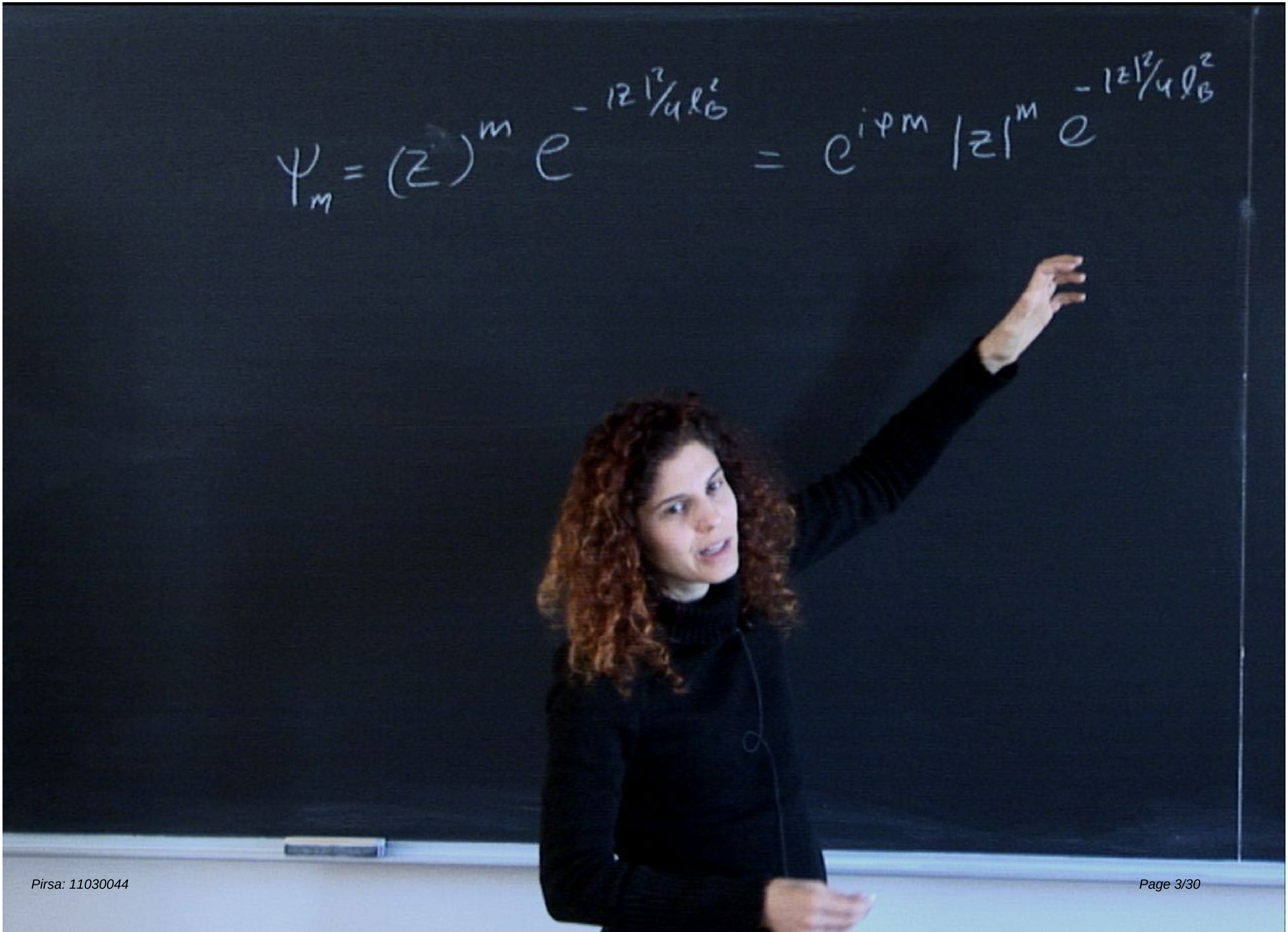
Title: Explorations in Condensed Matter - Lecture 9

