Title: Quantum Matter Lecture (230406)

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Collection: Quantum Matter (2022/2023)

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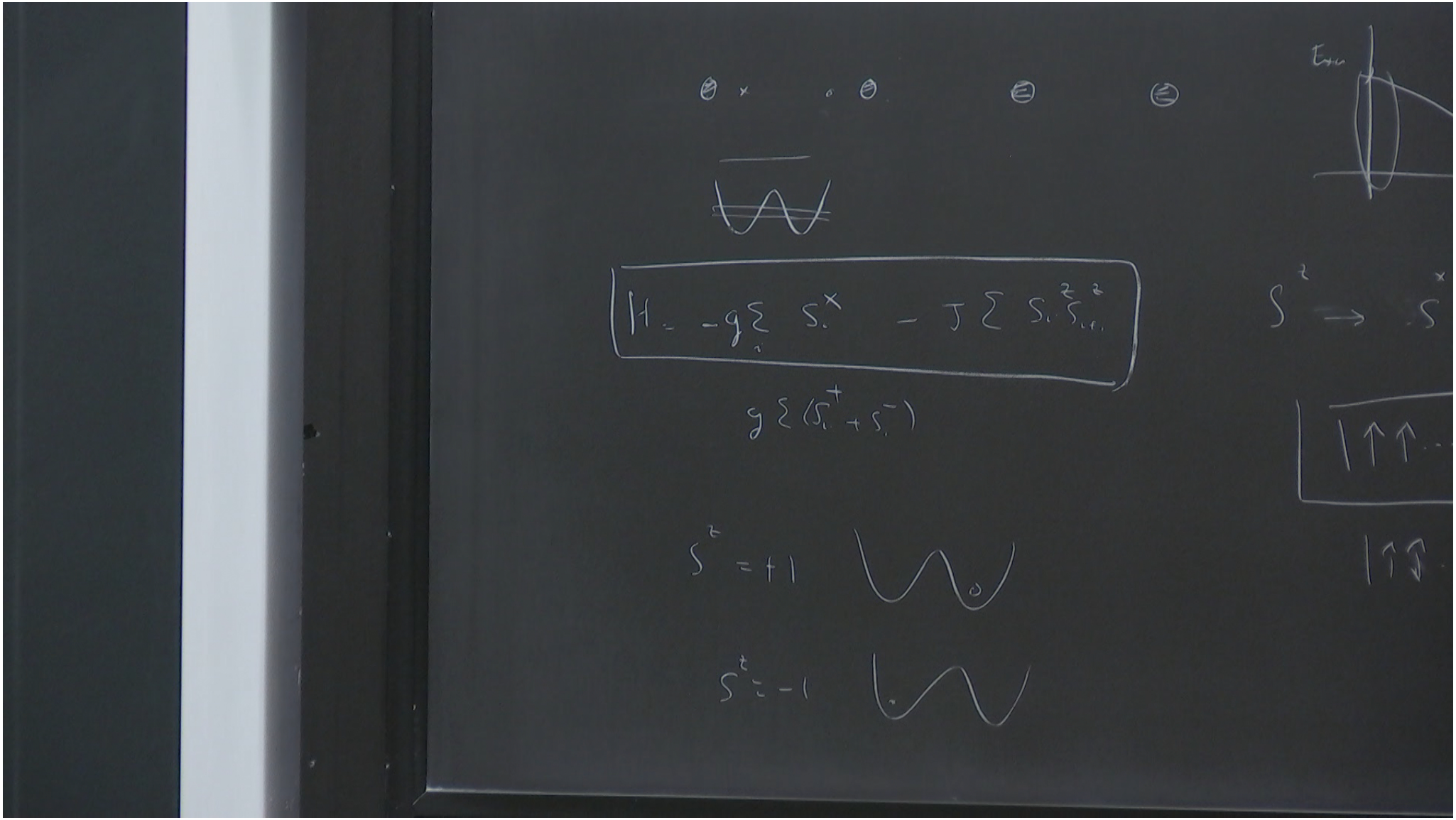
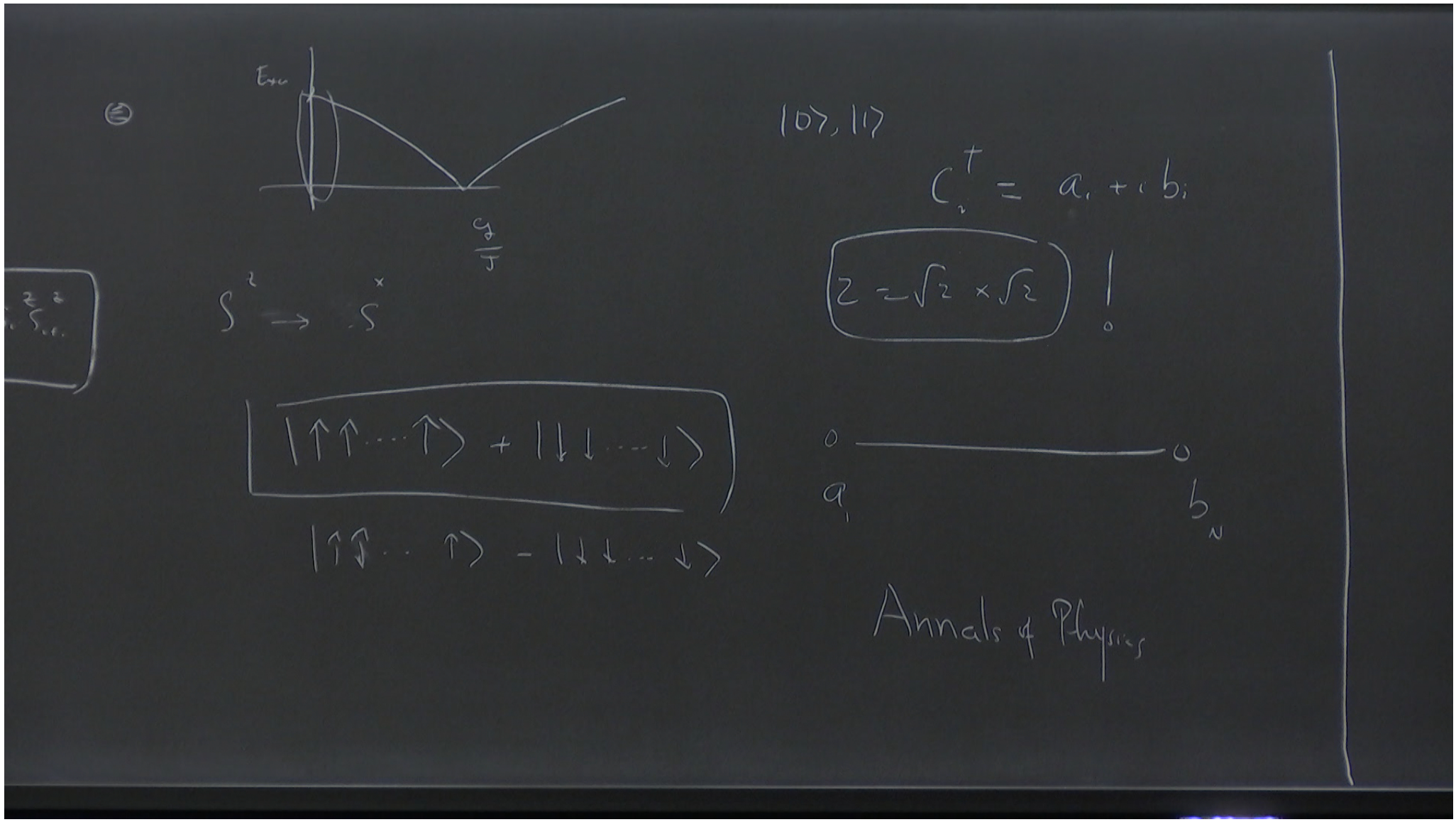
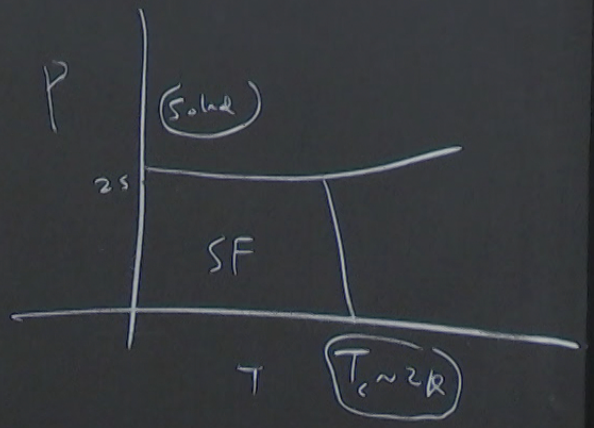

