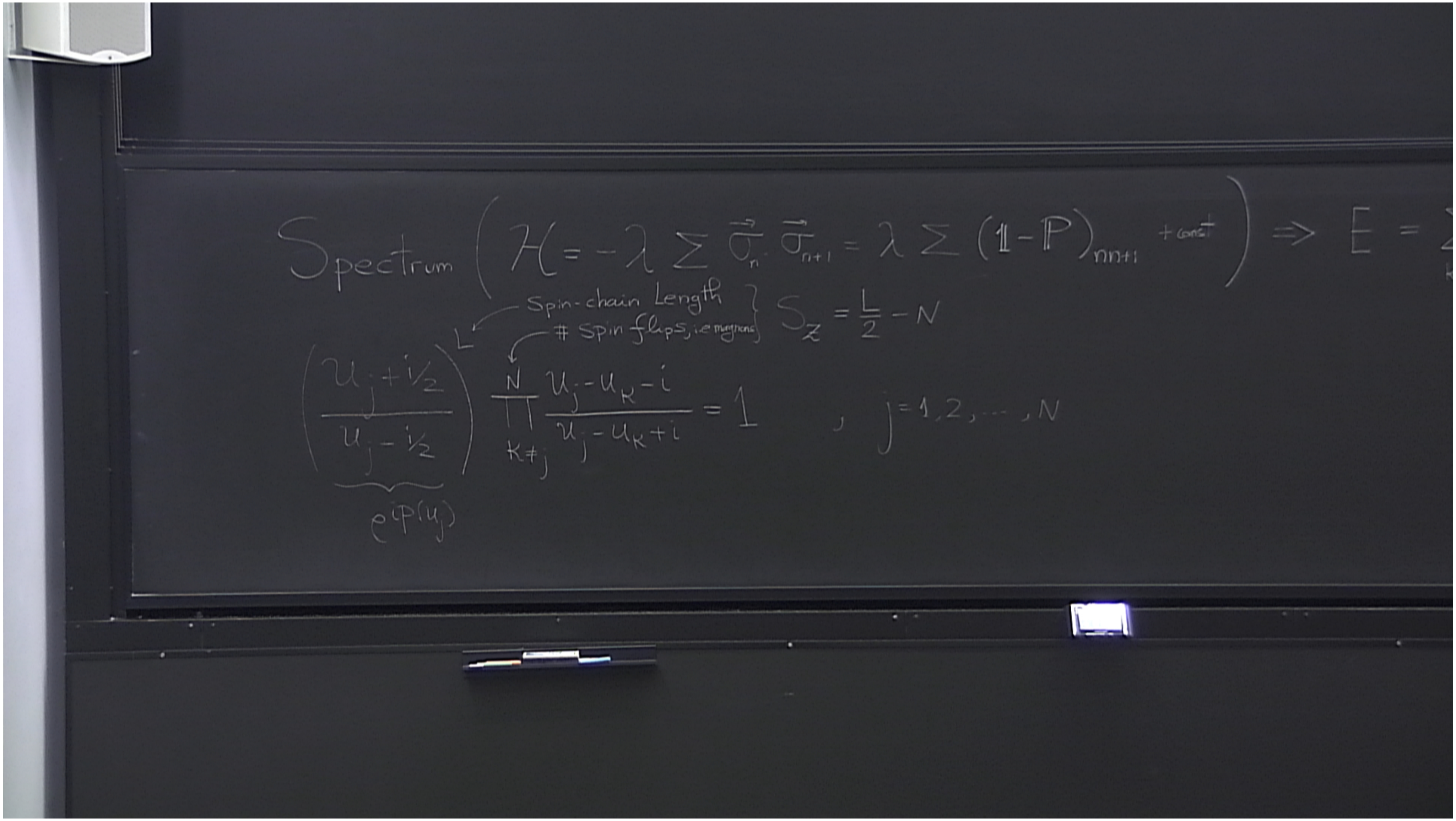
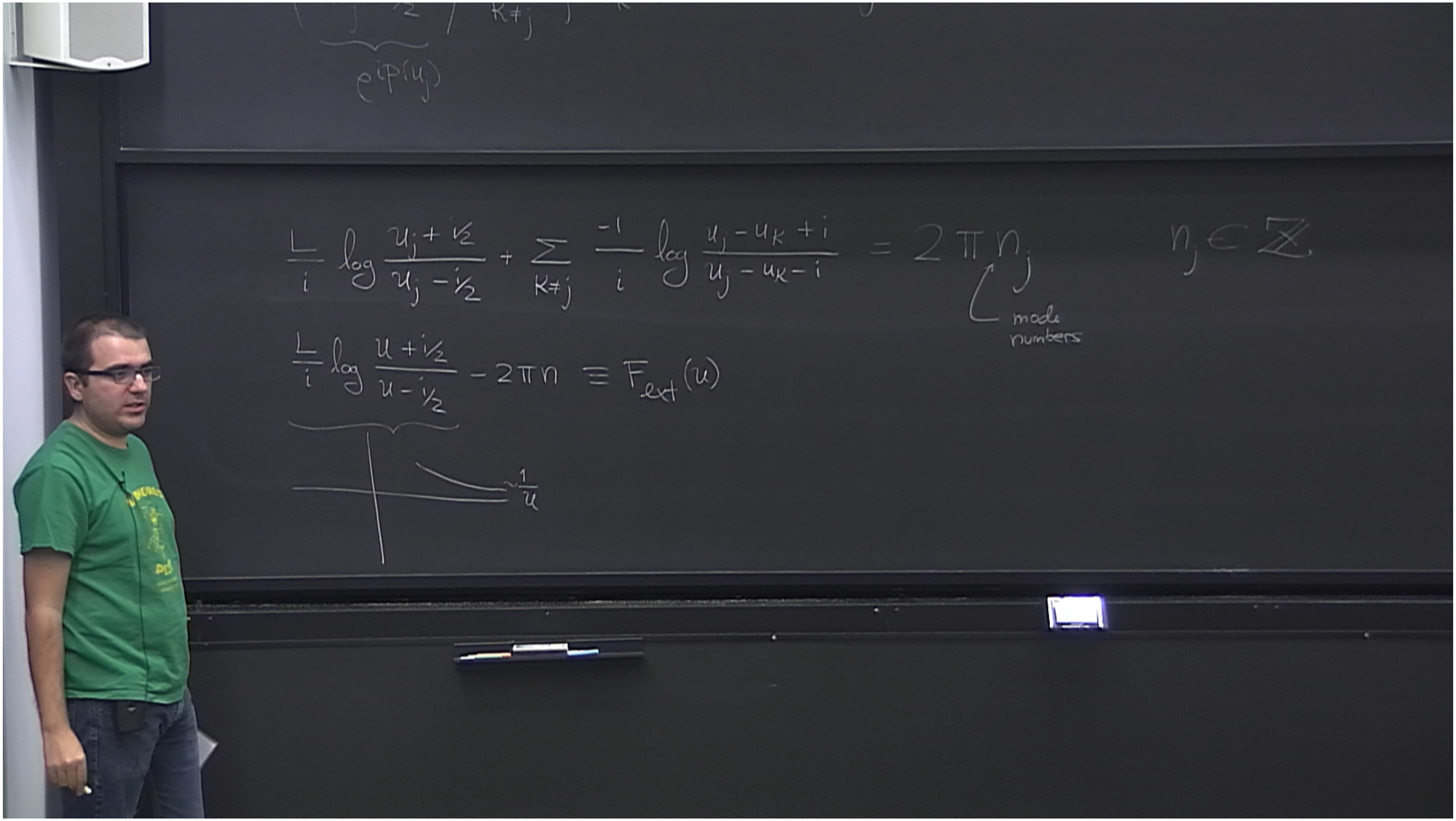
Title: Explorations in String Theory -5

Date: Apr 09, 2015 04:00 PM

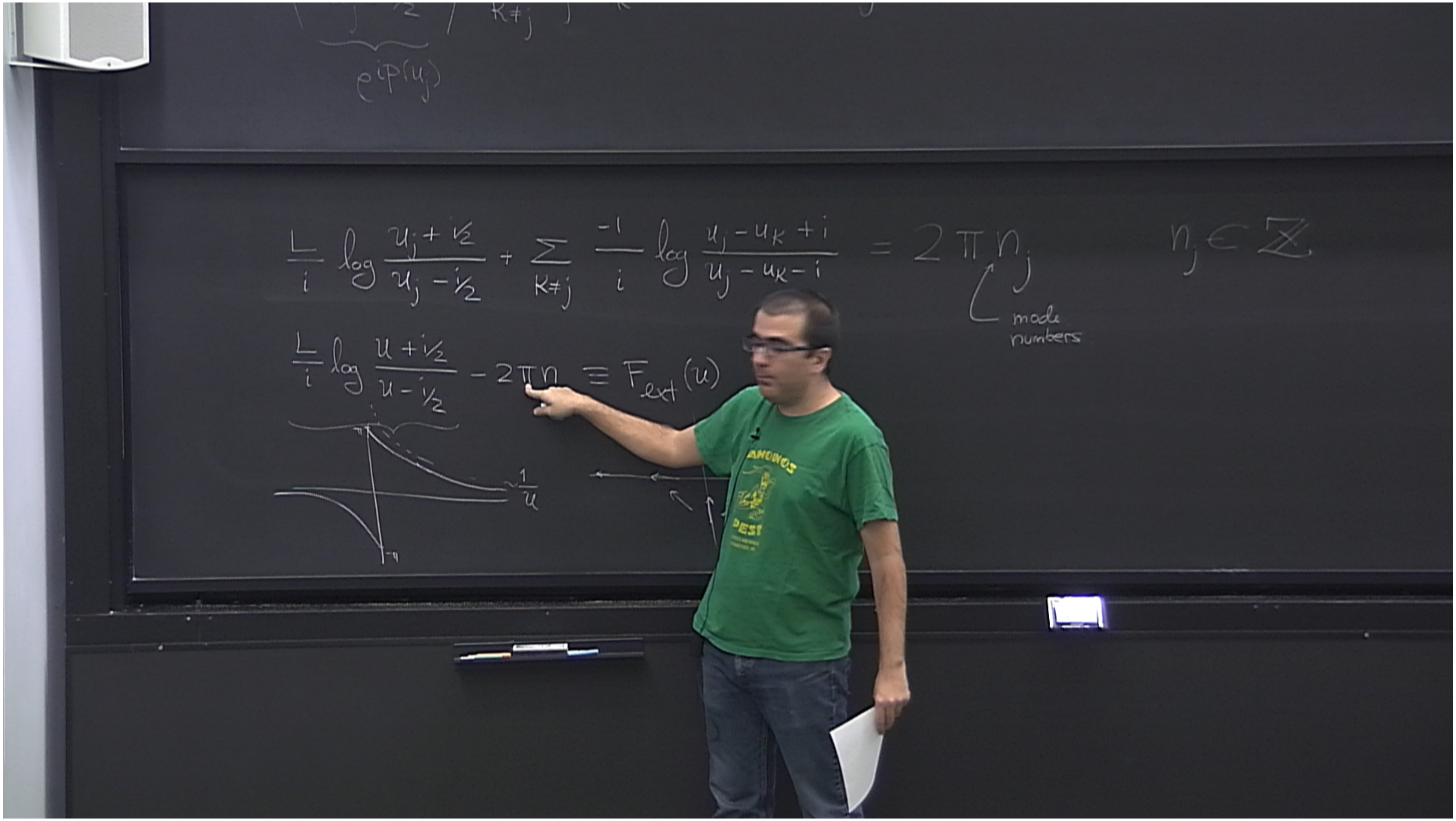
URL: http://pirsa.org/15040144

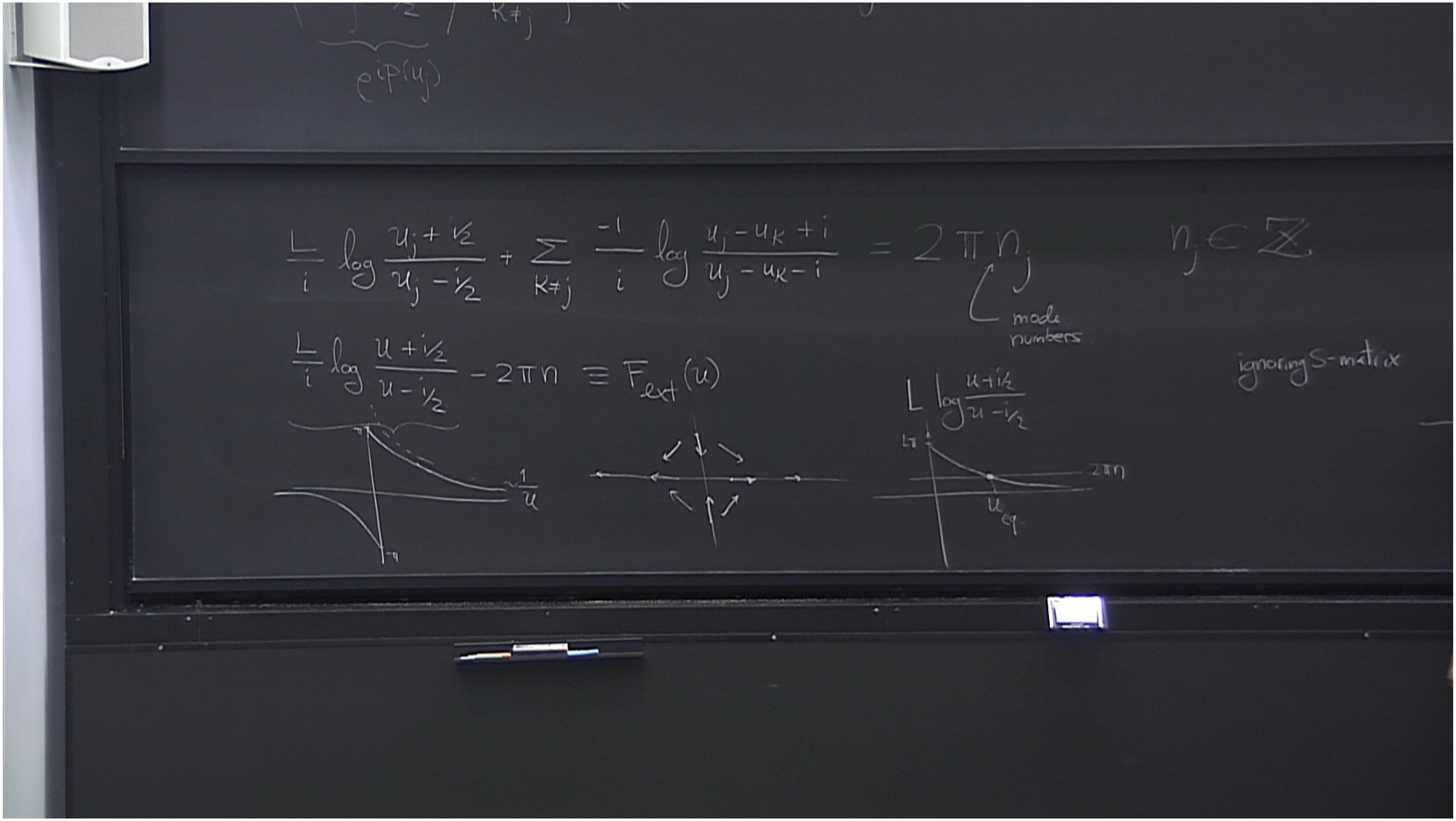
Abstract:

