Title: An Unconventional Classification of Multipartiteness + Inflation Techniques for Causal Inference for Quantum Networks

Date: Oct 30, 2018 03:30 PM

URL: http://pirsa.org/18100102

Abstract: <p>What does it mean for quantum state to be genuinely fully multipartite? Some would say, whenever the state cannot be decomposed as a mixture of states each of which has no entanglement across some partition. I'll argue that this partition-centric thinking is ill-suited for the task of assessing the connectivity of the network required to realize the state. I'll introduce a network-centric perspective for classifying multipartite entanglement, and it's natural device-independent counterpart, namely a network-centric perspective for classifying multipartite nonclassicality of correlations. Time permitting, we can then explore semidefinite programming (SDP) algorithms for convex optimization over k-partite-entangled states and k-partite-nonlocal correlations relative to the network-centric classification. Joint work with Denis Rosset and others. We will compare the new quantum-inflation techniques to the classical inflation of arXiv:1609.00672. I'll share a few results made possible by these SDPs, while being openly critical about some disappointing apparent limitations.</p>

Multipartite Entanglement & Nonclassical Correlations:
Network-Perspectives & Quantum Inflation

$$|\Psi_{AB}\rangle = |\Psi_A\rangle \otimes |\Psi_B\rangle$$

$$\rho^{SEP}_{AB} = \sum_i w_i |\Psi_{A_i}\rangle\langle\Psi_{A_i}| \otimes |\Psi_{B_i}\rangle\langle\Psi_{B_i}|$$

$$\rho \in \rho^{SEP}$$

Nonclassical Correlations:

tum Inflation

$|\psi_B\rangle$

$\otimes |\psi_{B_i}\rangle\langle\psi_{B_i}|$

$$\rho_{AB\perp C} = \sum_i |\psi_{AB_i}\rangle\langle\psi_{AB_i}| \otimes |\psi_{C_i}\rangle\langle\psi_{C_i}|$$

$$\rho = w_1 \rho_{AB\perp C} + w_2 \rho_{AC\perp B} + w_3 \rho_{BC\perp A}$$

$$p(ab|xy) = \sum_{\lambda} p(\lambda)\, p(a|x\lambda)\, p(b|y\lambda)$$

$$p(abc|xyz) = \sum_{\lambda} p(\lambda)\, p(a|x\lambda)\, p(b|y\lambda)\, p(c|z\lambda)$$

$$p(abc|xyz) = \sum_{\lambda} p_Q(ab|xy\lambda)\, p(c|z\lambda)$$

$$= w_1\, P_{AB\perp C}(abc|xyz) + w_2\, P_{AC\perp B}(\ldots) + w_3\, P_{BC\perp A}(\ldots)$$

$$\ldots(a|x\lambda)\, p(b|y\lambda)$$

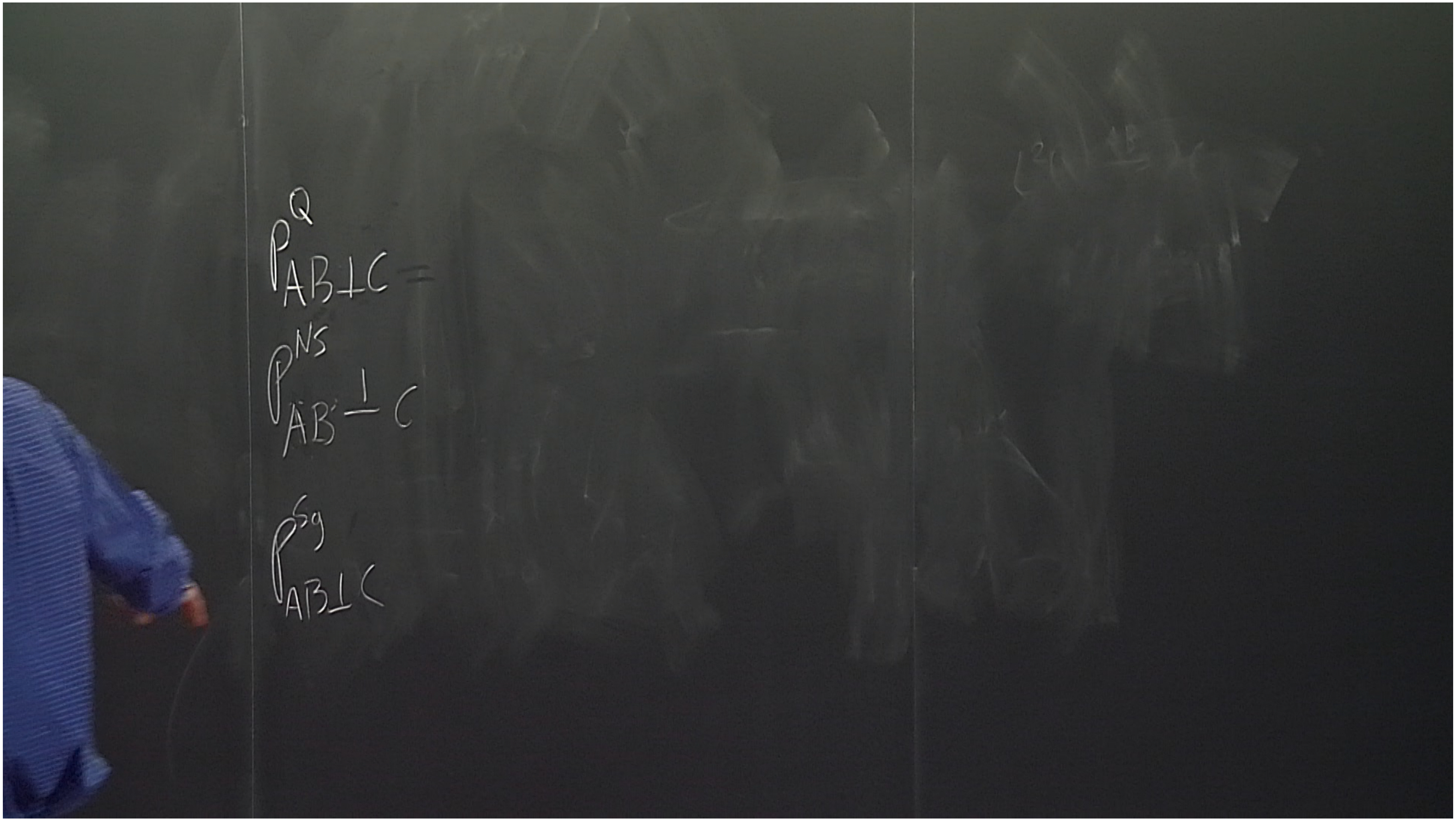
$$\ldots)\, p(a|x\lambda)\, p(b|y\lambda)\, p(c|z\lambda)$$