$H = -g\sum_i S_i^x - J\sum S_i^z S_{i+1}^z$
$g\sum(S_i^+ + S_i^-)$
$S^z = +1$
$S^z = -1$
$S^z \to S^x$
$|\uparrow\uparrow\ldots$
$|\uparrow\downarrow$


E_{exc}
J_2/J
$S^z \to S^x$
$|\uparrow\uparrow\uparrow\cdots\uparrow\rangle + |\downarrow\downarrow\downarrow\cdots\downarrow\rangle$
$|\uparrow\downarrow\uparrow\cdots\uparrow\rangle - |\downarrow\uparrow\downarrow\cdots\downarrow\rangle$
$|0\rangle, |1\rangle$
$c_i^\dagger = a_i + i b_i$
$z = \sqrt{2} \times \sqrt{2}$!
a_1
b_N
Annals of Physics

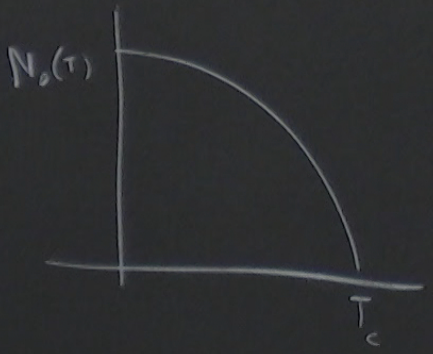
1924

BEC

$$N = \sum_{k} \frac{1}{1 - e^{\beta(\epsilon_k - \mu)}}$$



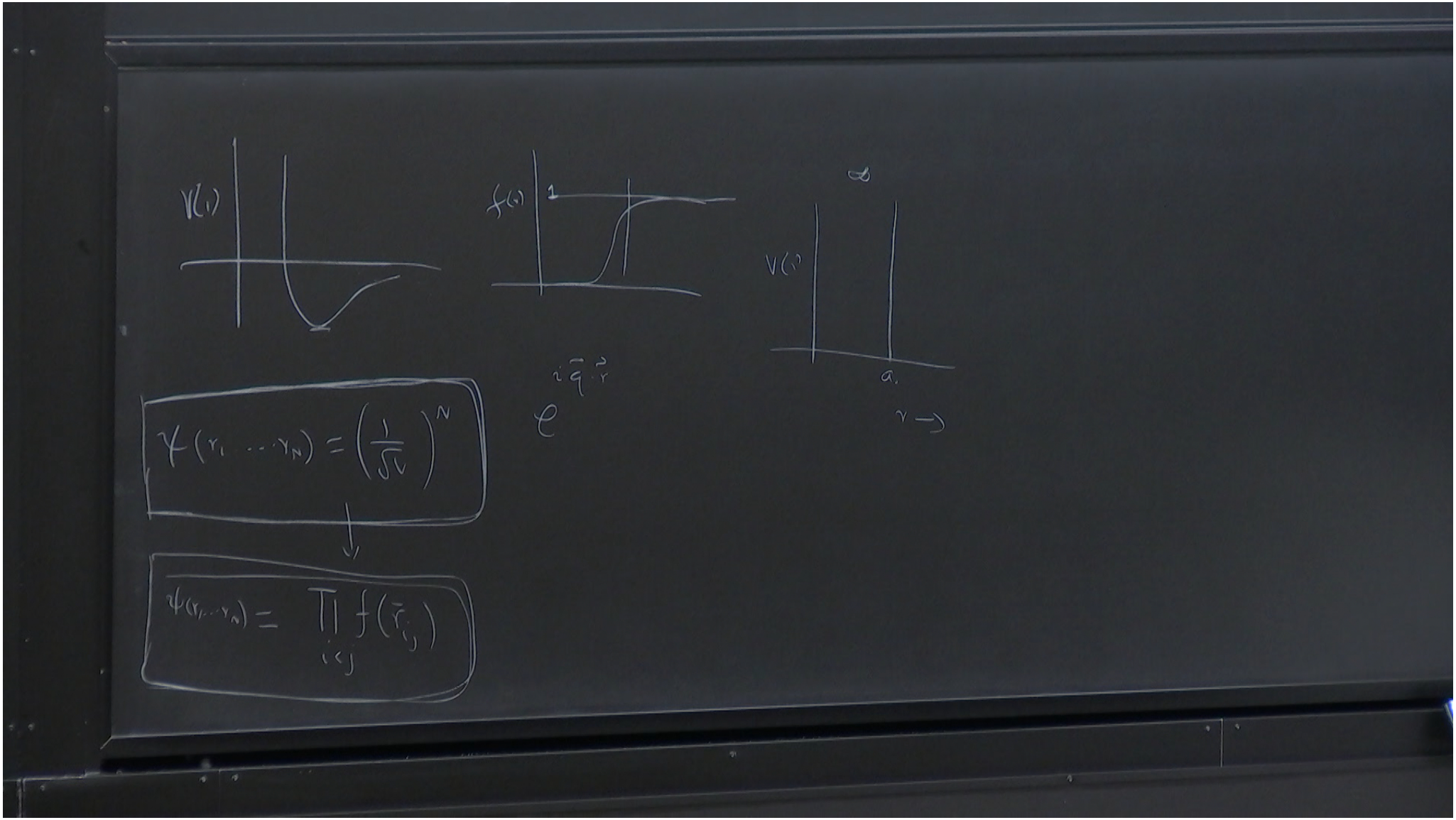
$$= N_0(T) + \sum_{k \neq 0} \frac{1}{1 - e^{\beta(\epsilon_k - \mu)}}$$