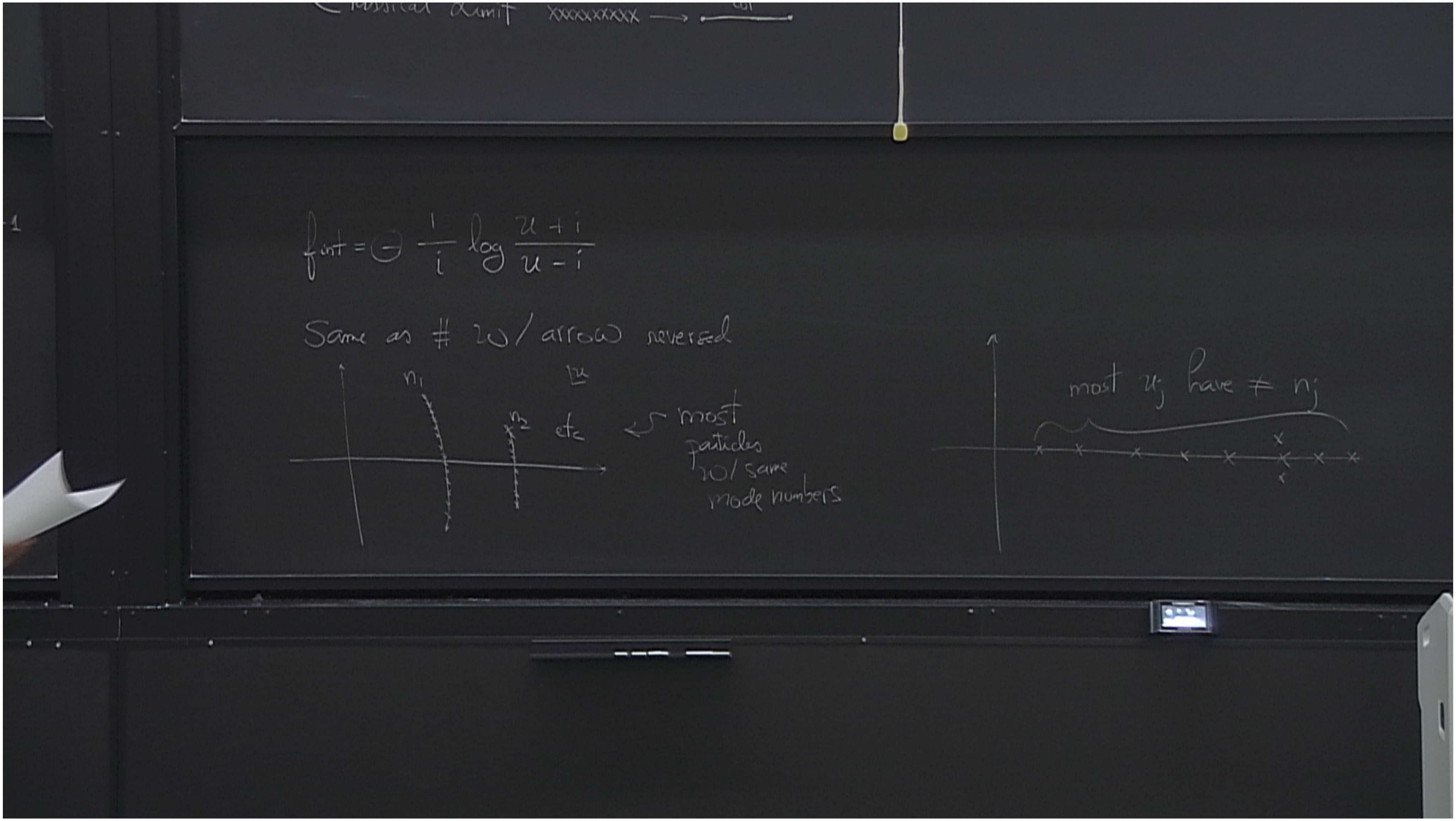

Spectrum ( H = -λ Σ σ⃗_n · σ⃗_{n+1} = λ Σ (1 - P)_{n n+1} + const ) ⇒ E =
Spin-chain Length
# spin flips, i.e. magnons
S_z = L/2 - N
((u_j + i/2)/(u_j - i/2))^L ∏_{k≠j}^N (u_j - u_k - i)/(u_j - u_k + i) = 1 , j = 1, 2, ..., N
e^{ip(u_j)}

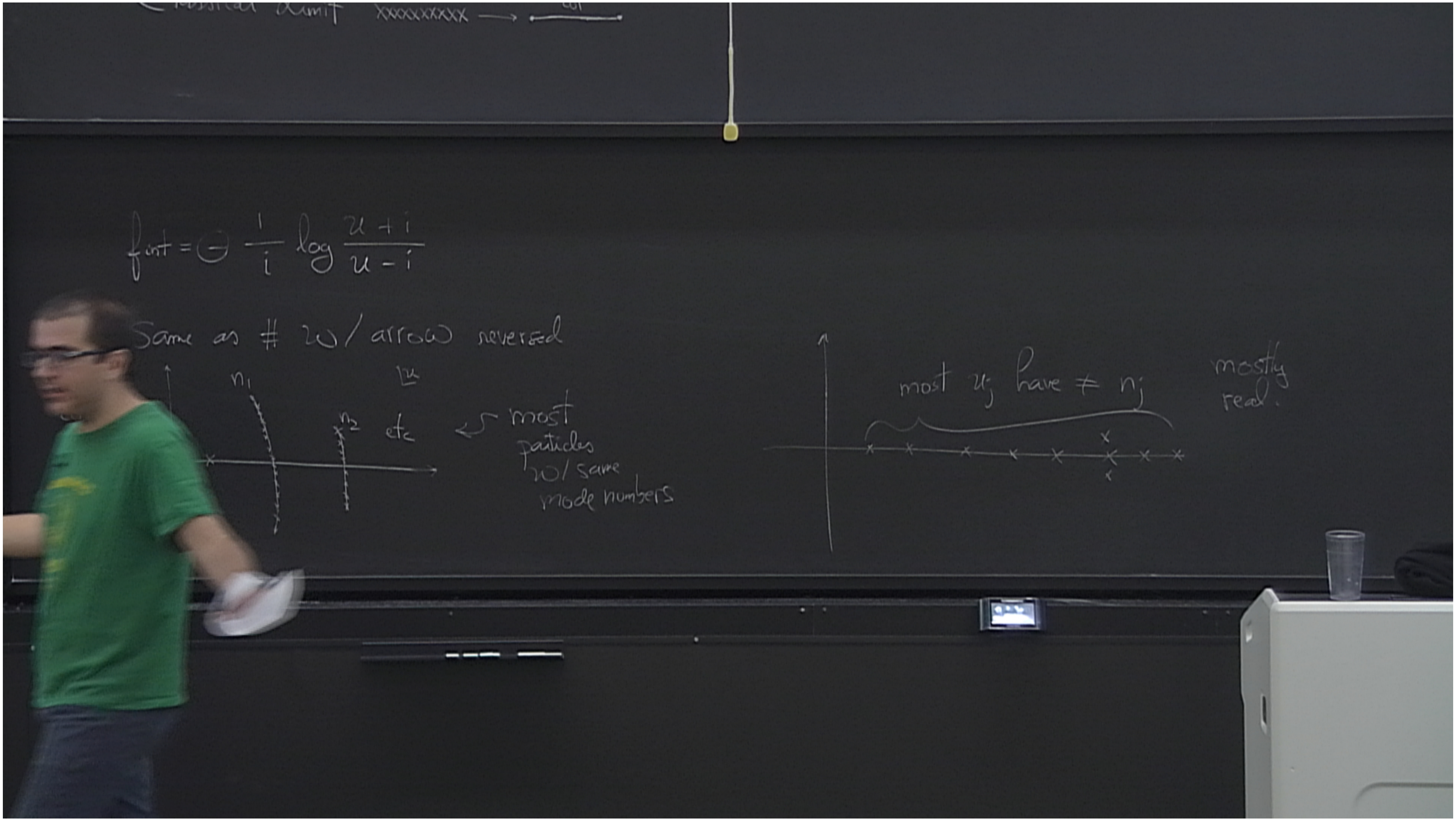


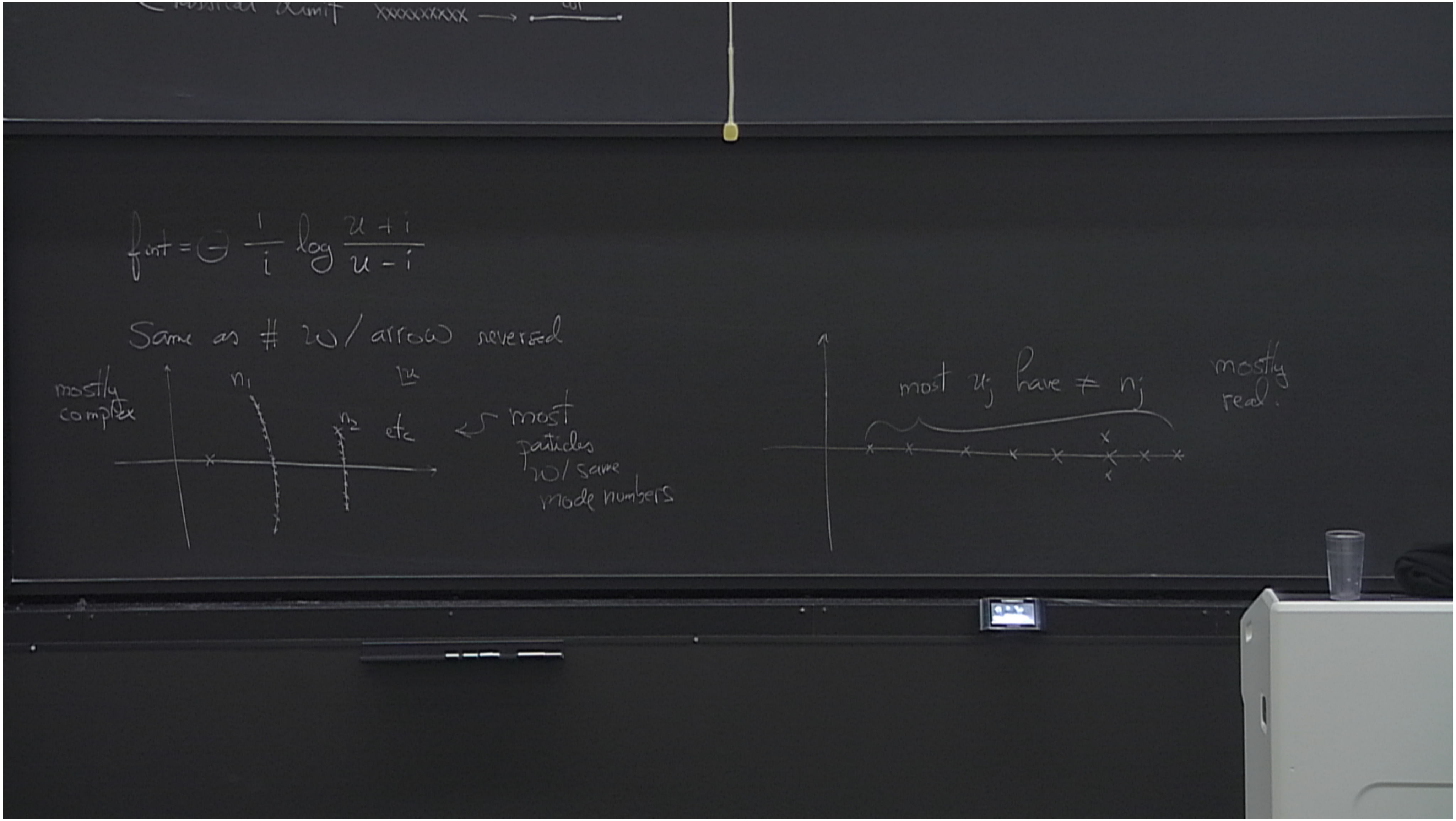
$e^{ip(u_j)}$
$\frac{L}{i} \log \frac{u_j + i/2}{u_j - i/2} + \sum_{k \neq j} \frac{-1}{i} \log \frac{u_j - u_k + i}{u_j - u_k - i} = 2\pi n_j$
$n_j \in \mathbb{Z}$
mode numbers
$\frac{L}{i} \log \frac{u + i/2}{u - i/2} - 2\pi n \equiv F_{ext}(u)$
$\sim \frac{1}{u}$

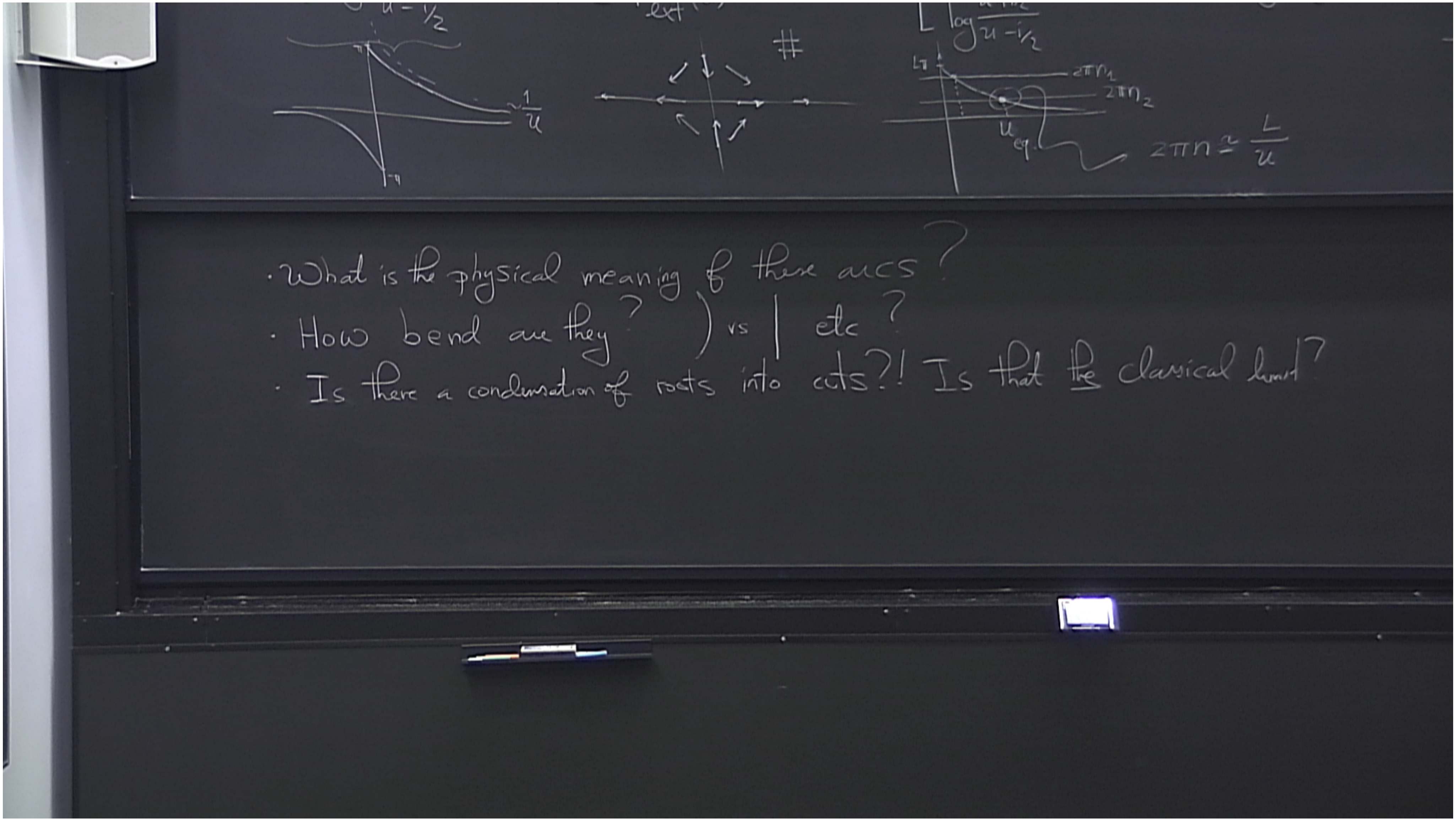

mode numbers


$e^{ip(u_j)}$
$\frac{L}{i}\log\frac{u_j+i/2}{u_j-i/2}+\sum_{k\neq j}\frac{-1}{i}\log\frac{u_j-u_k+i}{u_j-u_k-i}=2\pi n_j$
$n_j\in\mathbb{Z}$
mode numbers
$\frac{L}{i}\log\frac{u+i/2}{u-i/2}-2\pi n\equiv F_{ext}(u)$
ignoring S-matrix
$L\log\frac{u+i/2}{u-i/2}$
$\sim\frac{1}{u}$
$2\pi n$
$u_{eq}$