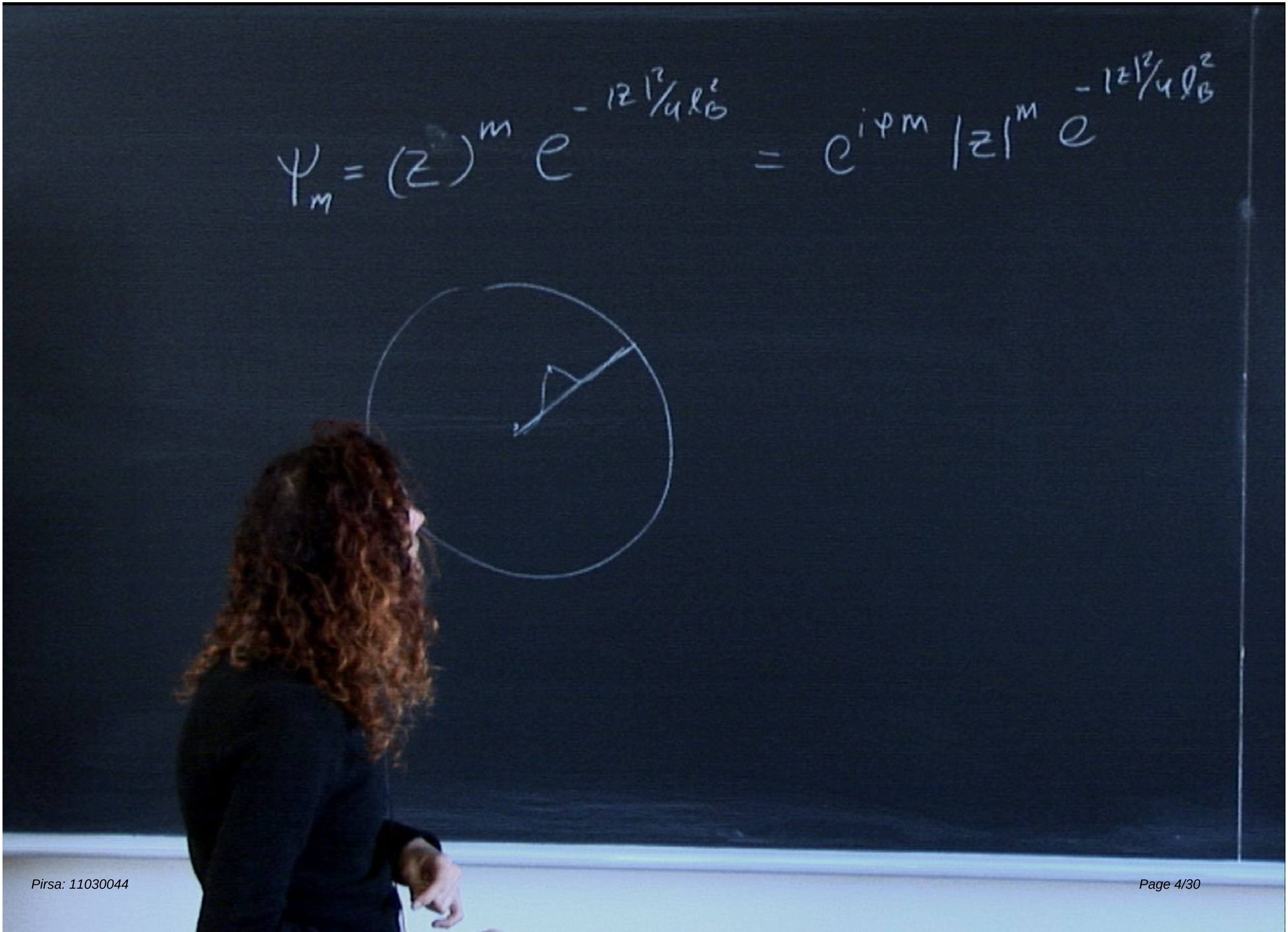
Date: Mar 24, 2011 10:15 AM

URL: http://pirsa.org/11030044

Abstract:


$\Psi_m = (z)^m e^{-|z|^2/4\ell_B^2}$


$\psi_m = (z)^m