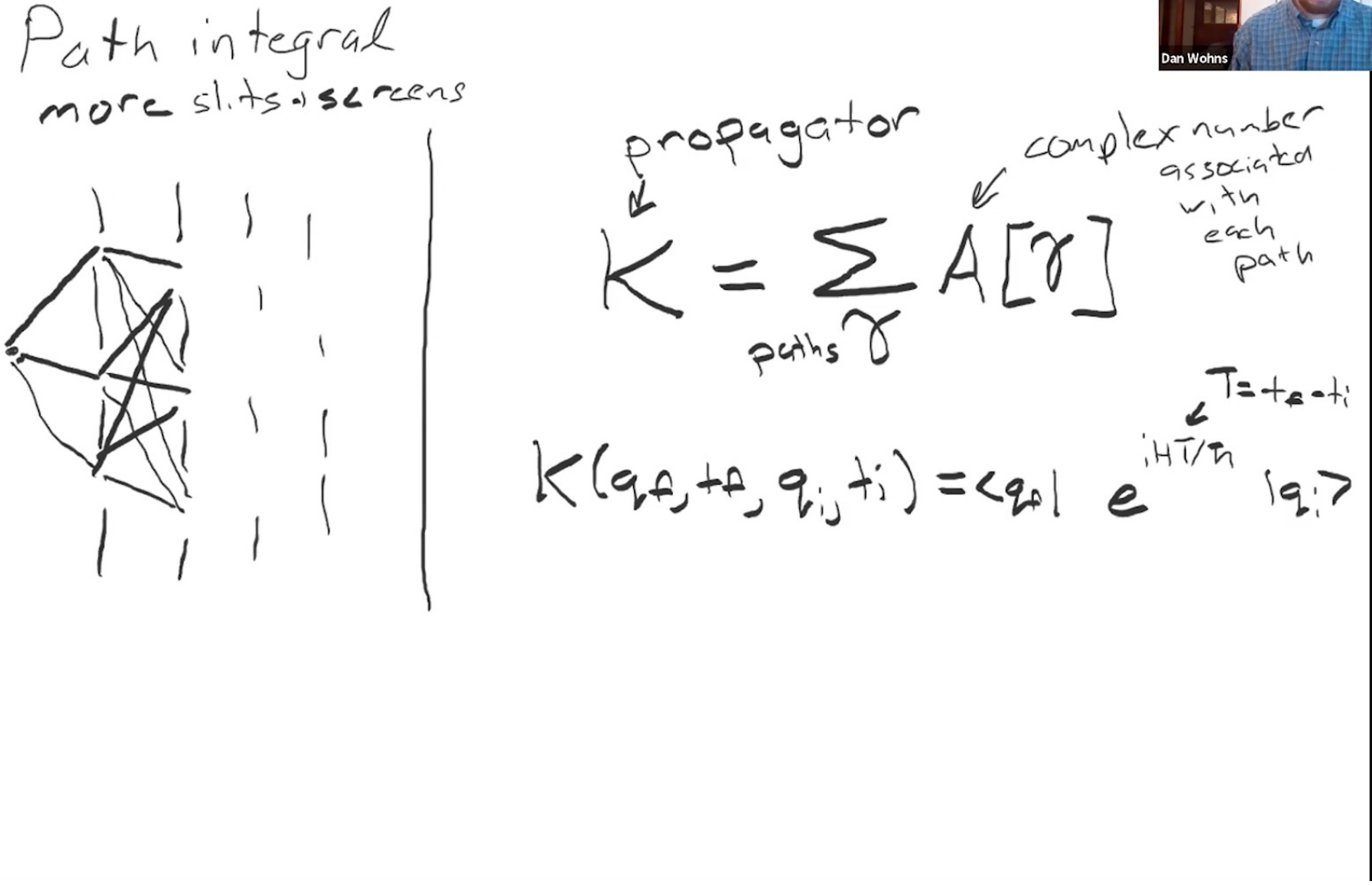
Path Integrals

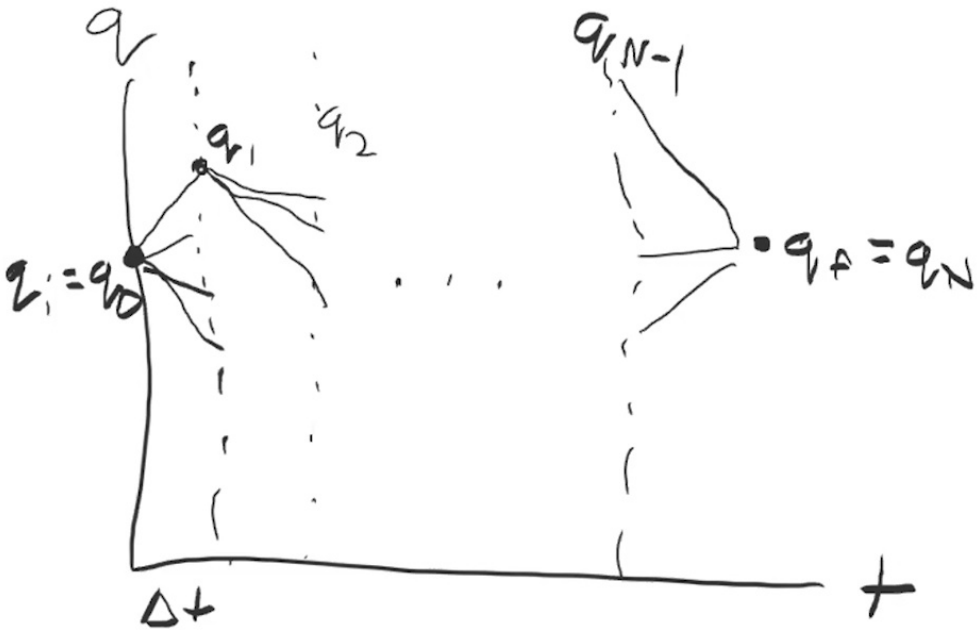
Double Slit



$K = A_1 + A_2 \rightarrow$ interference




Path integral
more slits + screens
propagator
complex number associated with each path
$K = \sum_{\text{paths } \gamma} A[\gamma]$
$T = t_f - t_i$
$K(q_f, t_f, q_i, t_i) = \langle q_f | e^{iHT/\hbar} | q_i \rangle$

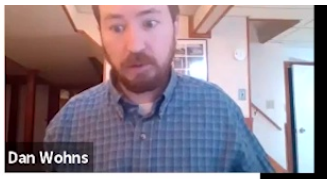


$$T = \Delta t \cdot N$$

$$\sum_{\text{paths } \gamma} = \int dq_1 \, dq_2 \cdots dq_{N-1}$$

$$N \to \infty$$

$$q(t)$$



Expectations: 1) $A[\gamma_{1,2}] = A[\gamma_1]\,A[\gamma_2]$

$$\rightarrow K(q_f, t_f; q_i, t_i) = \int dy\, K(q_f, t_f; y, t_{int}) \cdot K(y, t_{int}; q_i, t_i)$$

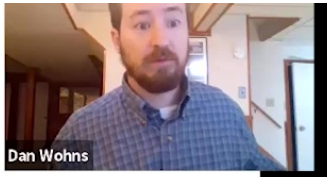