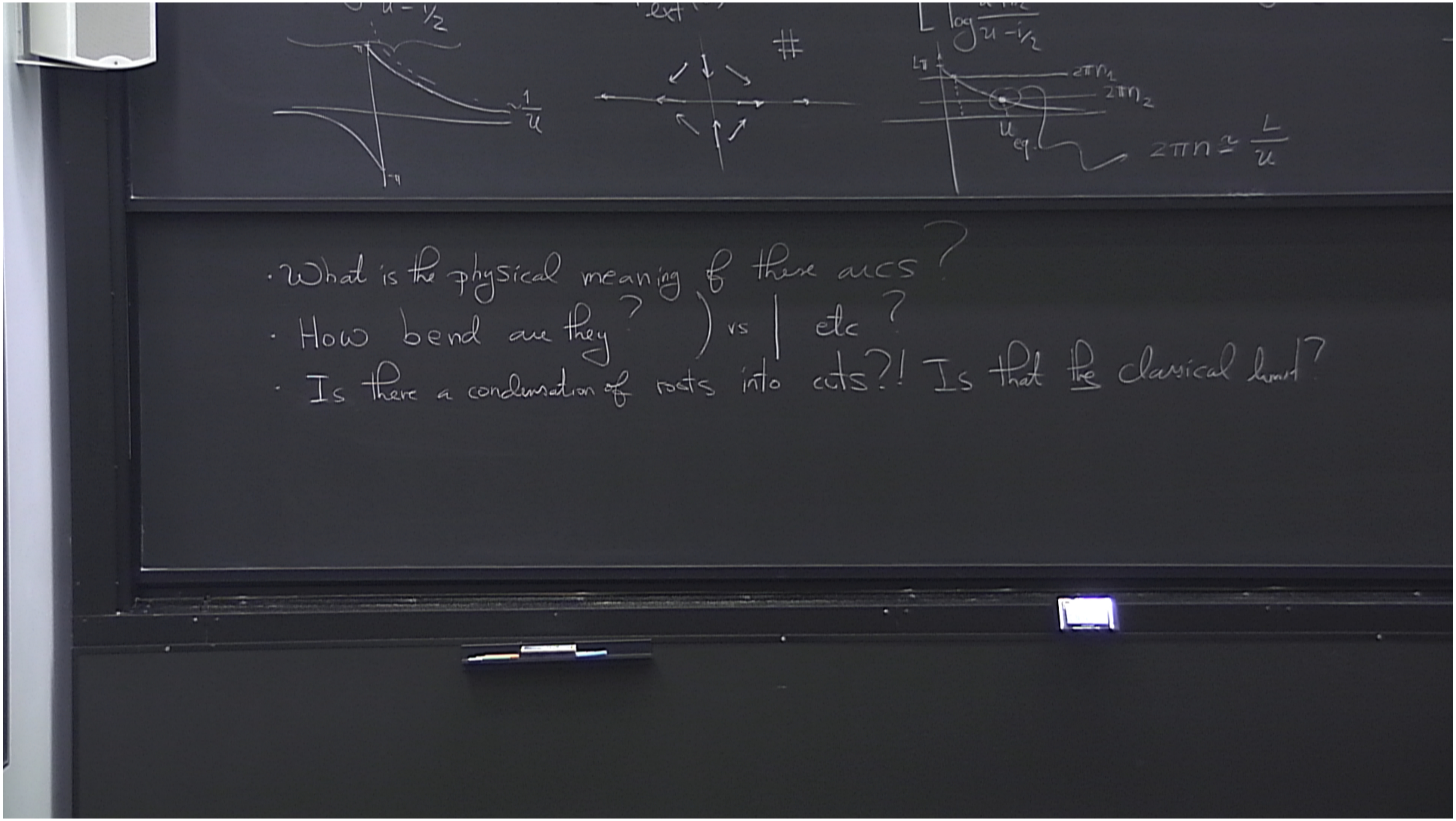

Classical limit xxxxxxxxx →
f_int = ⊖ 1/i log (u + i)/(u − i)
Same as # w/ arrow reversed
n_1
u
n_2
etc
most particles w/ same mode numbers
most u_j have ≠ n_j


f int = ⊖ 1/i log (u + i)/(u - i)
Same as # 2 w/ arrow reversed
n1
n2
etc
most particles w/ same mode numbers
most uj have ≠ nj
mostly real.


f_int = ⊖ 1/i log (u + i)/(u - i)
Same as # w/ arrow reversed
mostly complex
n_1
n_2
etc
most particles w/ same mode numbers
most u_j have ≠ n_j
mostly real.



· What is the physical meaning of these arcs?
· How bend are they? ) vs | etc ?
· Is there a condensation of roots into cuts?! Is that the classical limit?
~1/u
2πn1
2πn2
u eq.
2πn ≃ L/u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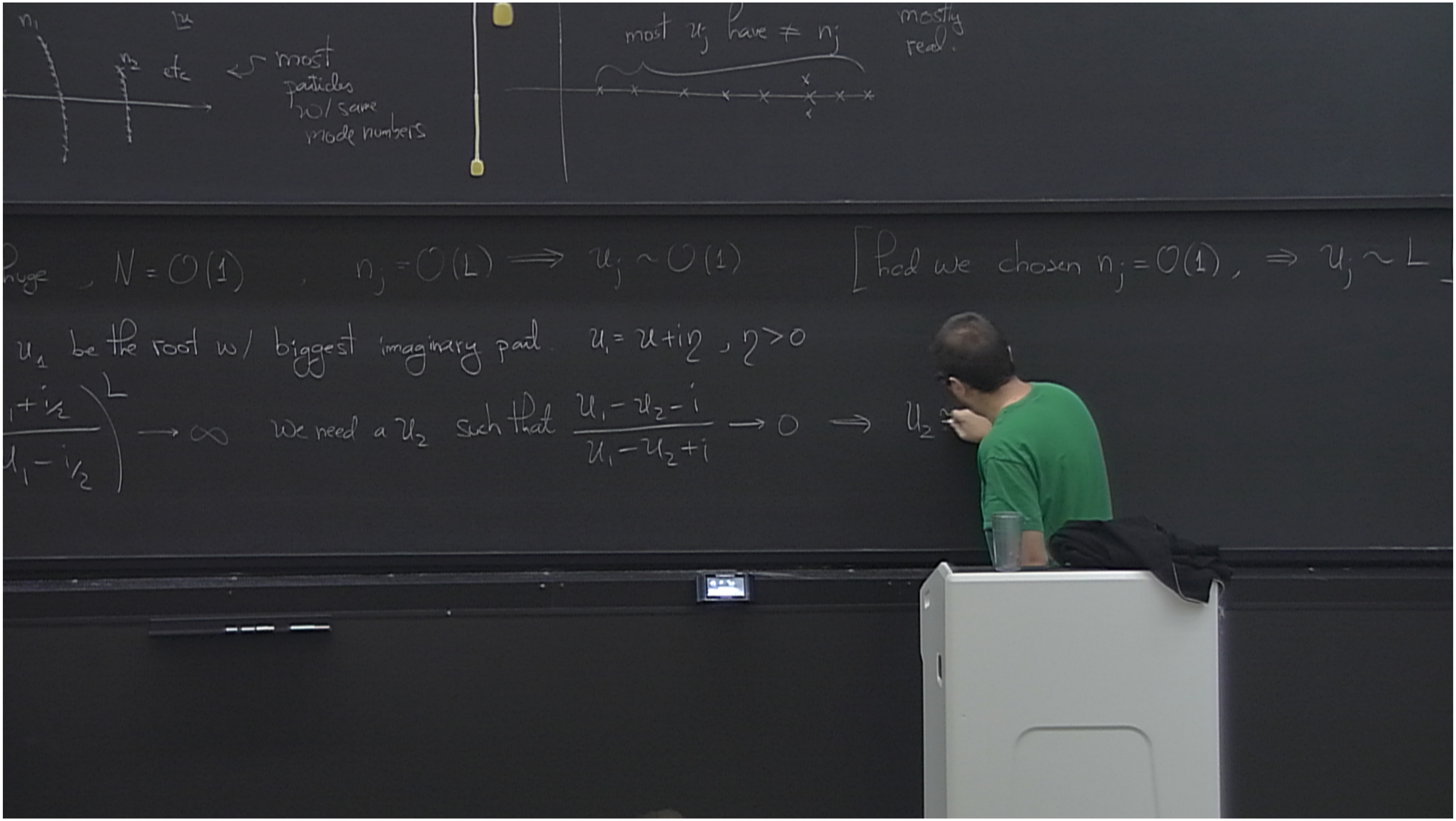
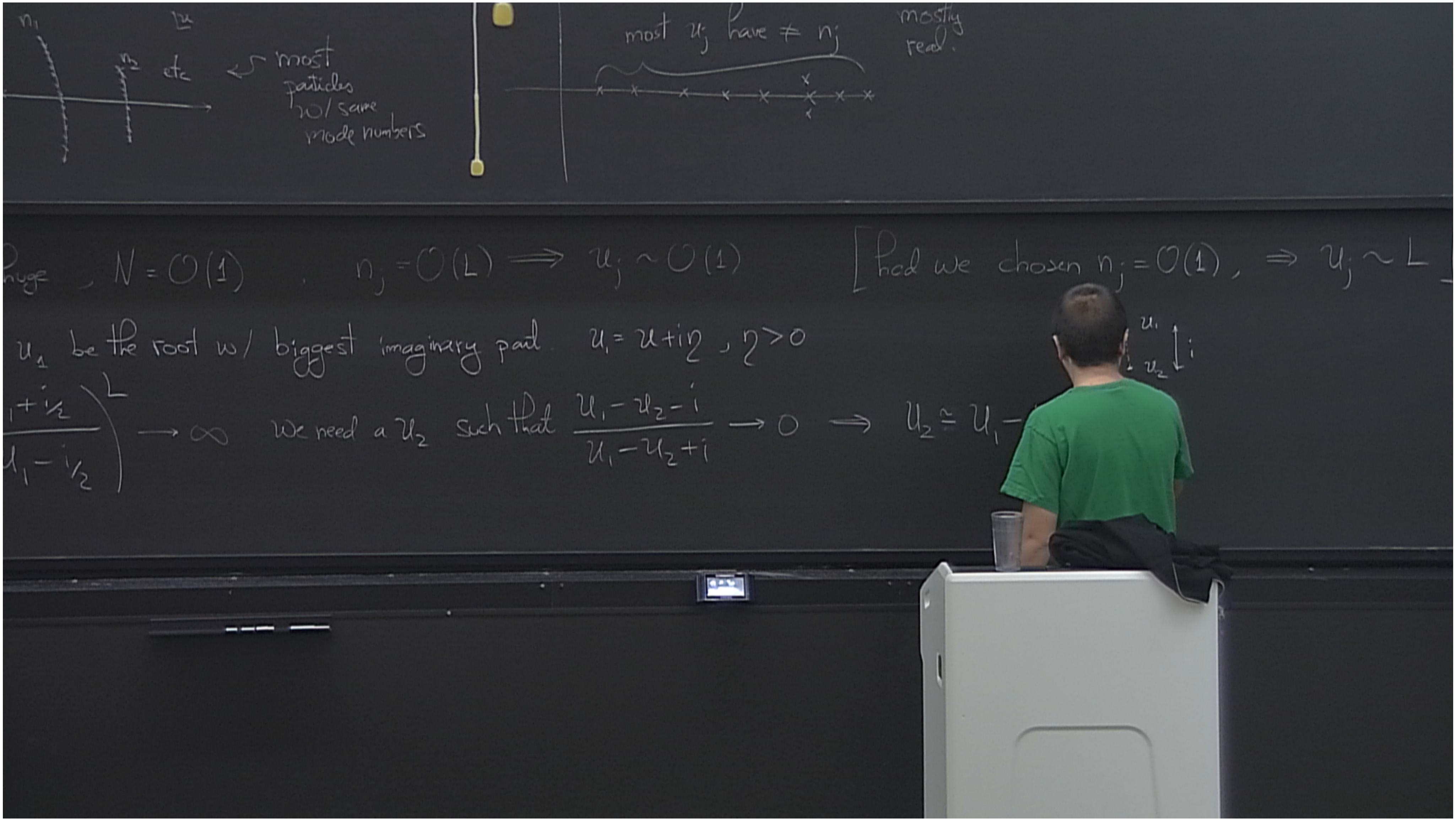
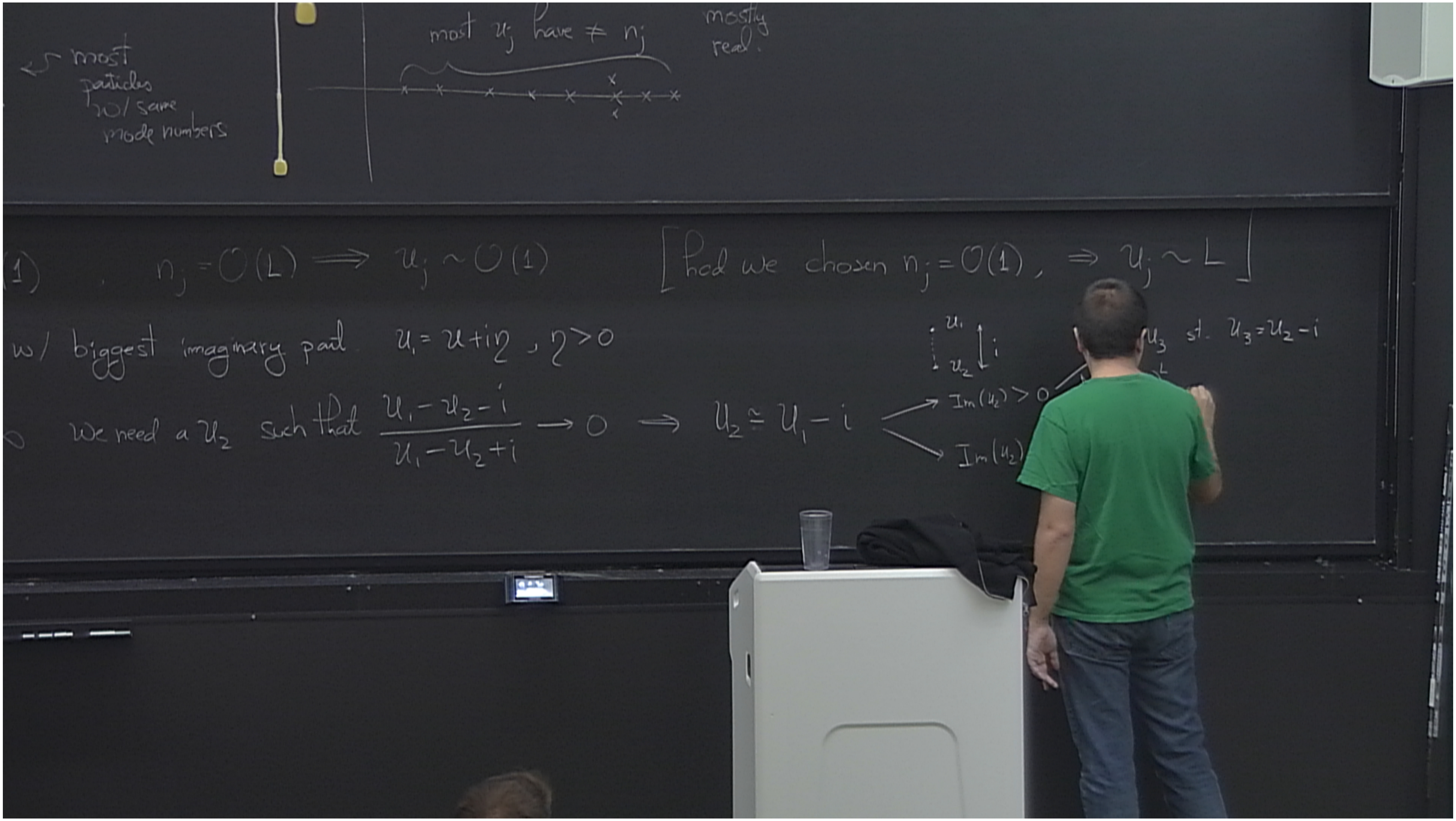
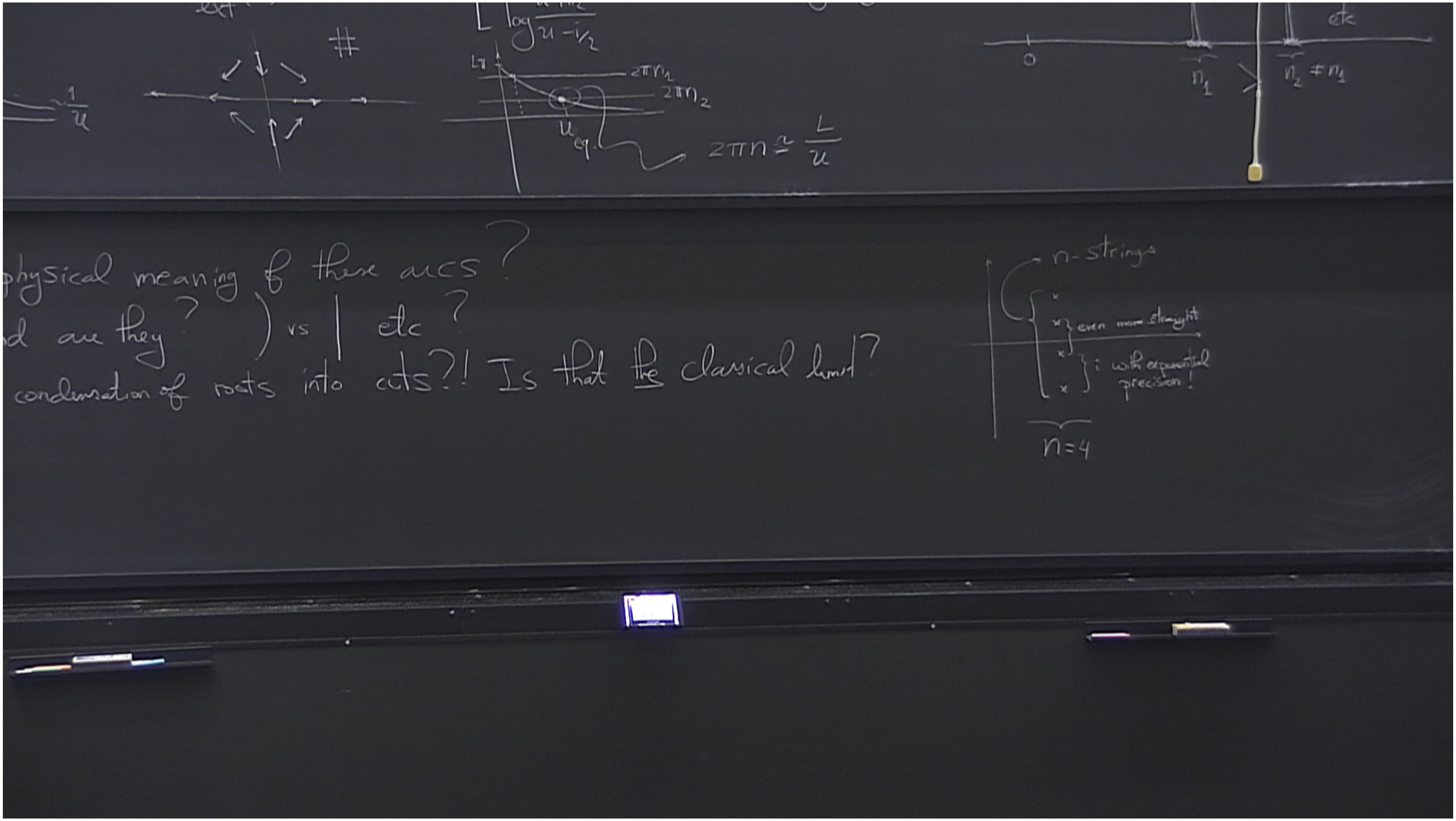
2πn ≃ L/u