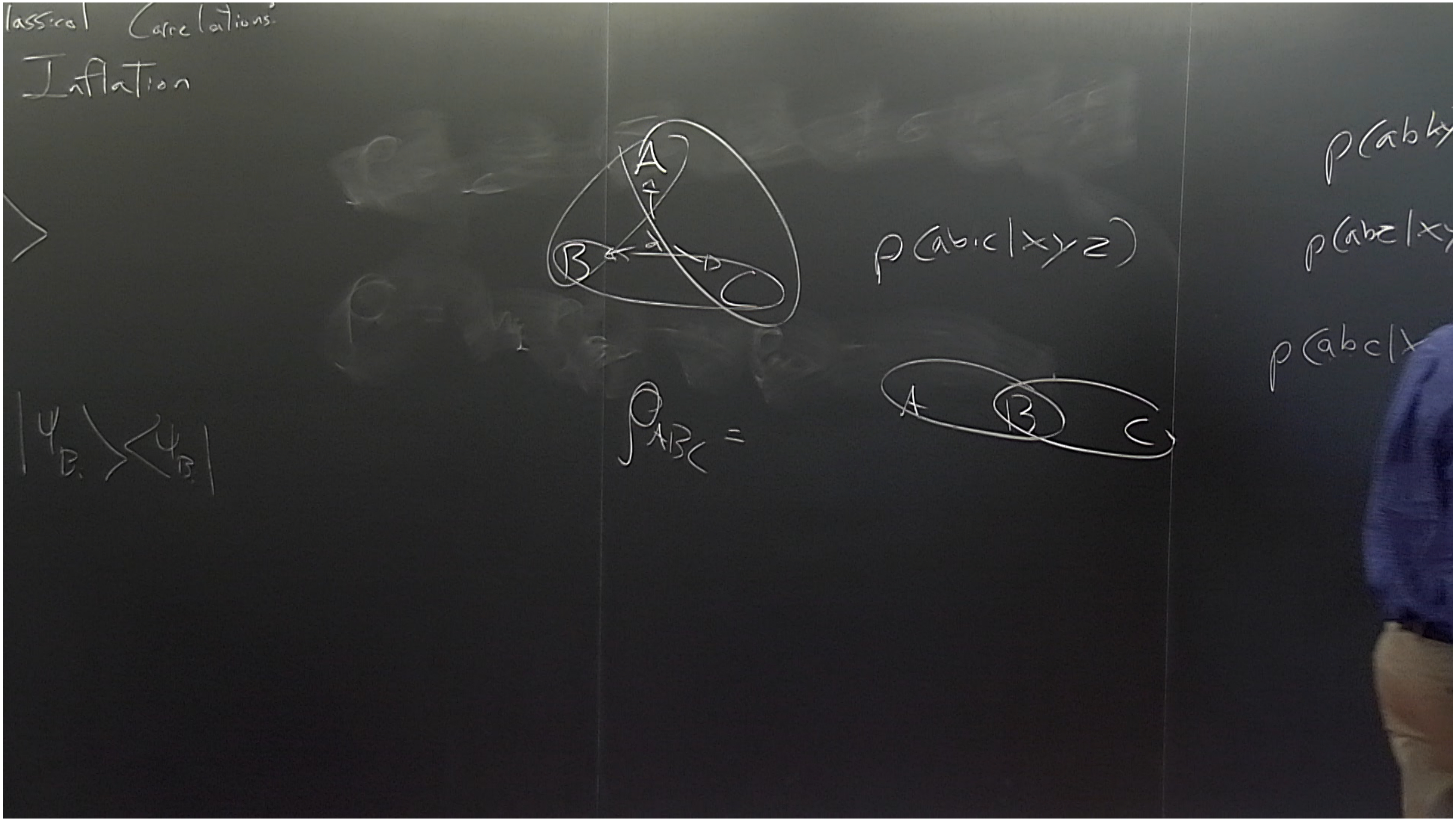
$$\ldots|xy\lambda)\, p(c|z\lambda)$$