e^{-|z|^2/4\ell_B^2} = e^{i\varphi m} |z|^m e^{-|z|^2/4\ell_B^2}$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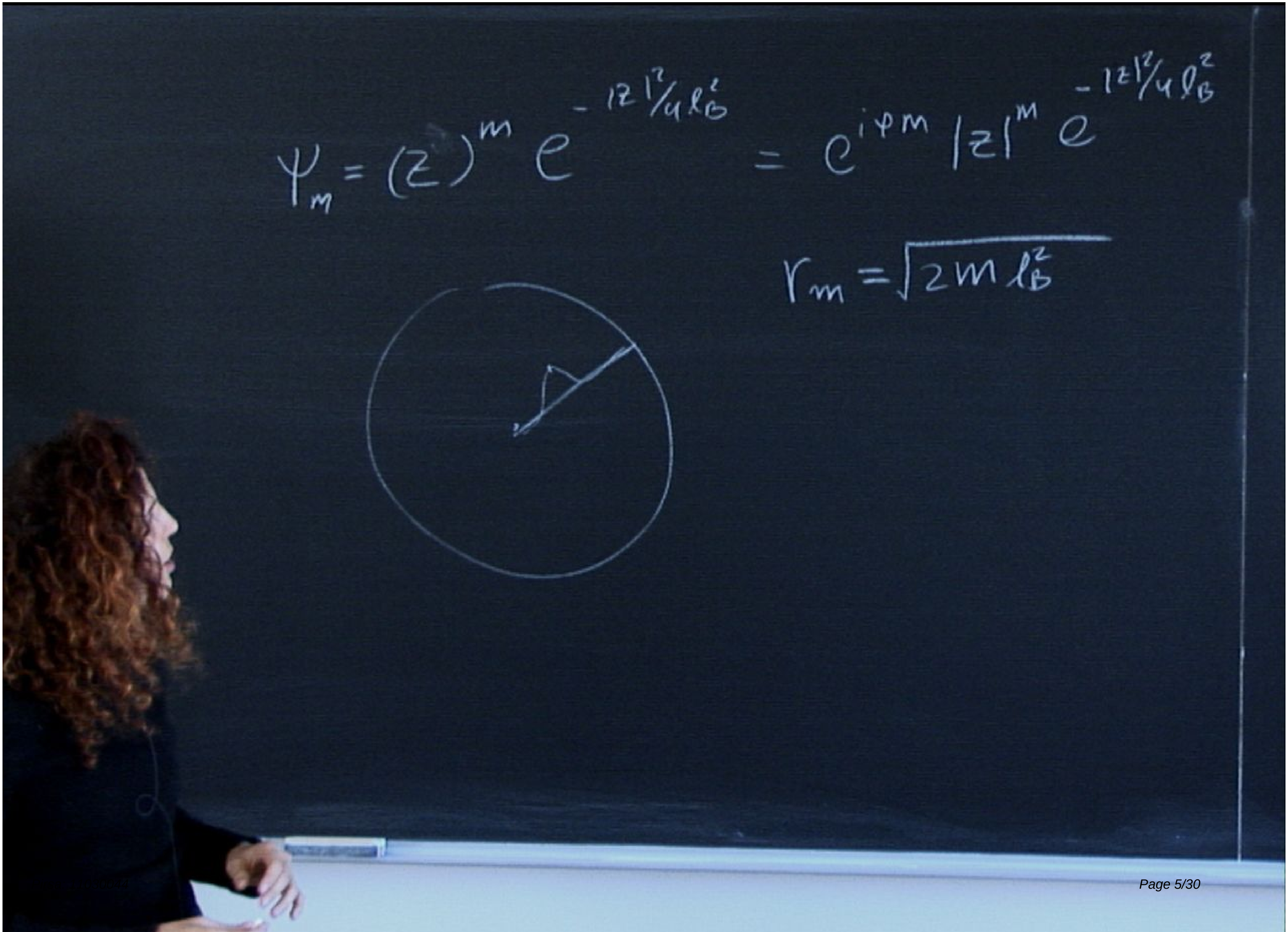
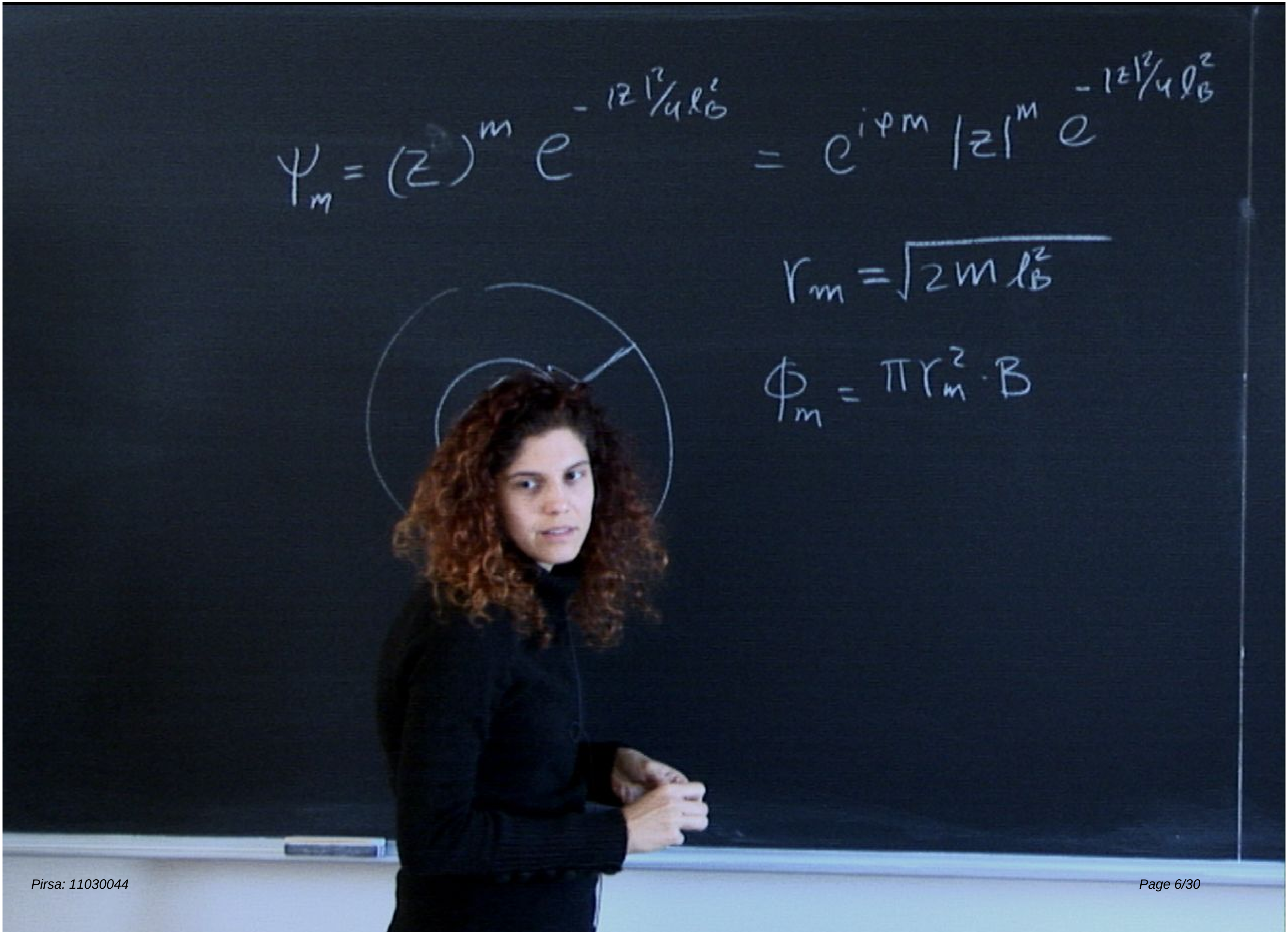