2) Classical limit $\hbar \rightarrow 0$

$S \gg \hbar$

→ classical paths most important

$$S = \int_{t_i}^{t_f} dt \left(\frac{1}{2} m \dot{q}^2(t) - V(q(t))\right)$$

$$\frac{\delta S}{\delta q(t)} = 0 \rightarrow m\ddot{q} + V'(q) = 0$$



$$\int e^{-f(x)}\,dx \quad \text{vs} \quad \int e^{if(x)}\,dx$$

$f'(x)=0$

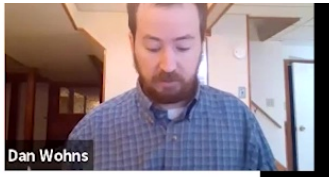
$f''(x)>0$

$f'(x)=0$

$$\delta S = 0$$

$$K = \int \mathcal{D}q(t)\, e^{iS[q(t)]/\hbar}$$

all paths contribute w/ equal weight



$$\int e^{-f(x)}\,dx \quad \text{vs} \quad \int e^{if(x)}\,dx$$

$f'(x)=0$ $\qquad$ $f'(x)=0$

$f''(x)>0$

$\int dq_1 \cdots dq_N$ $\qquad$ $\delta S = 0$

$$K = \int \mathcal{D}q(t)\, e^{iS[q(t)]/\hbar}$$

all paths contribute w/ equal weight