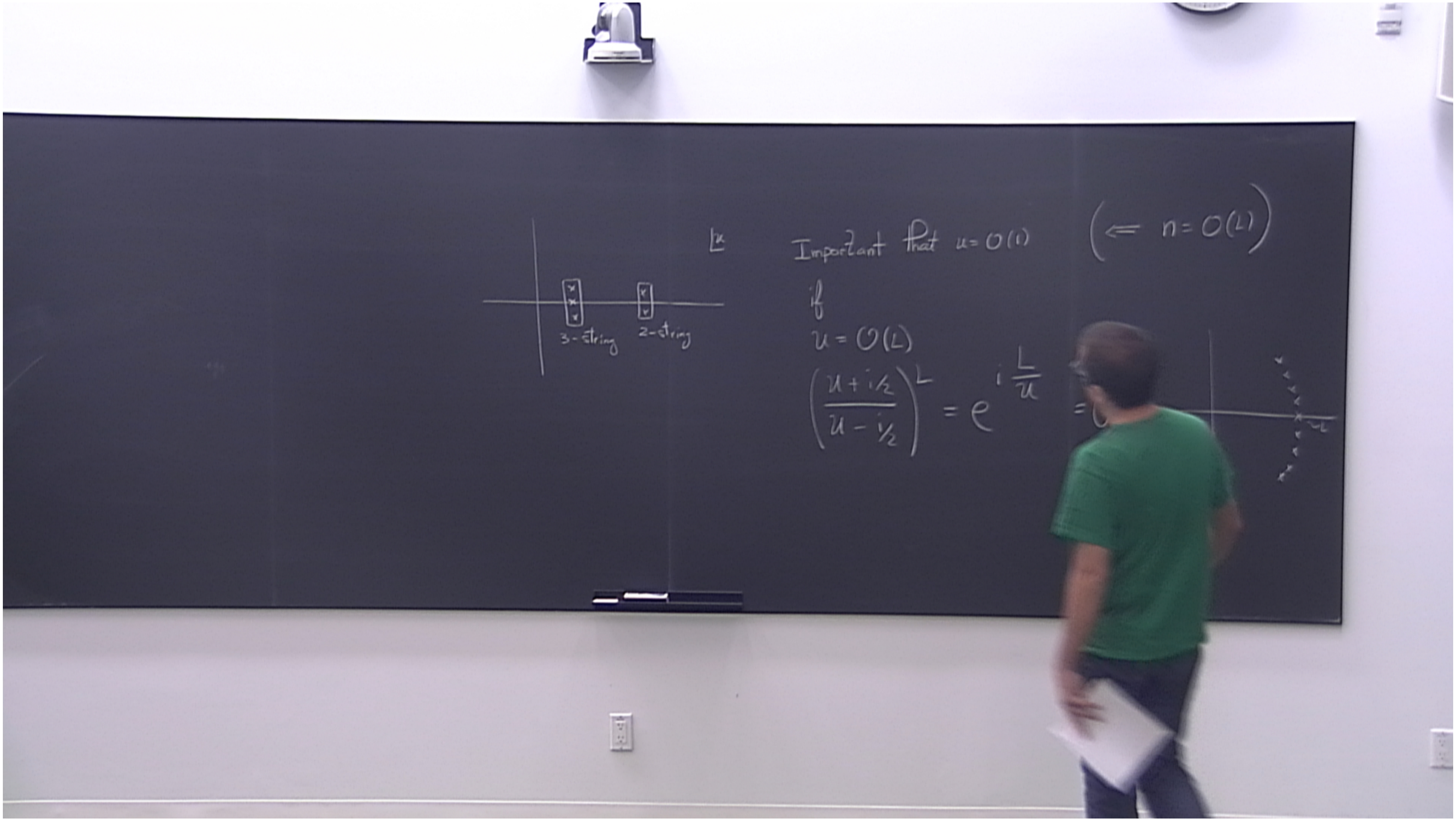

most particles w/ same mode numbers
etc
most u_j have ≠ n_j
mostly real.
N = O(1) , n_j = O(L) ⟹ u_j ~ O(1)
[Had we chosen n_j = O(1) , ⟹ u_j ~ L
u_1 be the root w/ biggest imaginary part. u_1 = u + iη , η > 0
We need a u_2 such that (u_1 − u_2 − i)/(u_1 − u_2 + i) → 0 ⟹ u_2

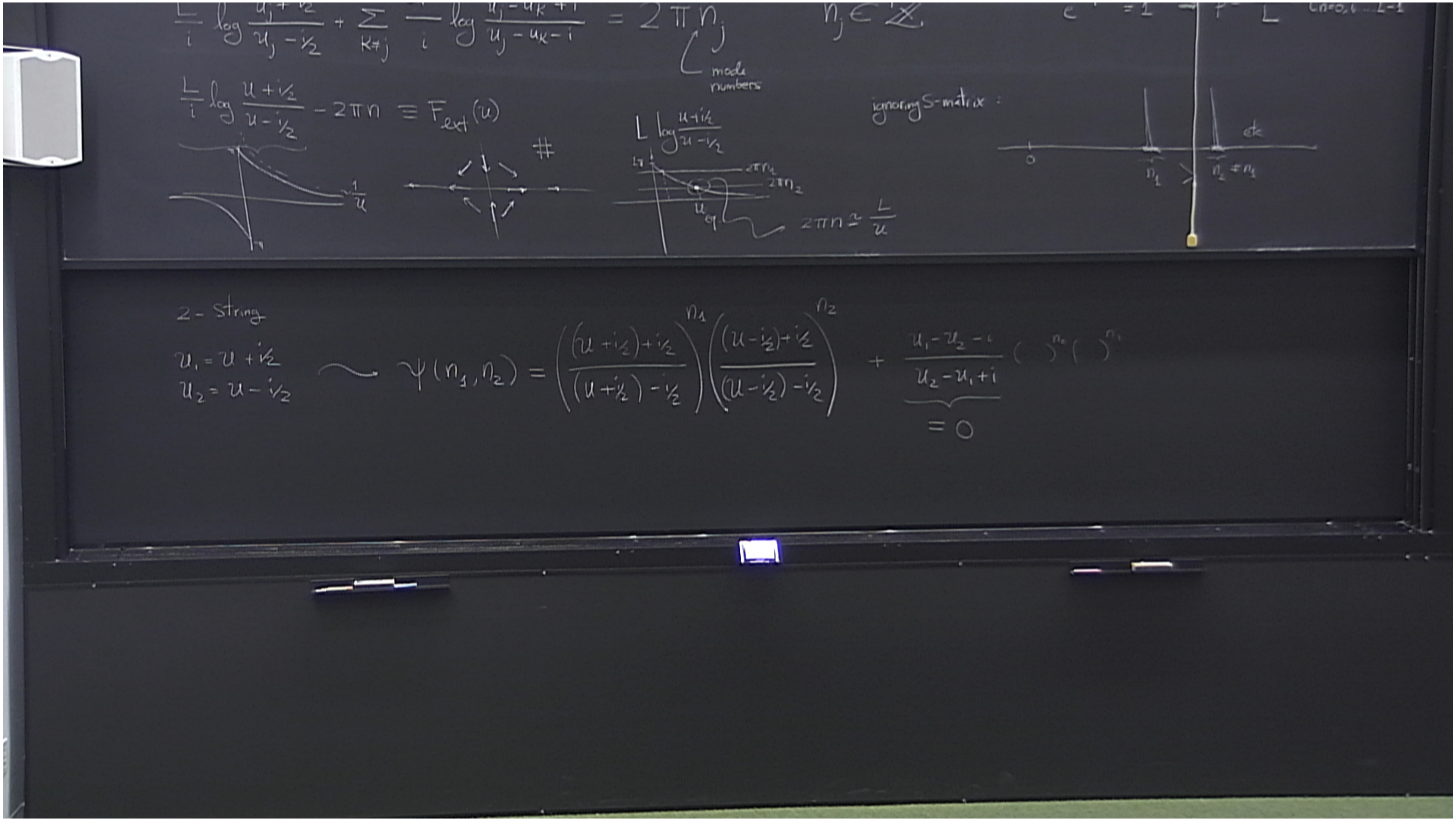


most particles w/ same mode numbers
etc
most $u_j$ have ≠ $n_j$
mostly real.
$N = O(1)$, $n_j = O(L) \Longrightarrow u_j \sim O(1)$
[had we chosen $n_j = O(1)$, $\Rightarrow u_j \sim L$
$u_1$ be the root w/ biggest imaginary part $u_1 = u + i\eta$, $\eta > 0$
$\to \infty$
We need a $u_2$ such that $\frac{u_1 - u_2 - i}{u_1 - u_2 + i} \to 0 \Longrightarrow u_2 \simeq u_1 -$