$\psi_m = (z)^m e^{-|z|^2/4\ell_B^2} = e^{i\varphi m} |z|^m e^{-|z|^2/4\ell_B^2}$
$r_m = \sqrt{2m\ell_B^2}$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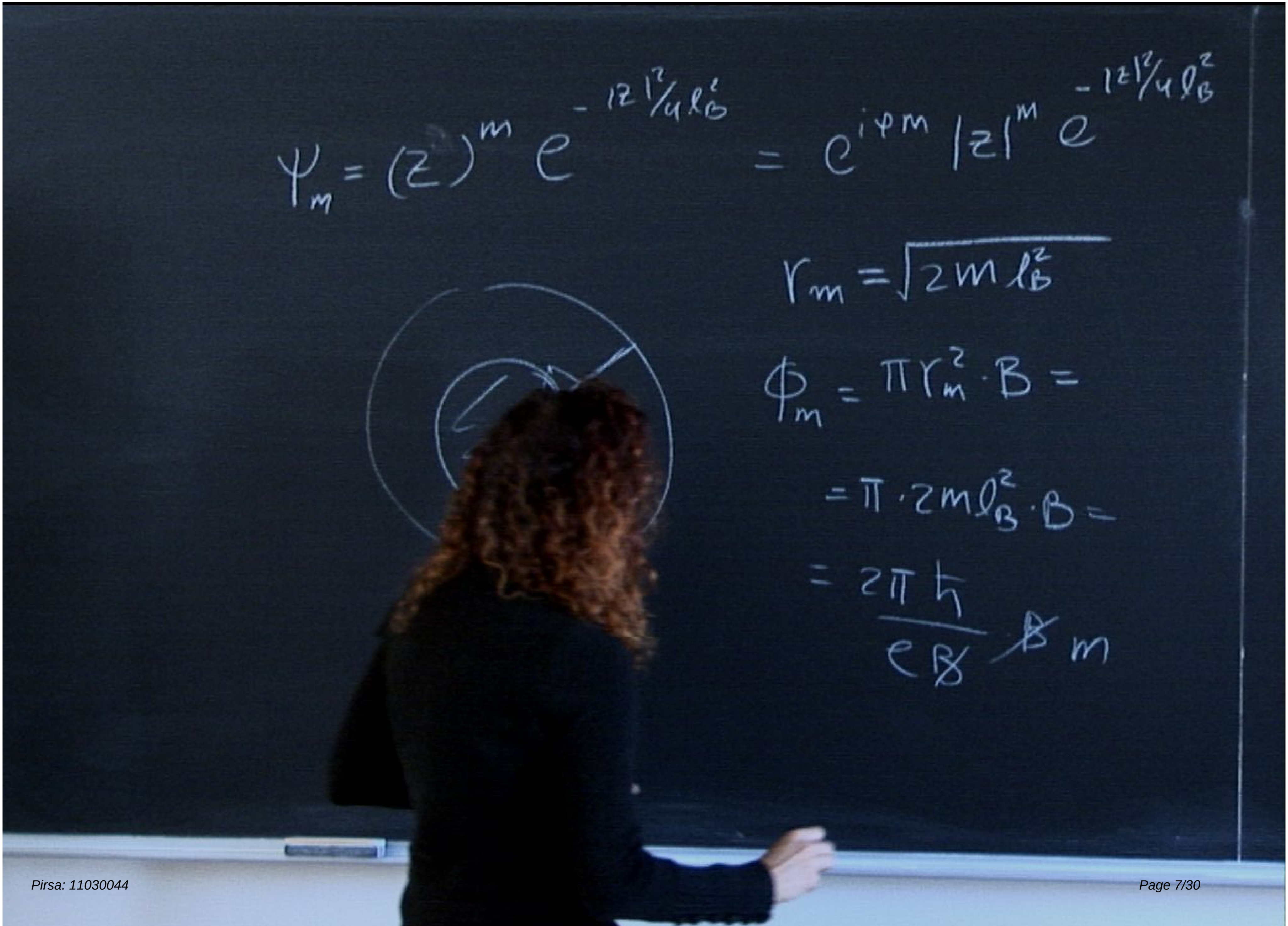
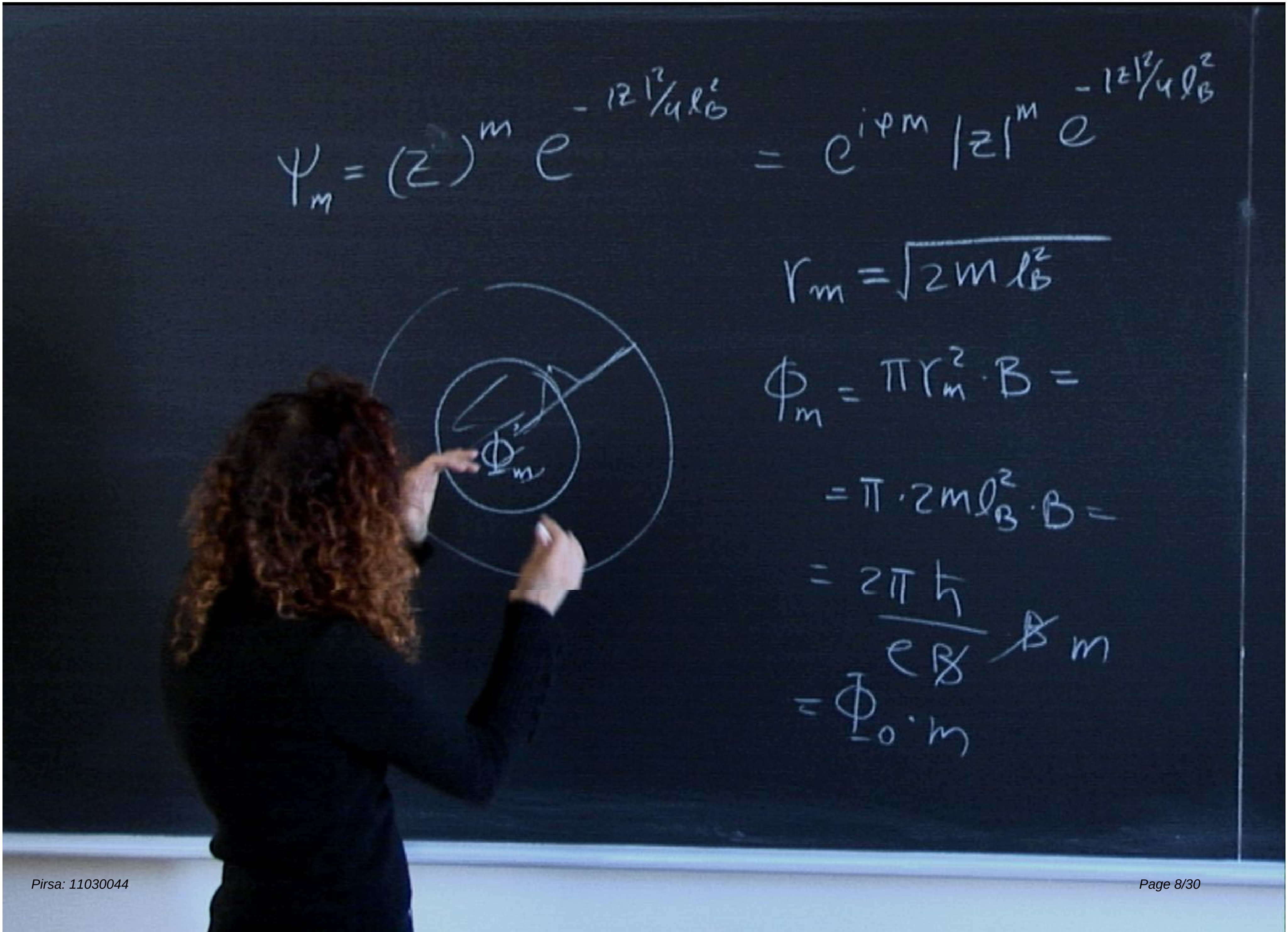
$\phi_m = \pi r_m^2 \cdot B$