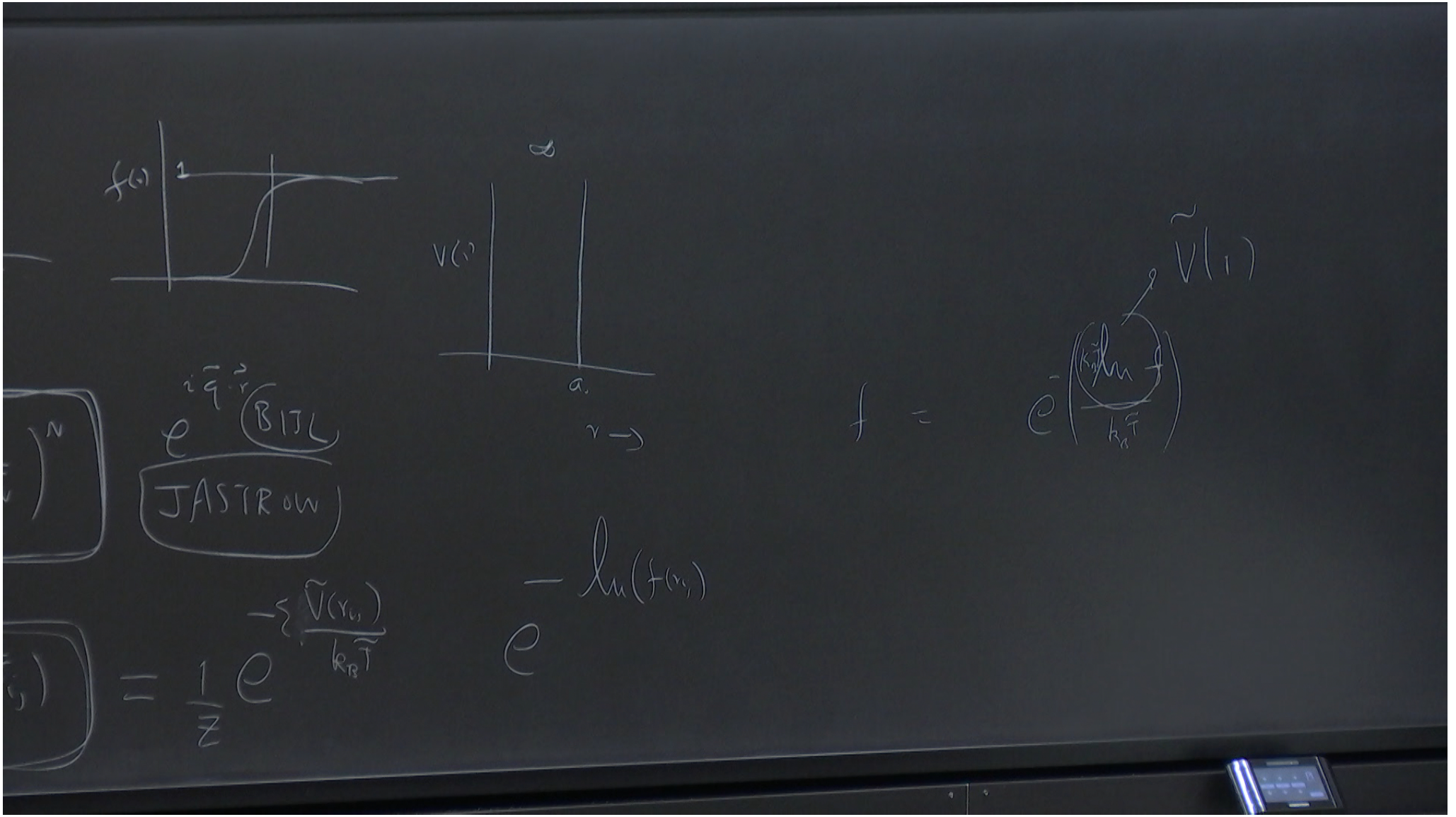


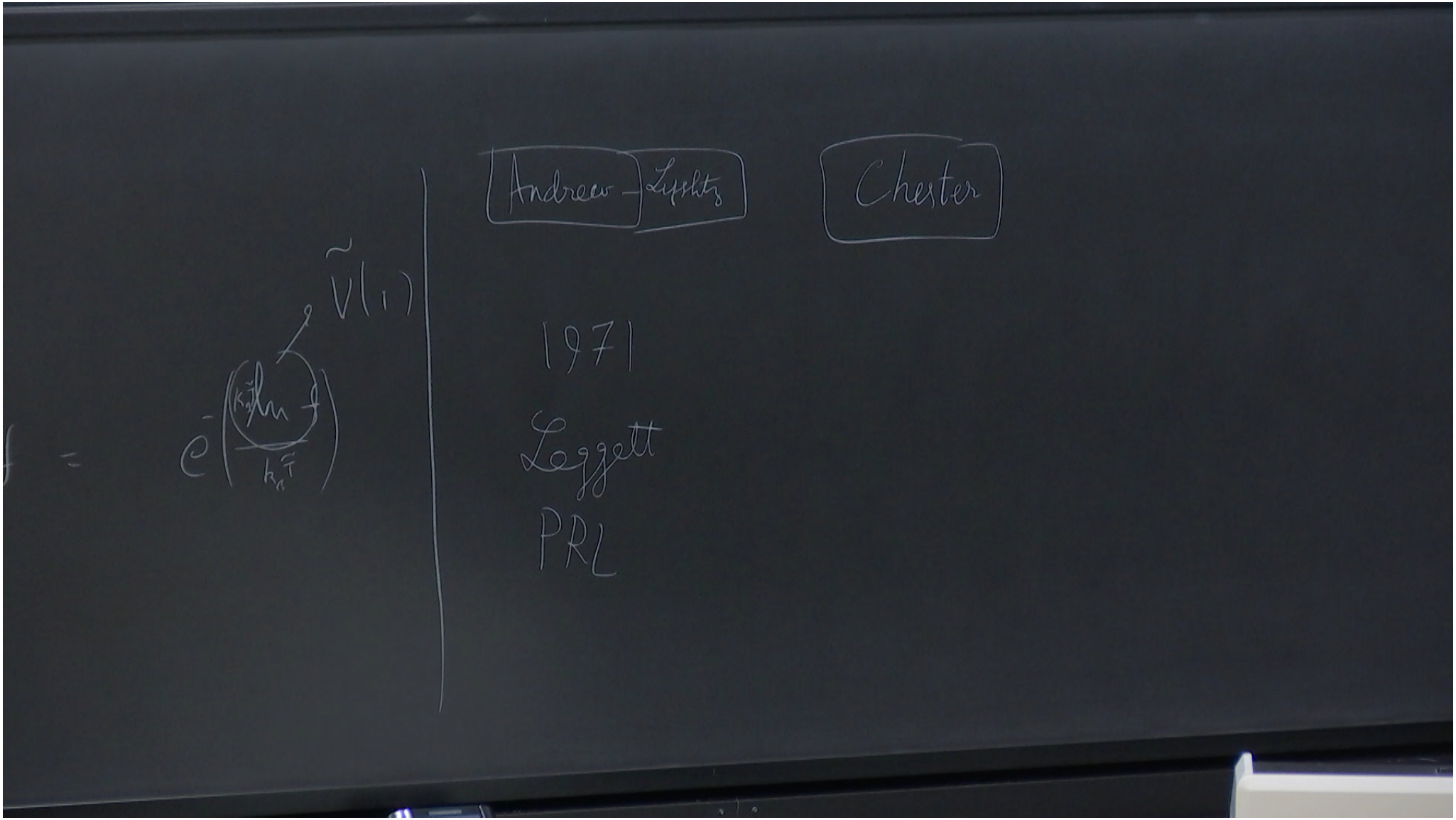
F. London

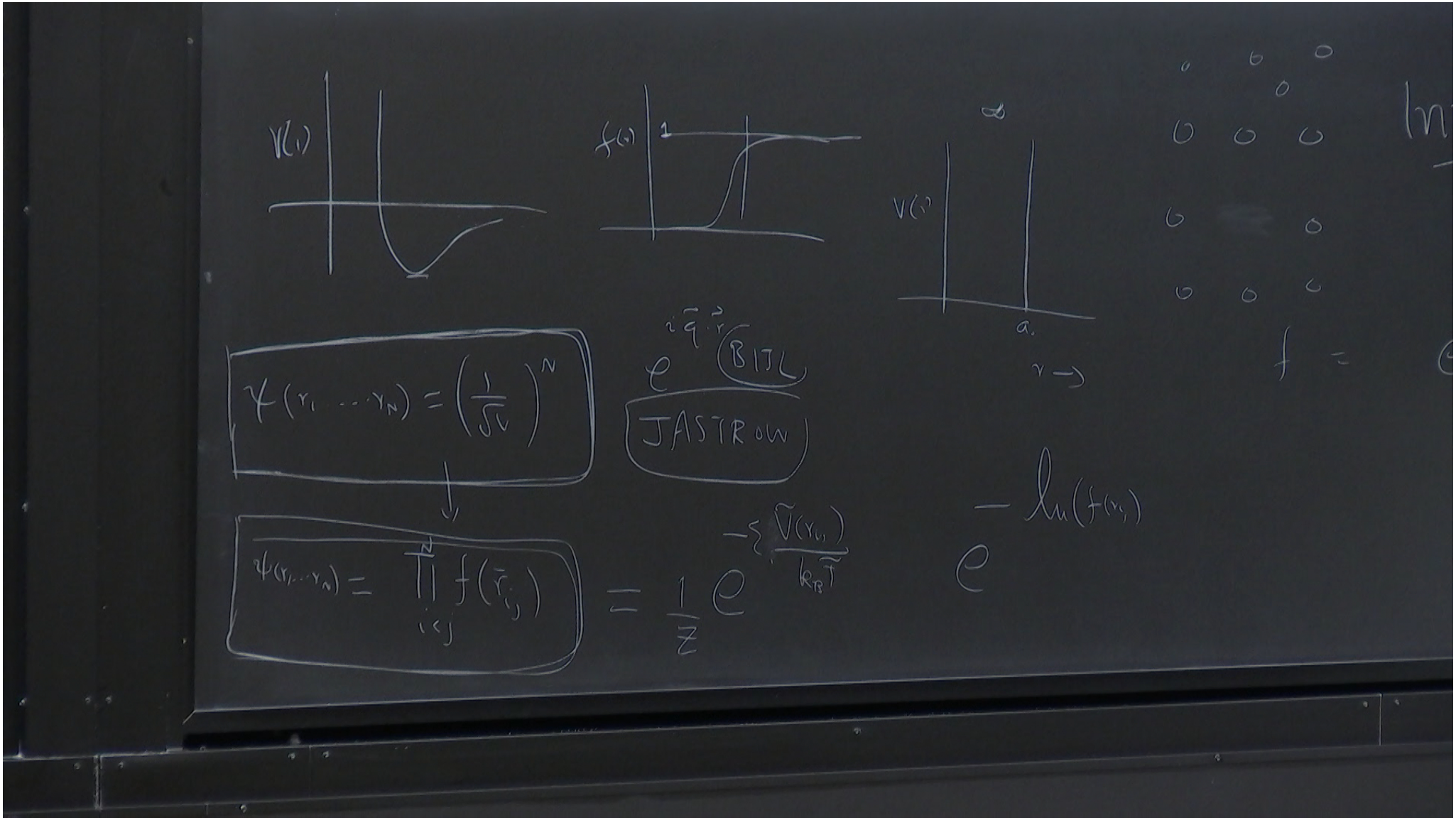
$$k_B T_c = \frac{2\pi\hbar^2}{m} \left(\frac{n}{g_{3/2}(1)} \right)^{2/3}$$

$T_c \sim 3.1^\circ K$ $2^\circ K$


V(r)
f(r)
1
V(r)
∞
a
r →
$e^{i\vec{q}\cdot\vec{r}}$
$\psi(r_1 \cdots r_N) = \left(\frac{1}{\sqrt{V}}\right)^N$
$\psi(r_1 \cdots r_N) = \prod_{i<j} f(\vec{r}_{ij})$


f(r)
1
V(r)
a
r →
BIJL
JASTROW
N
$e^{i\vec{q}\cdot\vec{r}}$
$\tilde{V}(r)$
$f = e^{-\left(\frac{\tilde{V}(r_{ij})}{k_B\tilde{T}} - \ln f\right)}$
$= \frac{1}{Z} e^{-\left\{\frac{\tilde{V}(r_{ij})}{k_B\tilde{T}} - \ln(f(r_{ij}))\right\}}$


Andreev – Lifshitz
Chester
1971
Leggett
PRL


V(r)
f(r)
1
V(r)
a
r →
BIJL
JASTROW
$\Psi(r_1 \dots r_N) = \left(\frac{1}{\sqrt{\Omega}}\right)^N$
$\psi(r_1 \dots r_N) = \prod_{i<j} f(r_{ij}) = \frac{1}{Z} e^{-\{\frac{\tilde{V}(r_{ij})}{k_B \tilde{T}}}$
$e^{-\ln(f(r_{ij}))}$