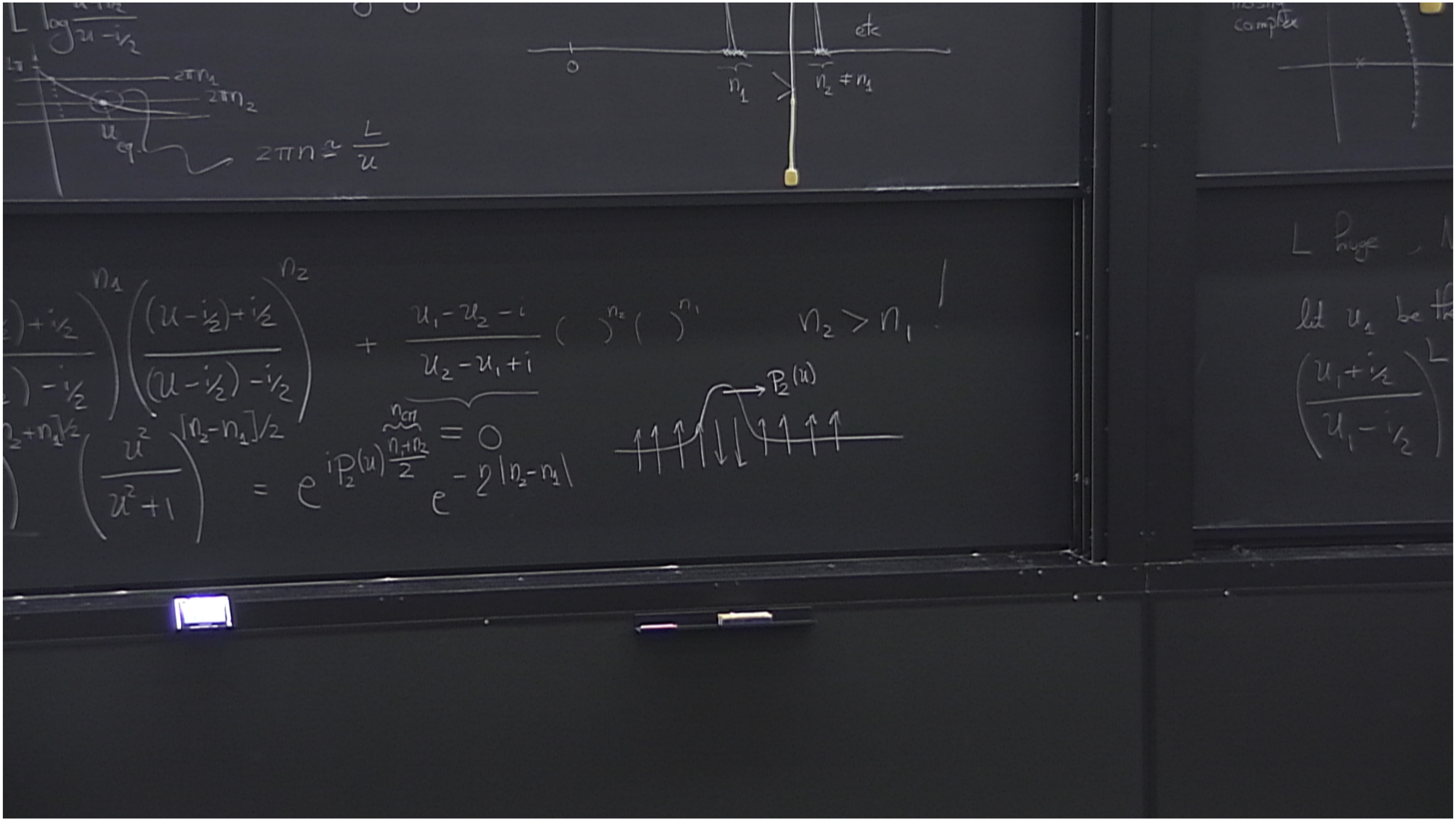

most particles w/ same mode numbers
most u_j have ≠ n_j
mostly real.
n_j = O(L) ⟹ u_j ~ O(1)
[Had we chosen n_j = O(1), ⟹ u_j ~ L]
w/ biggest imaginary part u_1 = u + iη , η > 0
We need a u_2 such that (u_1 − u_2 − i)/(u_1 − u_2 + i) → 0 ⟹ u_2 ≃ u_1 − i
Im(u_2) > 0
Im(u_2)
u_3 st. u_3 = u_2 − i

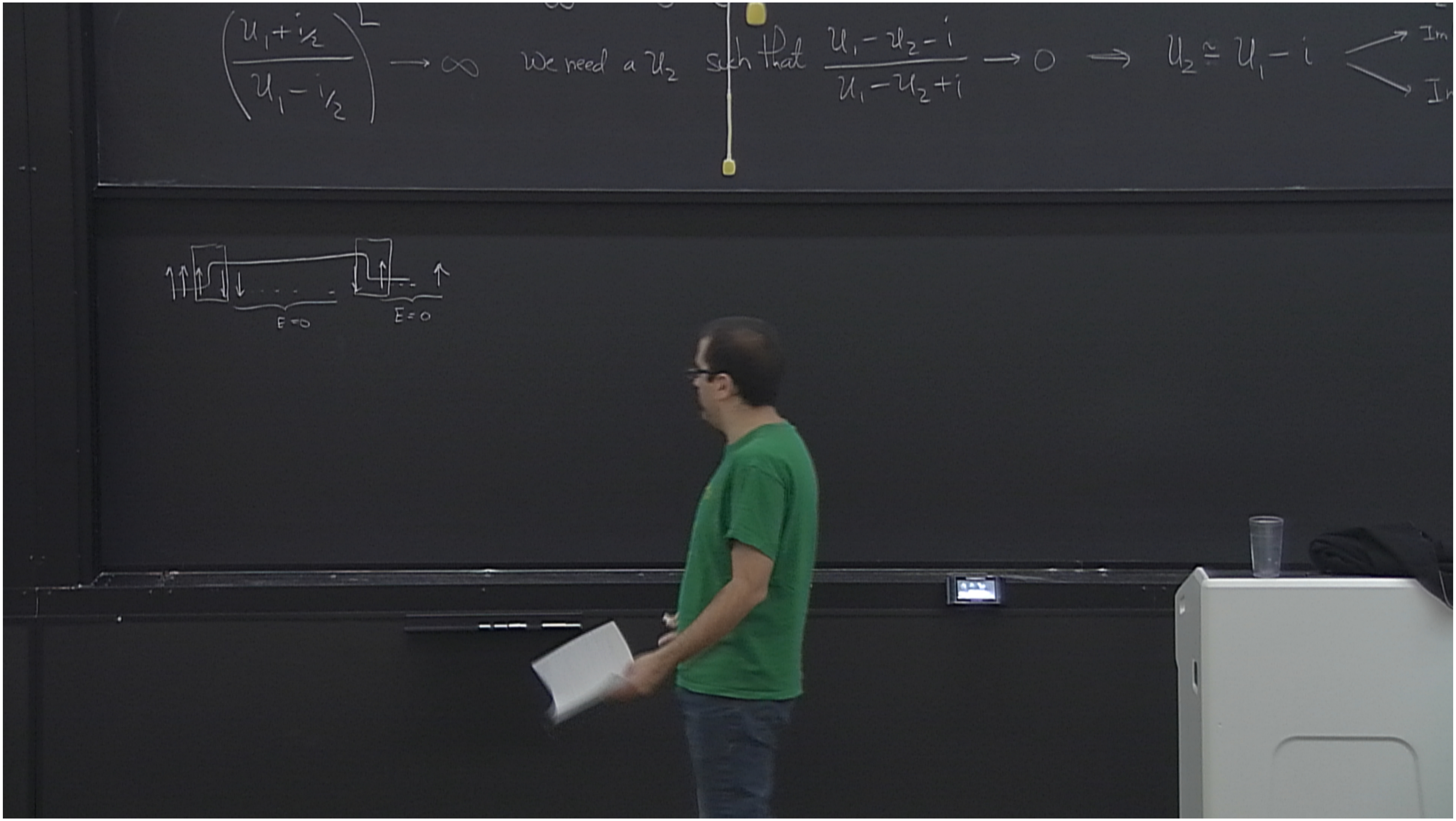

physical meaning of these arcs ?
d are they ? ) vs | etc ?
condensation of roots into cuts?! Is that the classical limit?
n-strings
even more straight
: with exponential precision !
n=4
2πn ≃ L/u
etc
n_2 ≠ n_1

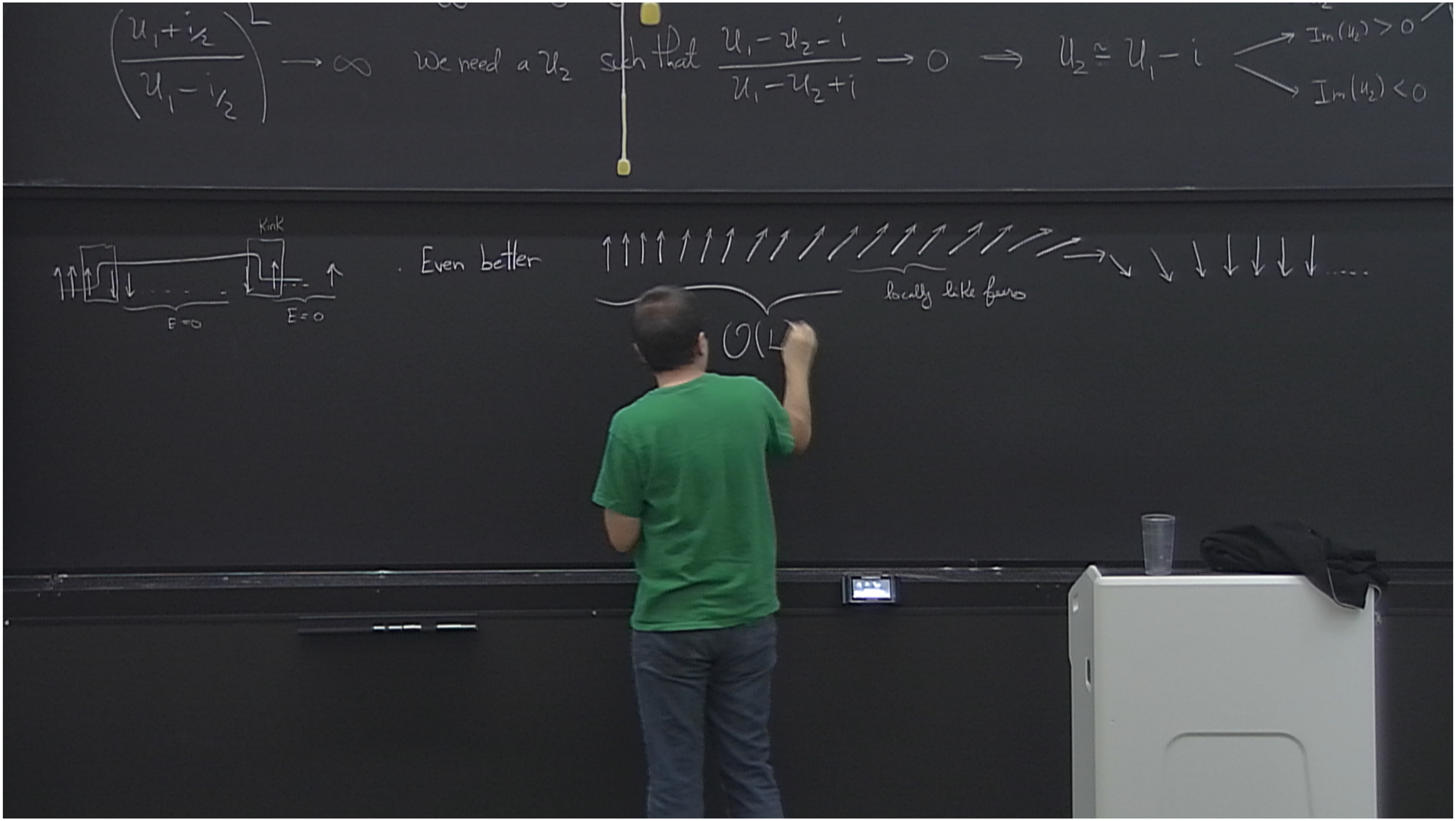

Important that u = O(1)
(⇐ n = O(L))
if
u = O(L)
((u + i/2)/(u − i/2))^L = e^(i L/u) =
3-string
2-string

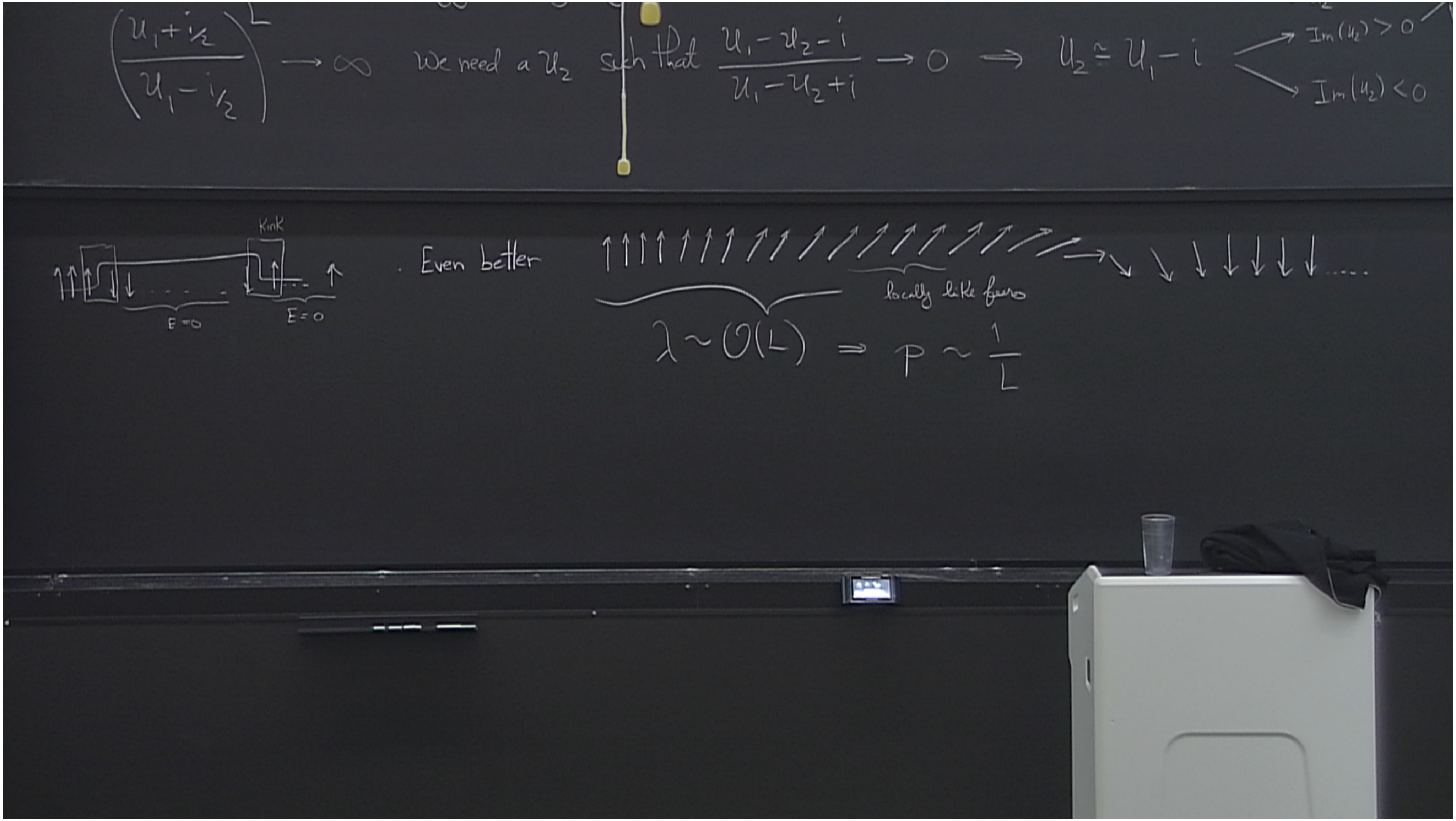


$\log \frac{u_j - u_k + i}{u_j - u_k - i} = 2\pi n_j$
$n_j \in \mathbb{Z}$
mode numbers
$\frac{L}{i} \log \frac{u + i/2}{u - i/2} - 2\pi n \equiv F_{ext}(u)$
$L \log \frac{u+i/2}{u-i/2}$
$2\pi n_1$
$2\pi n_2$
$u_q$
$2\pi n \simeq \frac{L}{u}$
ignoring S-matrix :
0
$n_1$
$n_2 \neq n_1$
etc
2 - String
$u_1 = u + i/2$
$u_2 = u - i/2$
$\psi(n_1, n_2) = \left(\frac{(u+i/2)+i/2}{(u+i/2)-i/2}\right)^{n_1} \left(\frac{(u-i/2)+i/2}{(u-i/2)-i/2}\right)^{n_2} + \frac{u_1 - u_2 - i}{u_2 - u_1 + i}$
$= 0$