$\Psi_m = (z)^m e^{-|z|^2/4\ell_B^2} = e^{i\varphi m} |z|^m e^{-|z|^2/4\ell_B^2}$
$r_m = \sqrt{2m\ell_B^2}$
$\Phi_m = \pi r_m^2 \cdot B =$
$= \pi \cdot 2m\ell_B^2 \cdot B =$
$= \frac{2\pi\hbar}{e\cancel{B}} \cancel{B} m$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Φ_m
$\Phi_m = \pi r_m^2 \cdot B =$
$= \pi \cdot 2m\ell_B^2 \cdot B =$
$= \frac{2\pi\hbar}{e\cancel{B}} \cancel{B}\, m$
$= \Phi_0 \cdot m$

$$m_{max} = \bar{\Phi}$$

$$\boxed{m = \frac{\Phi}{\Phi_0} = D_{LL} = \frac{A_{rea}}{2\pi l_B^2}}$$

$$\Psi_2(z_1, z_2) = (z_1 - z_2)^m \, e^{-\frac{|z_1|^2 + |z_2|^2}{4 l_B^2}} \times (z_1 + z_2)^M$$

$$N_{max} = \Phi$$

$$\boxed{N = \frac{\Phi}{\Phi_0} = D_{LL} = \frac{\text{Area}}{2\pi l_B^2}}$$

$$\Psi_2^{m,M}(z_1, z_2) = (z_1 - z_2)^m \, e^{-\frac{|z_1|^2 + |z_2|^2}{4 l_B^2}} \times (z_1 + z_2)^M$$

$$V(|z_1 - z_2|)\,\Psi_2$$

$$\langle \Psi_{mM} | \, V \, | \Psi_{m'M'} \rangle = \delta_{mm'}$$

$$\int dz\, dz^* \, z^{*m} z^{m'} \, V(|z|) \, e^{-|z|^2/2 l_B^2}$$

$$= \int r\,dr\,d\theta \left[e^{i(m'-m)\theta} \, f(r) \right] \propto \delta_{mm'}$$

$\varphi_m \; |z|^m e^{-|z|^2/4\ell_B^2}$

$= \sqrt{2m\ell_B^2}$

$\pi r_m^2 \cdot B =$

$\pi \cdot 2m\ell_B^2 \cdot B =$

$\frac{2\pi\hbar}{e\cancel{B}} \cancel{B}\, m$

$\Phi_0 \cdot m$

$m_{max} = \frac{\Phi}{}$

$$\boxed{m = \frac{\Phi}{\Phi_0} = D_{LL} = \frac{A_{rea}}{2\pi\ell_B^2}}$$

$$\frac{\langle \Psi_m | V | \Psi_m \rangle}{\langle \Psi_m | \Psi_m \rangle} = V_m$$

$\Psi_2^{m,M}(z_1 z_2) =$

$\times ($

$V(|z_1 - z_2|$

$\langle \Psi_{mM} | V | \Psi$

$\int dz\, dz^* \; z^{*m} z^{M}$

$= \int r\,dr\,d\theta \left\{ e^{i(m'-m)\theta} \right.$

1, 2, Many

$$\Psi_{full} = \prod_{i<j} (z_i - z_j)\, e^{-\sum_i \frac{|z_i|^2}{4\ell_0^2}}$$

$$\Psi_m = z^m e$$

$$\Psi_{MB} = \begin{vmatrix} \varphi_1(z_1) & \cdots & \varphi_N(z_N) \\ \varphi_2(z_1) & & \vdots \\ \vdots & & \vdots \\ \varphi_N(z_1) & & \varphi_N(z_N) \end{vmatrix} \rightarrow e^{-\sum \frac{|z}{4}}$$

$$= \prod_{i<j} (z_i - z_j)\, e^{-\sum_i \frac{|z_i|^2}{4\ell_B^2}}$$

$$\psi_m = z^m e^{-|z|^2/4\ell_B^2}$$

$$\begin{vmatrix} \ldots(z_1) & \cdots & \psi_N(z_N) \\ \ldots(z_1) & & \vdots \\ \vdots & & \vdots \\ \ldots(z_1) & & \psi_N(z_N) \end{vmatrix} \to e^{-\sum \frac{|z_i|^2}{4\ell_B^2}} \begin{vmatrix} 1 & \cdots & 1 \\ z_1^1 & & z_N^1 \\ z_1^2 & & \vdots \\ \vdots & & \vdots \\ z_1^N & \cdots & z_N^N \end{vmatrix} = \ldots$$

$$e^{-\sum_i \frac{|z_i|^2}{4\ell_B^2}}$$

$$\psi_m = z^m e^{-|z|^2/4\ell_B^2}$$

$$\rightarrow e^{-\sum \frac{|z_i|^2}{4\ell_B^2}} \begin{vmatrix} 1 & \cdots & 1 \\ z_1^1 & \cdots & z_N^1 \\ z_1^2 & & \vdots \\ \vdots & & \vdots \\ z_1^N & \cdots & z_N^N \end{vmatrix} = -\prod_{i<j}(z_i - z_j)$$

1, 2, Many

$$\boxed{\Psi_{full} = \prod_{i<j} (z_i - z_j)\, e^{-\sum_i \frac{|z_i|^2}{4\ell_0^2}}}$$

$$\Psi_{MB} = \begin{vmatrix} \varphi_1(z_1) & \cdots & \varphi_N(z_N) \\ \varphi_2(z_1) & & \vdots \\ \vdots & & \vdots \\ \varphi_N(z_1) & & \varphi_N(z_N) \end{vmatrix}$$

Ψ_M

$\rightarrow e$

$$= z^m e^{-|z|^2/4 l_B^2}$$

$$H = H_0 + \sum V_0 \, \delta(|z_i - z_j|)$$

$$e^{-\sum \frac{|z_i|^2}{4 l_B^2}} \begin{vmatrix} 1 & \cdots & 1 \\ z_1^1 & \cdots & z_N^1 \\ z_1^2 & & \vdots \\ \vdots & & \vdots \\ z_1^N & \cdots & z_N^N \end{vmatrix} = -\prod_{i<j} (z_i - z_j)$$

$\nu = \frac{1}{3} \xrightarrow{\text{generalize}} \nu = \frac{1}{q} \leftarrow$ odd

1, 2, Many

$$\boxed{\Psi_{full} = \prod_{i<j} (z_i - z_j)\, e^{-\sum_i \frac{|z_i|^2}{4\ell_B^2}}}$$