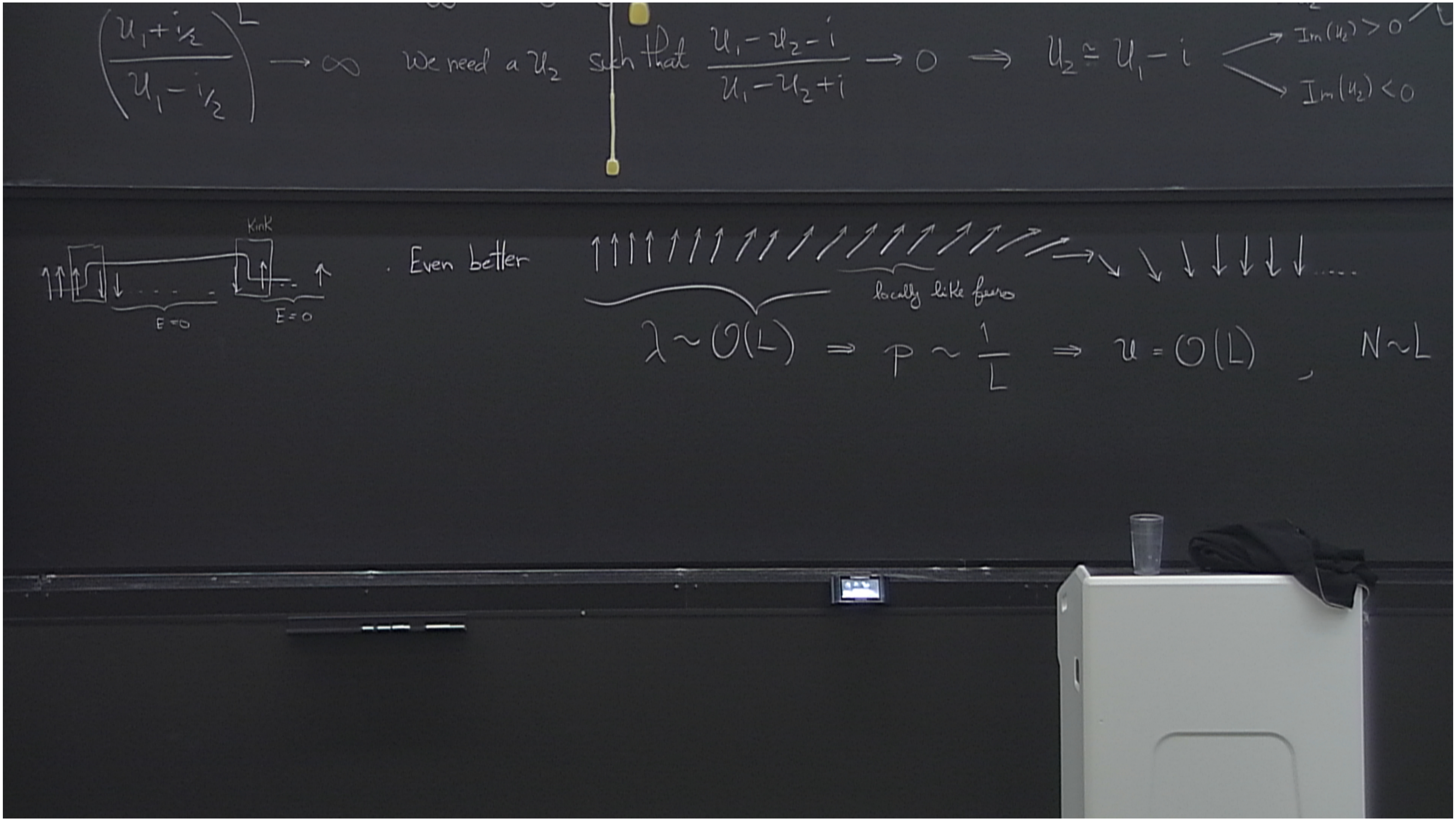

etc
complex
2πn ≈ L/u
n_2 ≠ n_1
L huge
n_2 > n_1
P_2(u)
= 0
let u_1 be th

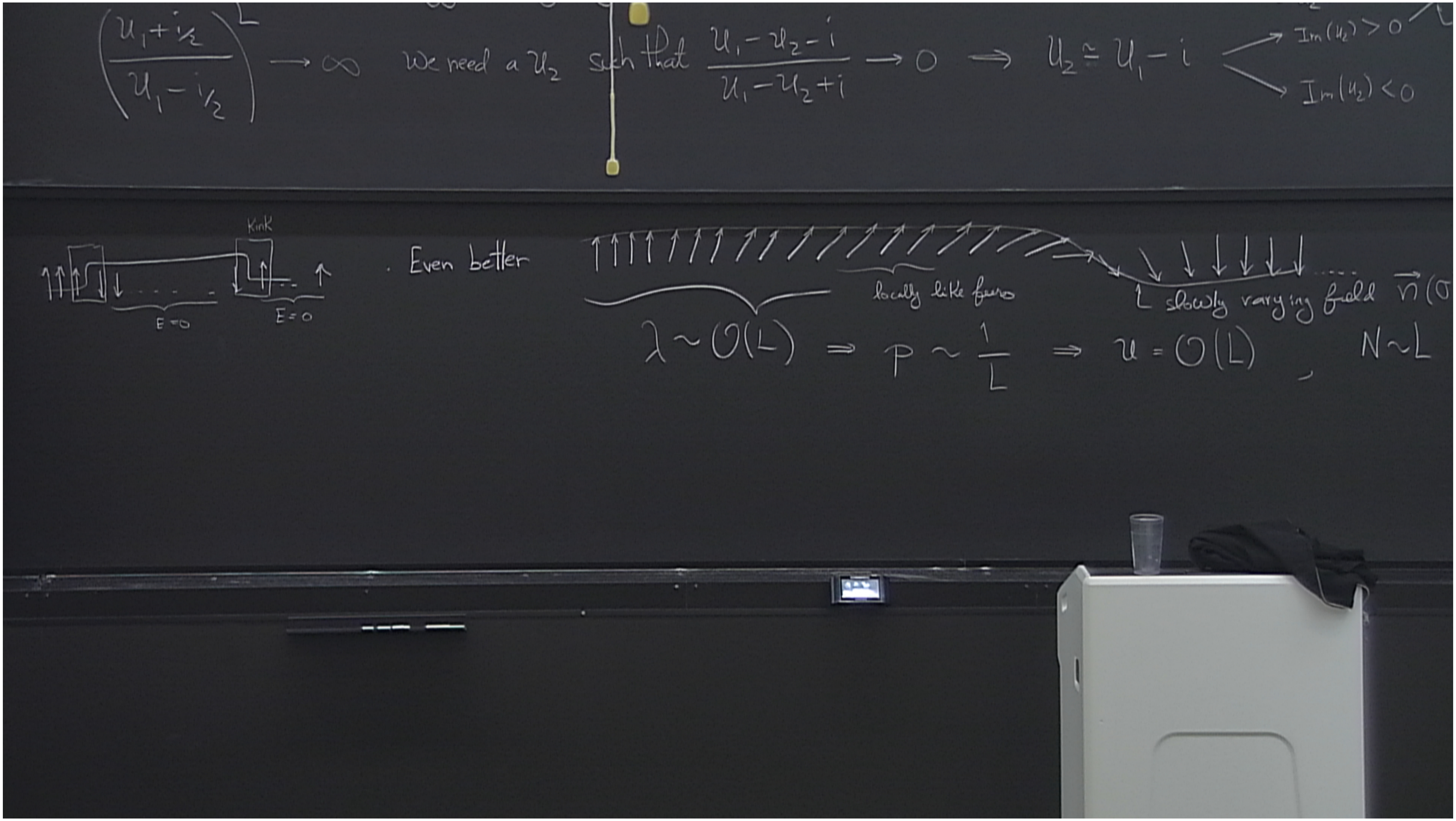

$\left(\frac{u_1+i/2}{u_1-i/2}\right)^L \to \infty$
We need a $u_2$ such that $\frac{u_1-u_2-i}{u_1-u_2+i} \to 0 \Rightarrow u_2 \simeq u_1 - i$
E = 0
E = 0


We need a u2 such that
Im(u2) > 0
Im(u2) < 0
Kink
E=0
E=0
Even better
locally like ferro

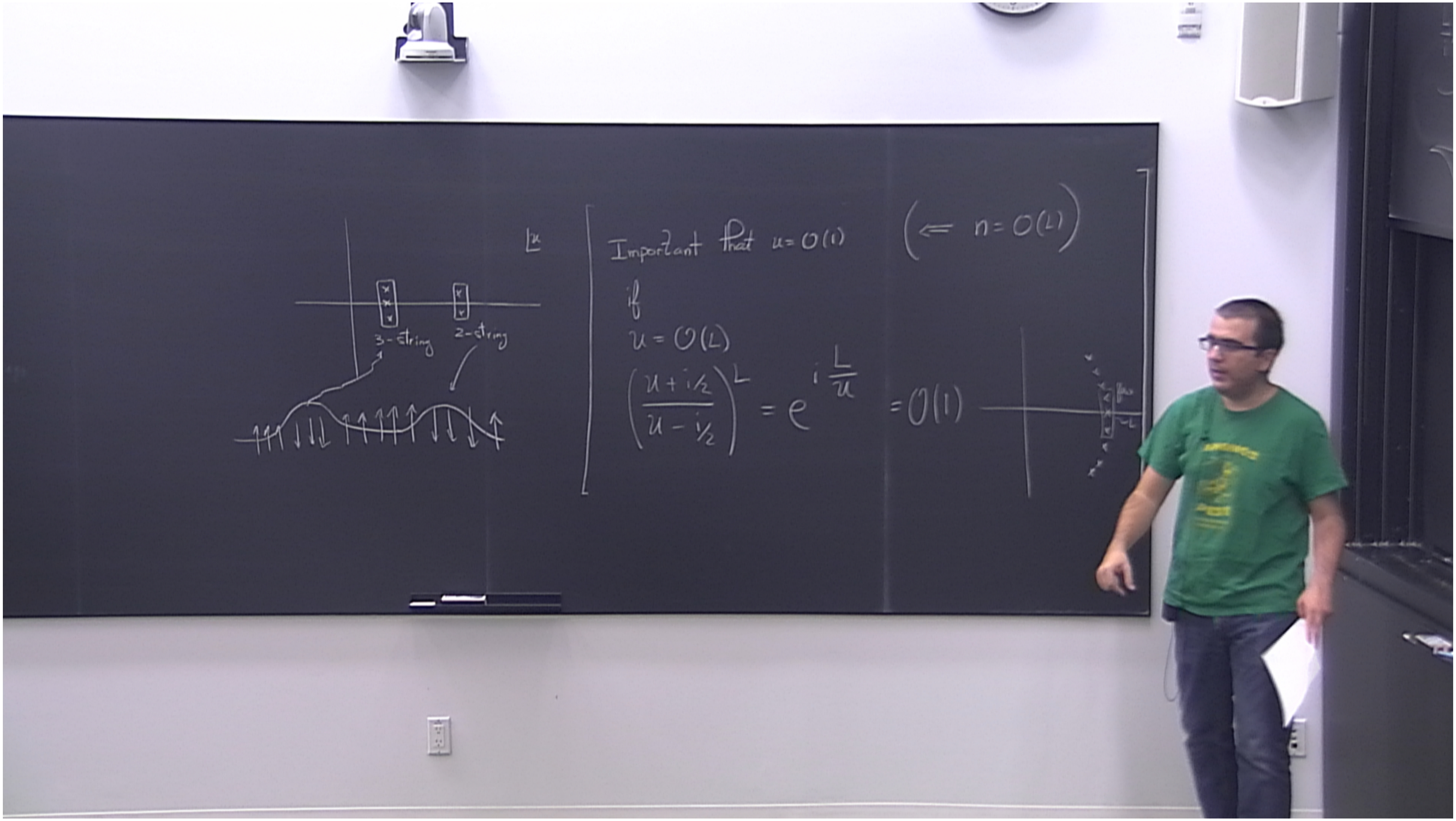


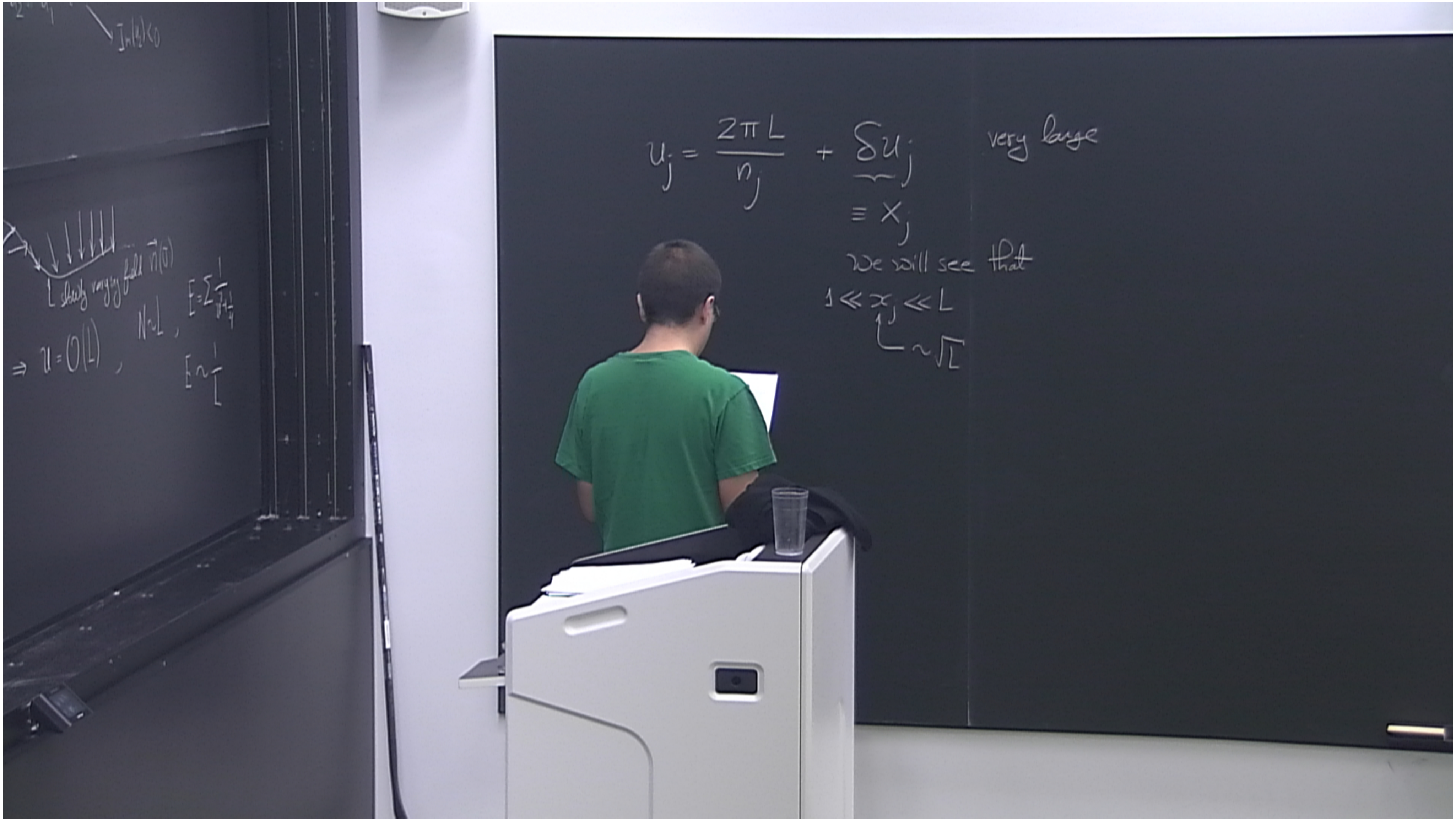
$\left(\frac{u_1+i/2}{u_1-i/2}\right)^L \to \infty$
We need a $u_2$ such that $\frac{u_1-u_2-i}{u_1-u_2+i} \to 0 \Rightarrow u_2 \simeq u_1 - i$
$\mathrm{Im}(u_2) > 0$
$\mathrm{Im}(u_2) < 0$
Kink
$E=0$
$E=0$
Even better
locally like ferro
$\lambda \sim O(L) \Rightarrow p \sim \frac{1}{L}$


$\left(\frac{u_1+i/2}{u_1-i/2}\right)^L \to \infty$
We need a $u_2$ such that $\frac{u_1-u_2-i}{u_1-u_2+i} \to 0 \Rightarrow u_2 \simeq u_1 - i$
$\mathrm{Im}(u_2) > 0$
$\mathrm{Im}(u_2) < 0$
Kink
E=0
E=0
. Even better
locally like ferro
$\lambda \sim O(L) \Rightarrow p \sim \frac{1}{L} \Rightarrow u = O(L)$
$N \sim L$

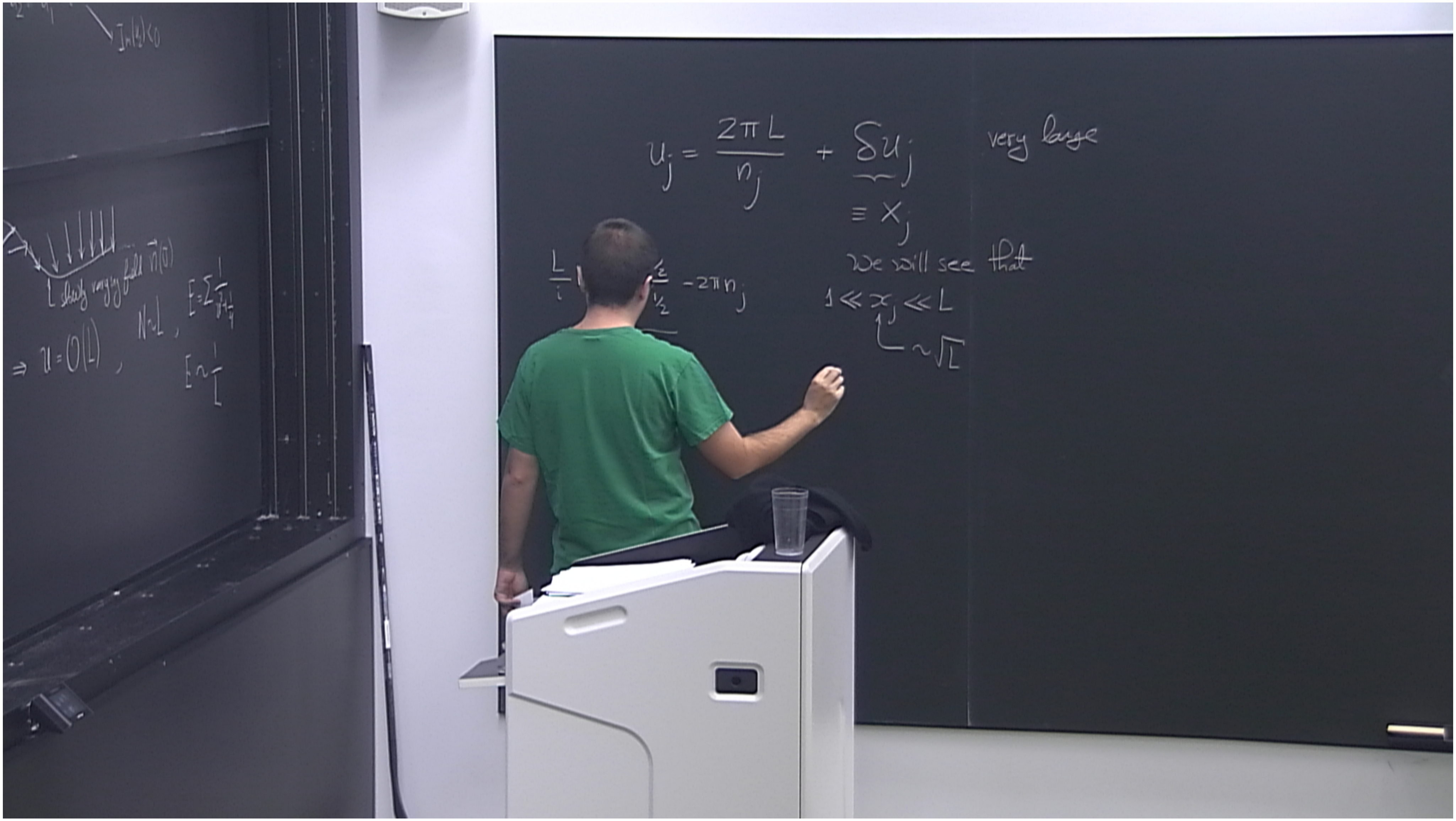


We need a $u_2$ such that $\frac{u_1 - u_2 - i}{u_1 - u_2 + i} \to 0 \Rightarrow u_2 \simeq u_1 - i$
$\left(\frac{u_1 + i/2}{u_1 - i/2}\right)^L \to \infty$
$\mathrm{Im}(u_2) > 0$
$\mathrm{Im}(u_2) < 0$
Kink
E = 0
E = 0
Even better
locally like ferro
slowly varying field $\vec{n}$
$\lambda \sim O(L) \Rightarrow p \sim \frac{1}{L} \Rightarrow u = O(L)$
$N \sim L$

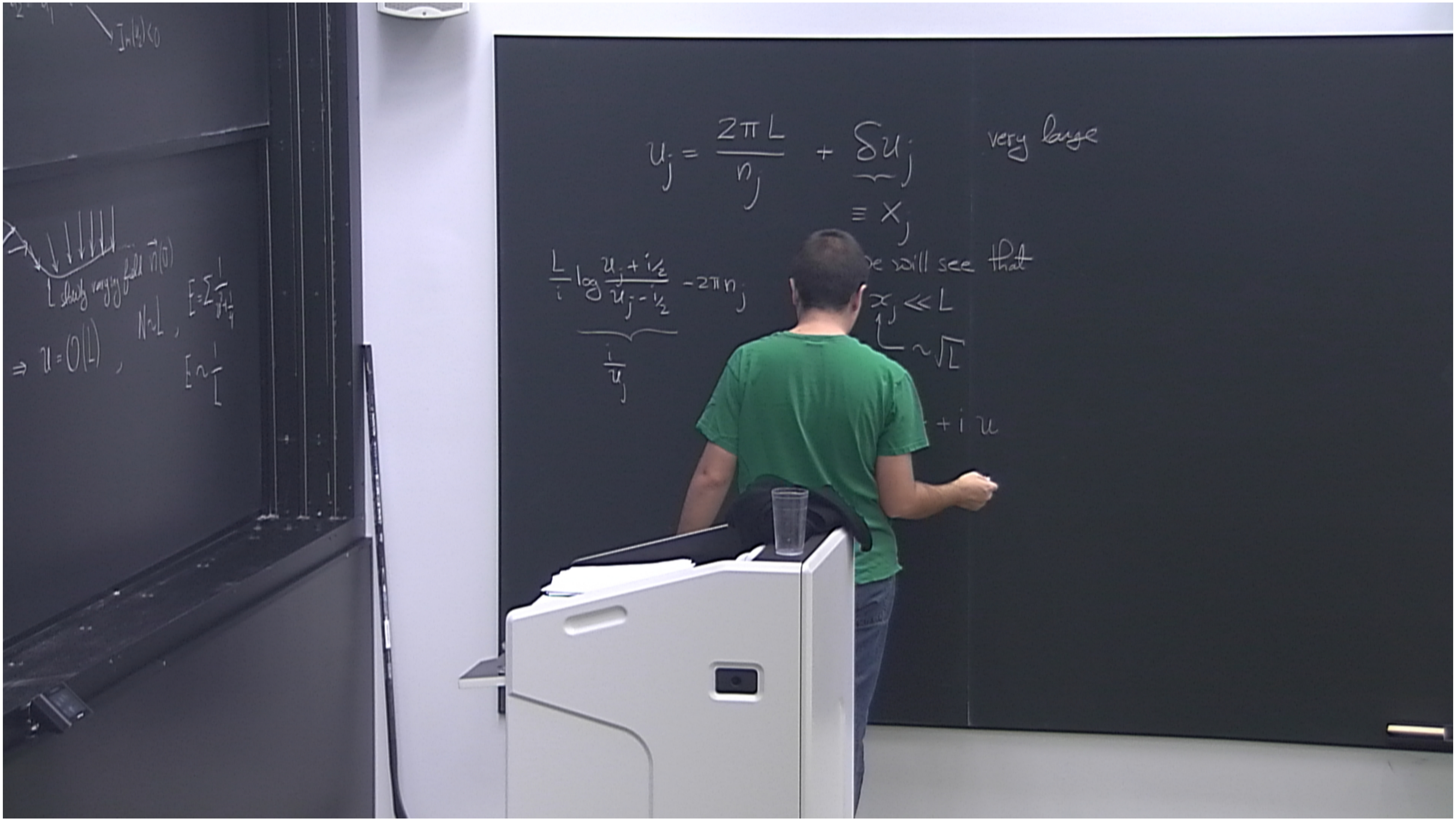

3-string
2-string
Important that u = O(1)
(⇐ n = O(L))
if
u = O(L)
((u + i/2)/(u − i/2))^L = e^(i L/u) = O(1)



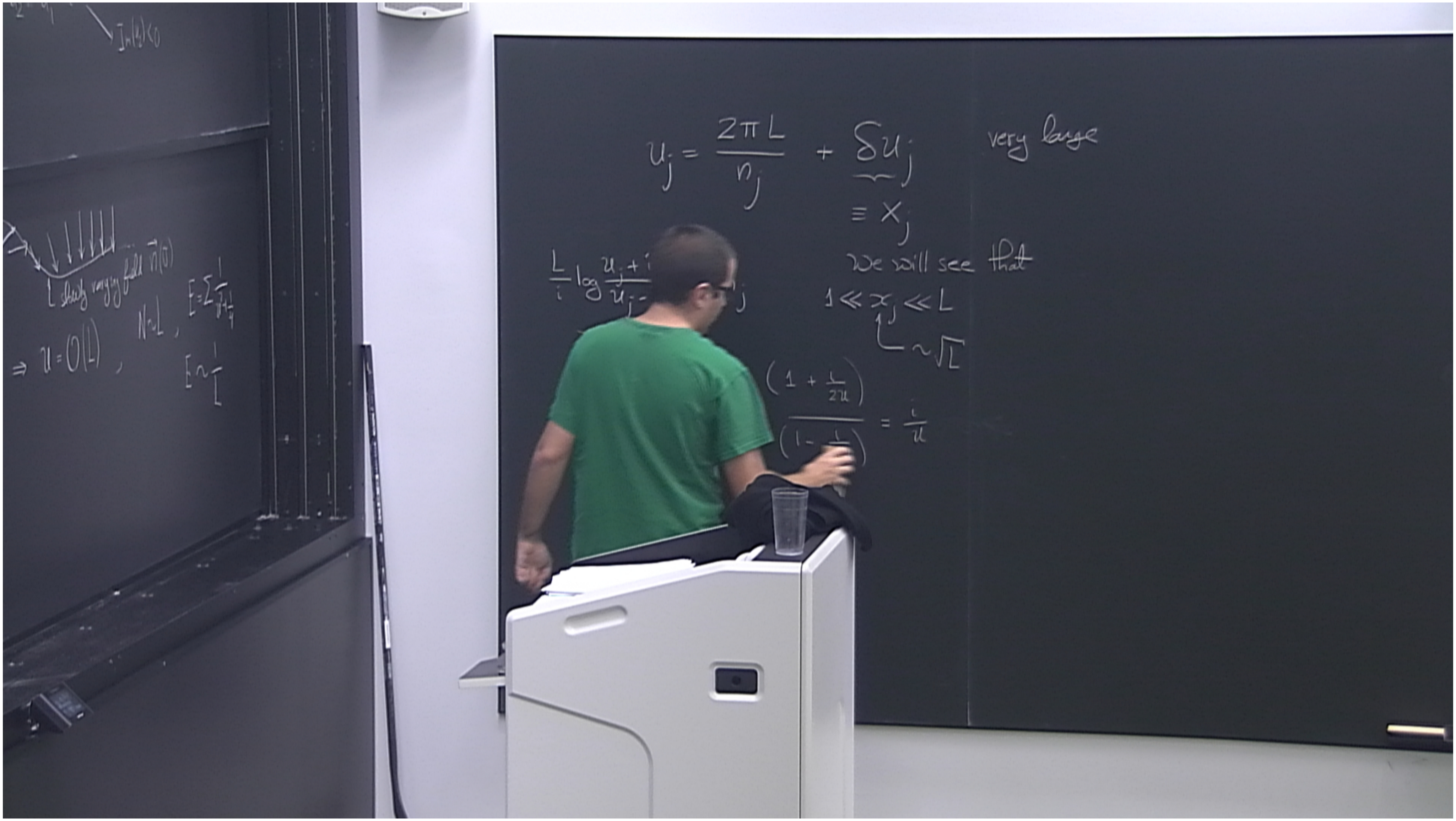
$u_j = \frac{2\pi L}{n_j} + \delta u_j$
very large
$\equiv x_j$
we will see that
$1 \ll x_j \ll L$
$\sim \sqrt{L}$