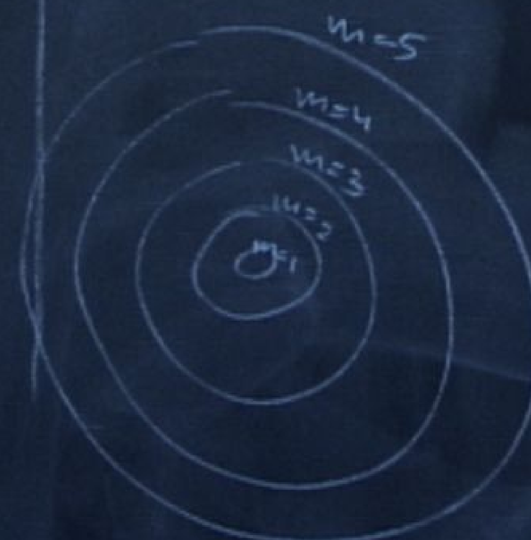
$$\Psi_q = \prod_{i<j} (z_i - z_j)^q\, e^{-\sum \frac{|z_i|^2}{4\ell_B^2}}$$

$$\nu = \frac{1}{3} \xrightarrow{\text{generalize}} \nu = \frac{1}{q} \leftarrow \text{odd}$$

$$E(\vec{\tau}) = \langle \Psi(\vec{\tau}) | H | \Psi(\tau) \rangle$$

$$E(\tau^*) \qquad \frac{\partial E(\tau)}{\partial \tau} = 0$$

$$\psi_z^{(q)} \propto z^q e^{-|z|^2/2\ell_B^2} \times f(CM)$$



1, 2, Many

$$\boxed{\Psi_{full} = \prod_{i<j} (z_i - z_j)\, e^{-\sum_i \frac{|z_i|^2}{4\ell_B^2}}}$$

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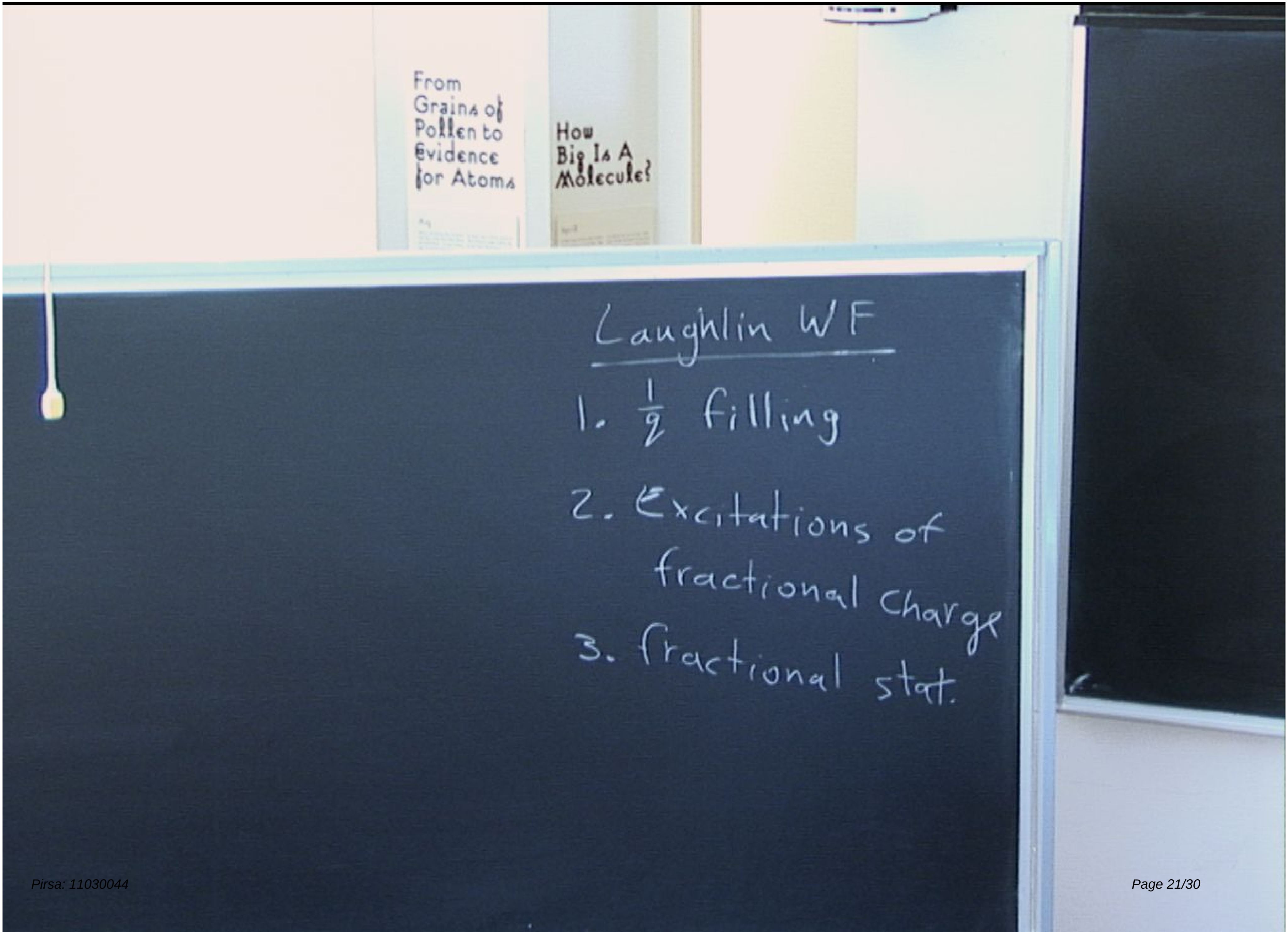
From Grains of Pollen to Evidence for Atoms
How Big Is A Molecule?
Laughlin WF
1. $\frac{1}{q}$ filling
2. Excitations of fractional charge
3. fractional stat.

$$\nu = \frac{1}{3} \xrightarrow[\text{generalize}]{} \nu = \frac{1}{q} \leftarrow \text{odd}$$

1. $$M_{max} = q \cdot N = \frac{\Phi}{\Phi_0} = D_{LL}$$

$$N = \frac{D_{LL}}{q}$$

$$\boxed{\nu = \frac{1}{q}}$$

$$\nu = \frac{1}{3} \xrightarrow{\text{generalize}} \nu = \frac{1}{q} \leftarrow \text{odd}$$

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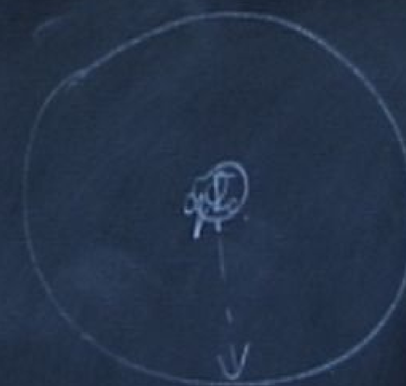


$$N = \frac{D_{LL}}{q}$$

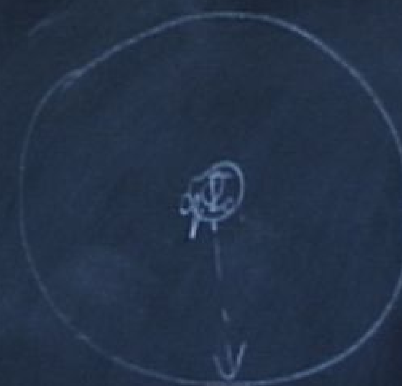
$$\boxed{\nu = \frac{1}{q}}$$

$$I = \frac{\Delta U}{\Delta \phi} = \frac{eV}{q\frac{h}{e}}$$

$$\boxed{\sigma_{xy} = \frac{1}{q}\frac{e^2}{h}}$$

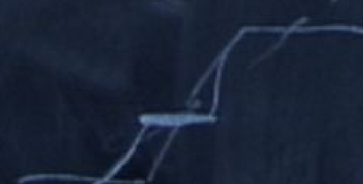
$$\nu = \frac{1}{3} \xrightarrow{\text{generalize}} \nu = \frac{1}{q} \leftarrow \text{odd}$$

$$1.\quad M_{max} = q \cdot \underline{\underline{N}} = \frac{\Phi}{\Phi_0} = \underline{\underline{D_{LL}}}$$



$$I = \frac{\Delta U}{\Delta \Phi} = \frac{eV}{q\,\frac{h}{e}}$$

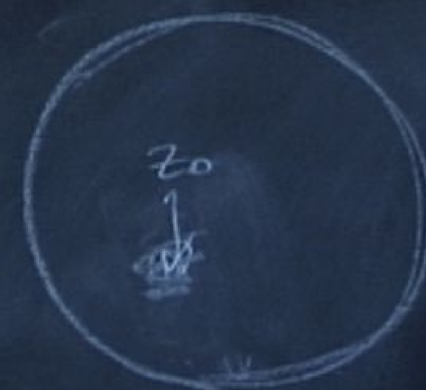
$$\nu = \frac{N}{D_{LL}}$$



$$\boxed{\sigma_{xy} = \frac{1}{2}\frac{e^2}{h}}$$

$$\nu = \frac{1}{3} \xrightarrow{\text{generalize}} \nu = \frac{1}{q} \leftarrow \text{odd}$$

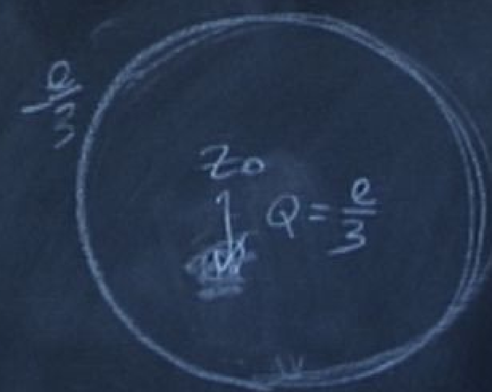
1. $$M_{max} = q \cdot \underline{\underline{N}} = \frac{\Phi}{\Phi_0} = \underline{\underline{D_{LL}}}$$