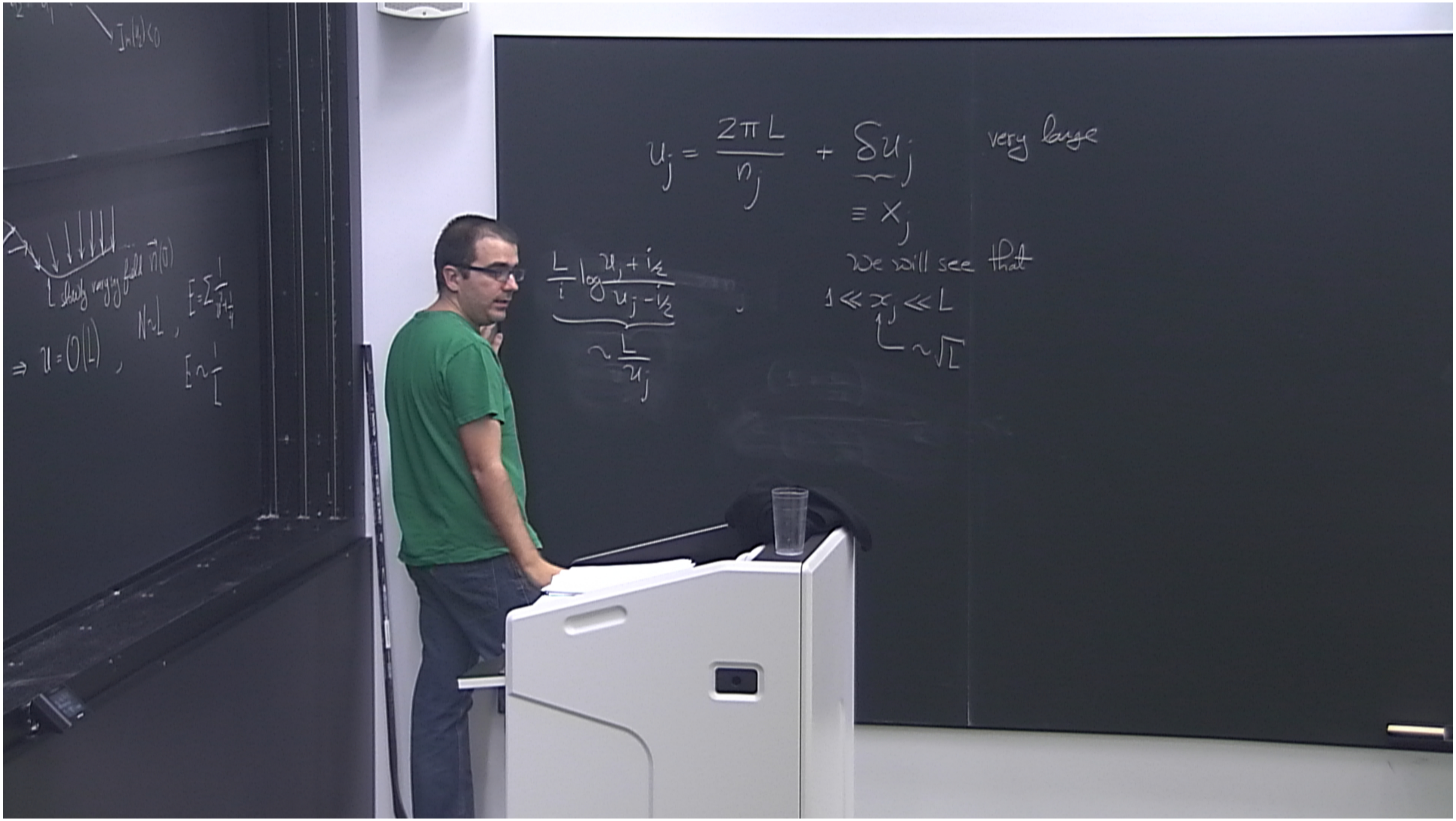
$u_j = \frac{2\pi L}{n_j} + \delta u_j$
very large
$\equiv x_j$
We will see that
$1 \ll x_j \ll L$
$\sim \sqrt{L}$
$-2\pi n_j$
slowly varying field $\vec{n}(0)$
$\Rightarrow u = O(L)$
$N \sim L$
$E \sim \frac{1}{L}$



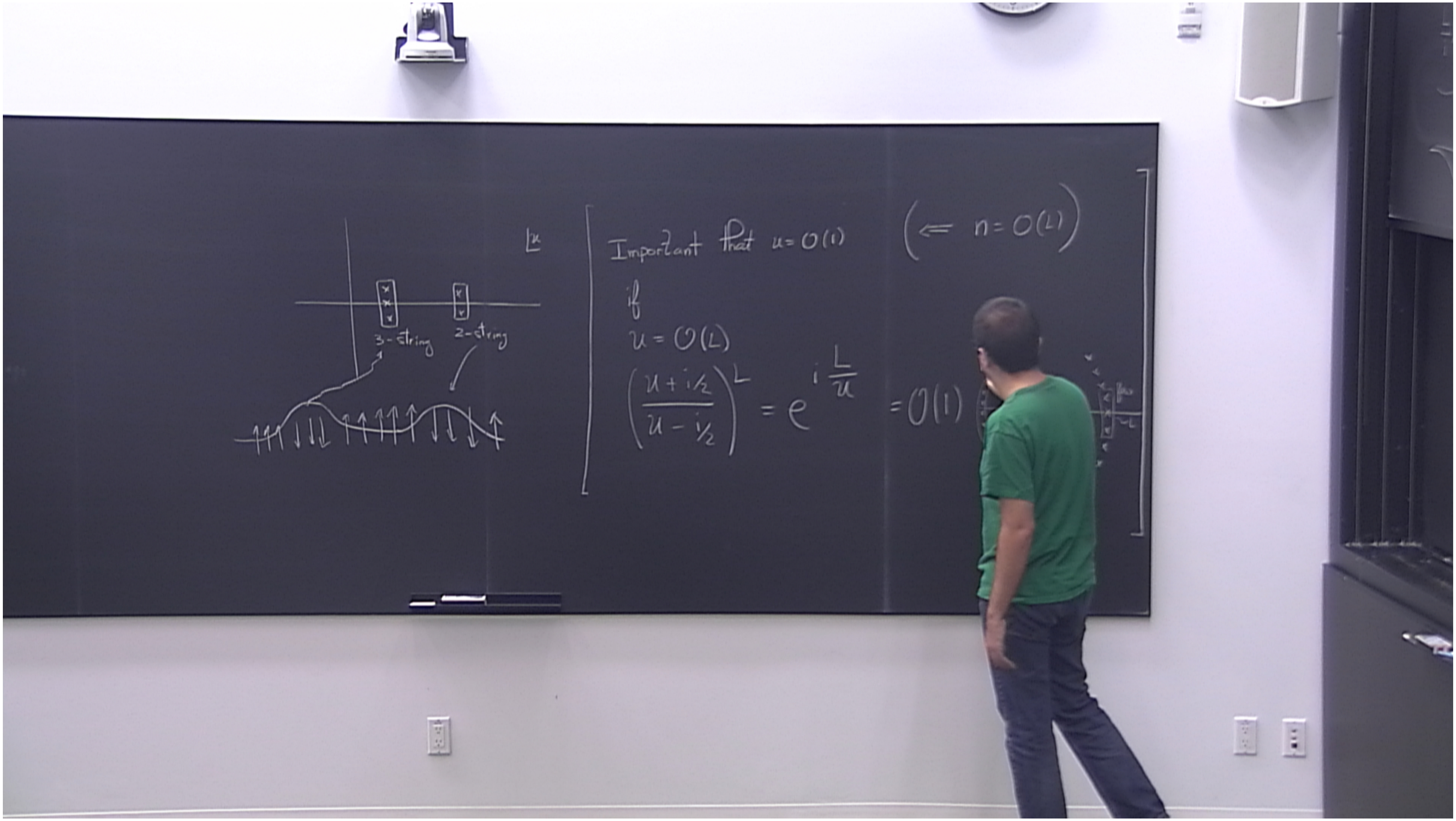
$u_j = \frac{2\pi L}{n_j} + \delta u_j$
very large
$\equiv x_j$
will see that
$x_j \ll L$
$\sim \sqrt{L}$
$\frac{L}{i} \log \frac{u_j + i/2}{u_j - i/2} - 2\pi n_j$
$\frac{i}{u_j}$
$\Rightarrow u = O(L)$
$N \sim L$
$E \sim \frac{1}{L}$

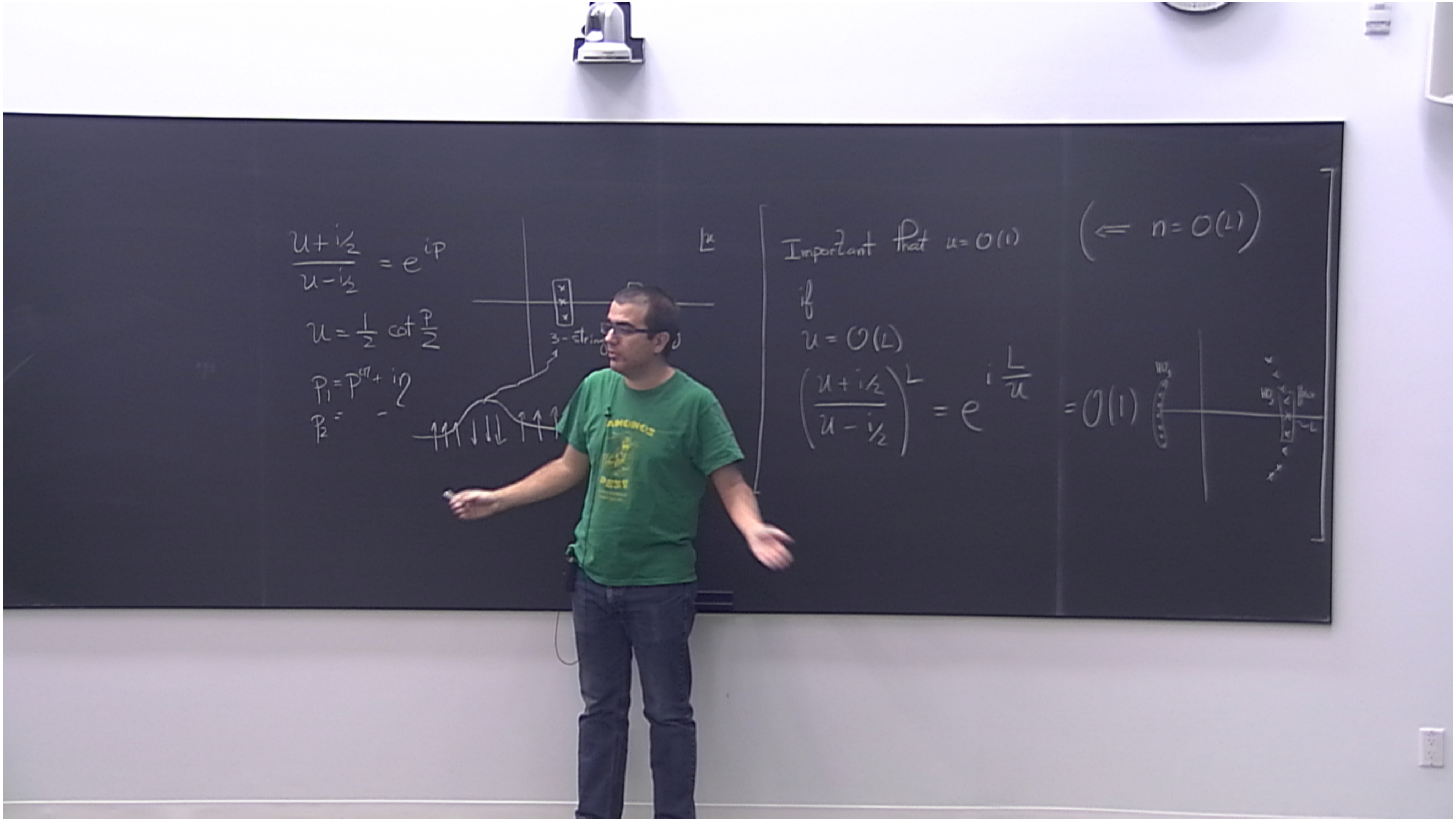


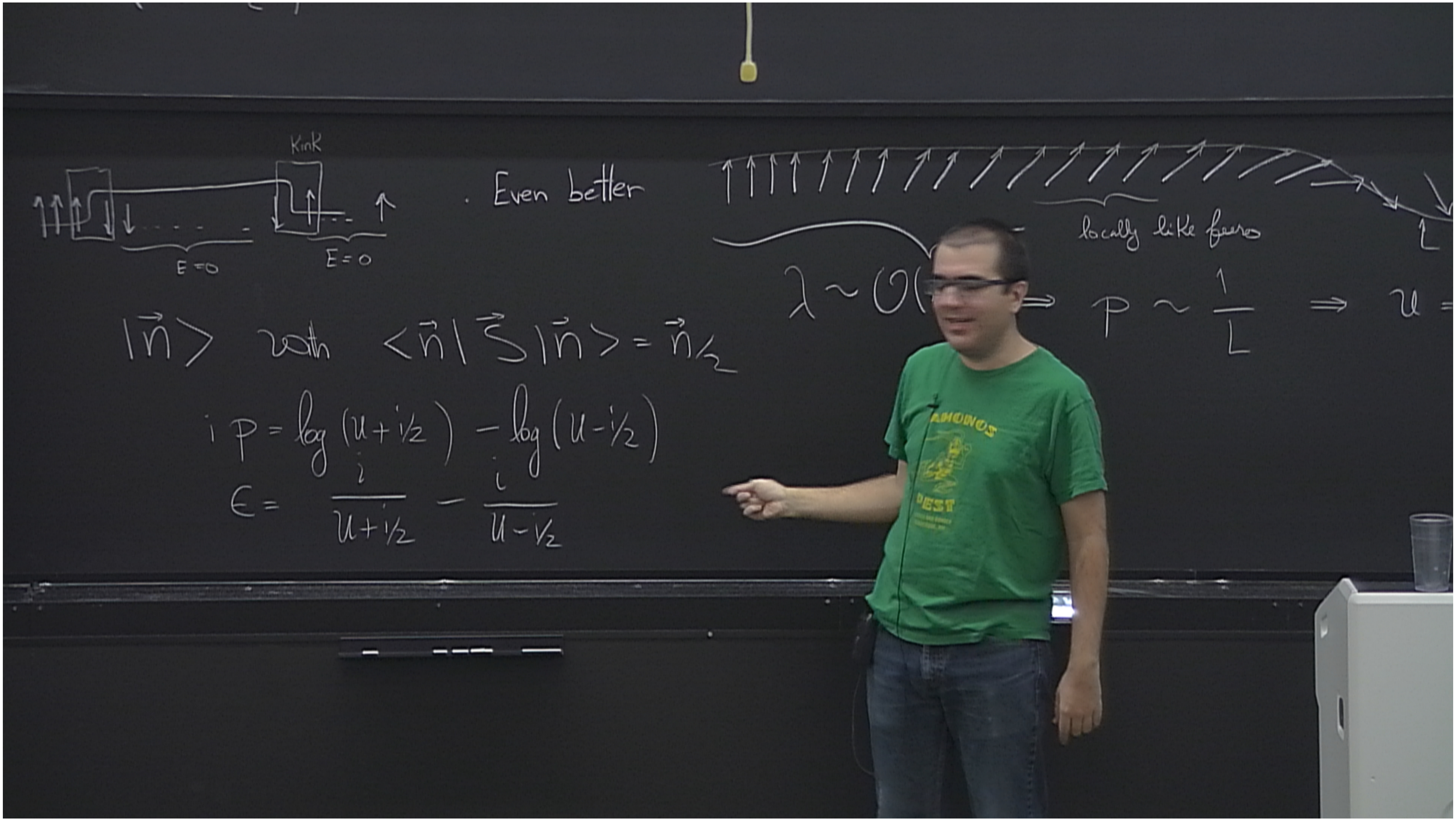
very large
We will see that



u_j = 2πL / n_j + δu_j
very large
≡ x_j
We will see that
1 ≪ x_j ≪ L
~ √L
L/i log (u_j + i/2)/(u_j − i/2)
~ L/u_j
slowly varying field
N~L
E~1/L
⇒ u = O(L)


Important that u = O(1)
(⇐ n = O(L))
if
u = O(L)
3-string
2-string
$\left(\frac{u+i/2}{u-i/2}\right)^L = e^{i\frac{L}{u}}$
= O(1)


(u + i/2)/(u − i/2) = e^{ip}
u = 1/2 cot p/2
Important that u = O(1)
(⇐ n = O(L))
if
u = O(L)
((u + i/2)/(u − i/2))^L = e^{i L/u}
= O(1)


Kink
E = 0
E = 0
Even better
locally like ferro
L
$\lambda \sim O($
$\Rightarrow p \sim \frac{1}{L} \Rightarrow u =$
$|\vec{n}\rangle$ with $\langle \vec{n}|\vec{S}|\vec{n}\rangle = \vec{n}/2$
$i\,p = \log(u + i/2) - \log(u - i/2)$
$E = \frac{i}{u+i/2} - \frac{i}{u-i/2}$