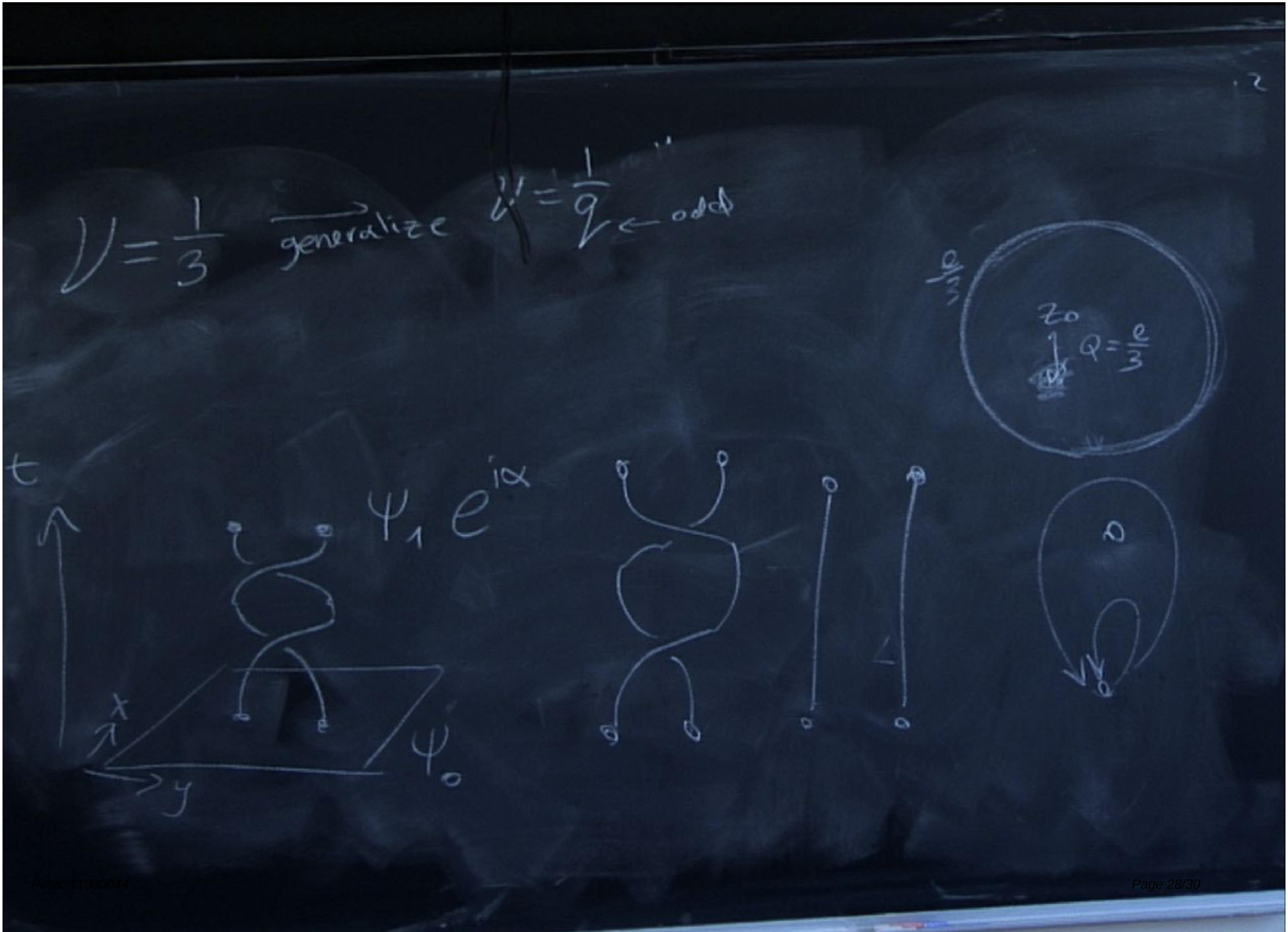


$$\Psi_\nu^{+z_0} = \prod_i (z_i - z_0)\, \Psi_\nu$$

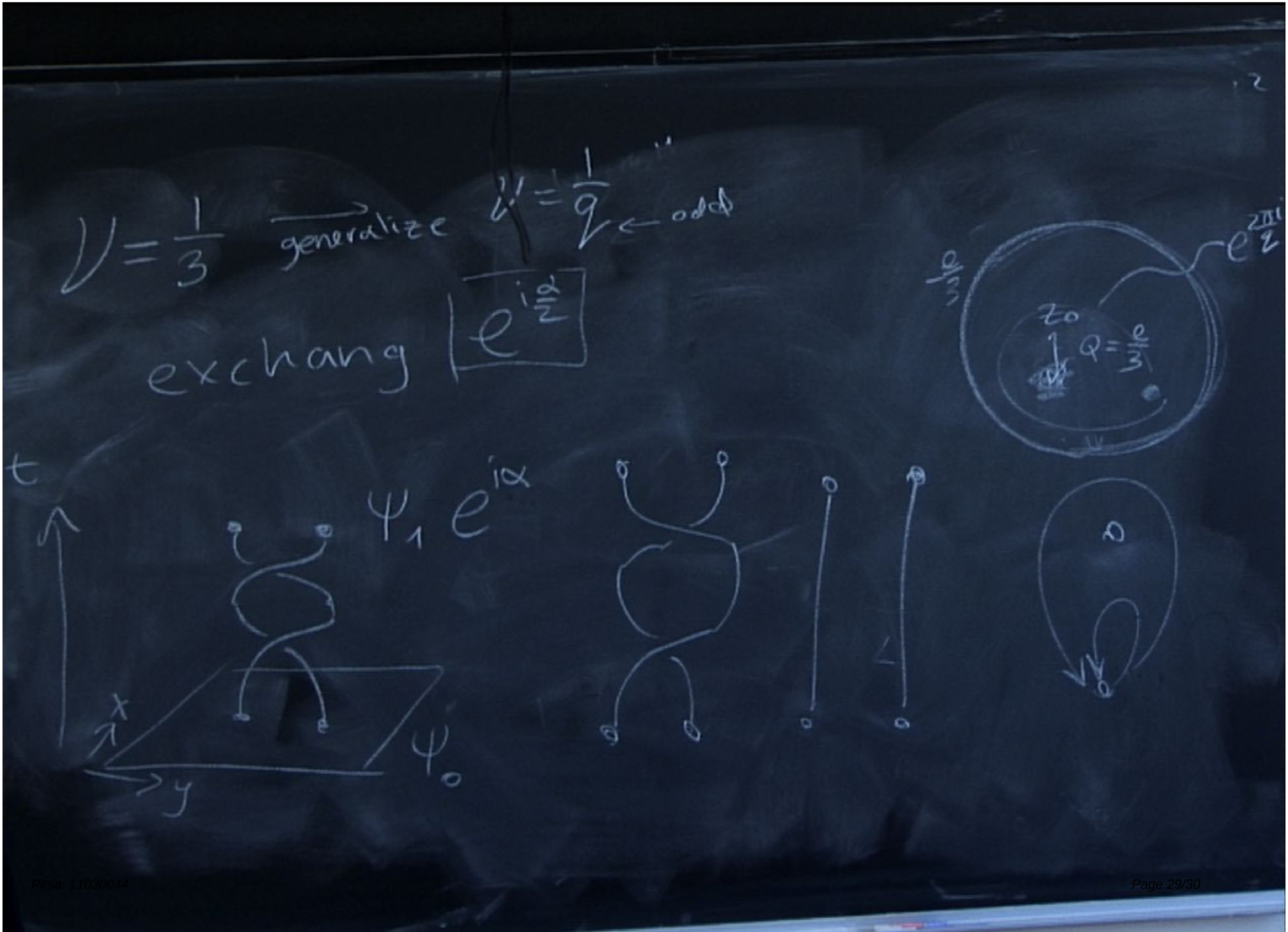
$$\nu = \frac{N}{D_{LL}}$$

$$\nu = \frac{1}{3} \xrightarrow{\text{generalize}} \nu = \frac{1}{q} \leftarrow \text{odd}$$





ν = 1/3
generalize
ν = 1/q
← odd
e/3
z0
Q = e/3
t
Ψ1 e^iα
x
y
Ψ0



ν = 1/3
generalize
ν = 1/q
← odd
exchang
e^{iα/2}
Ψ_1 e^{iα}
t
x
y
Ψ_0
z_0
Q = e/3
e/3

1, 2, Many

$$\boxed{\Psi_{full} = \prod_{i<j} (z_i - z_j)\, e^{-\sum_i \frac{|z_i|^2}{4\ell_B^2}}}$$

$$\Psi_q = \prod_{i<j} (z_i - z_j)^{\overset{\text{odd}}{q}} e^{-\sum \frac{|z_i|^2}{4\ell_B^2}}$$

$$\Psi_q^{+z_0} = \Psi_q \prod_i (z_i - z_0) \prod (z_i$$