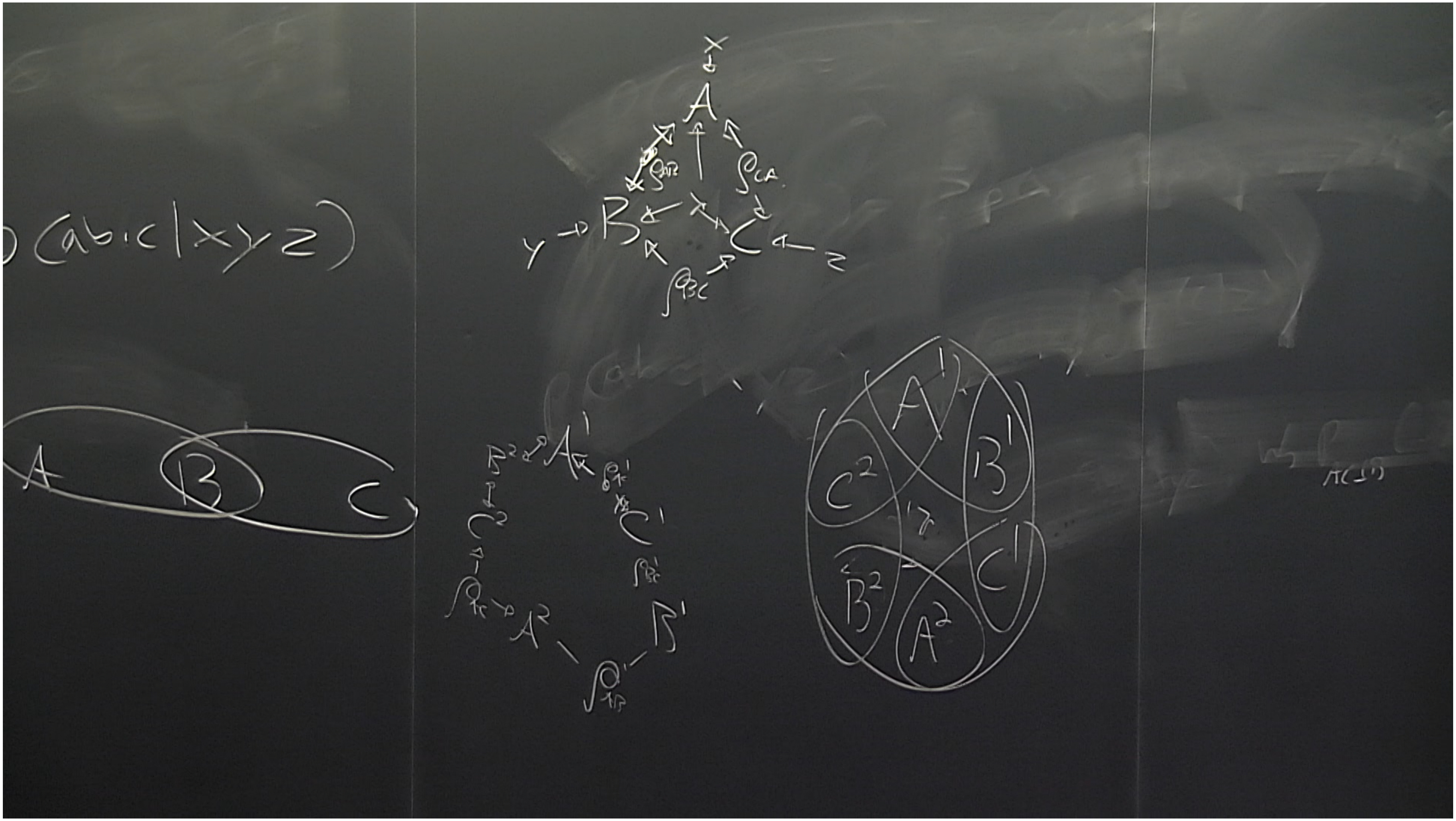
$$\ldots_{C}(abc|xyz) + w_2\, P_{AC|B}(\ldots) + w_3\, P_{BC|A}(\ldots)$$

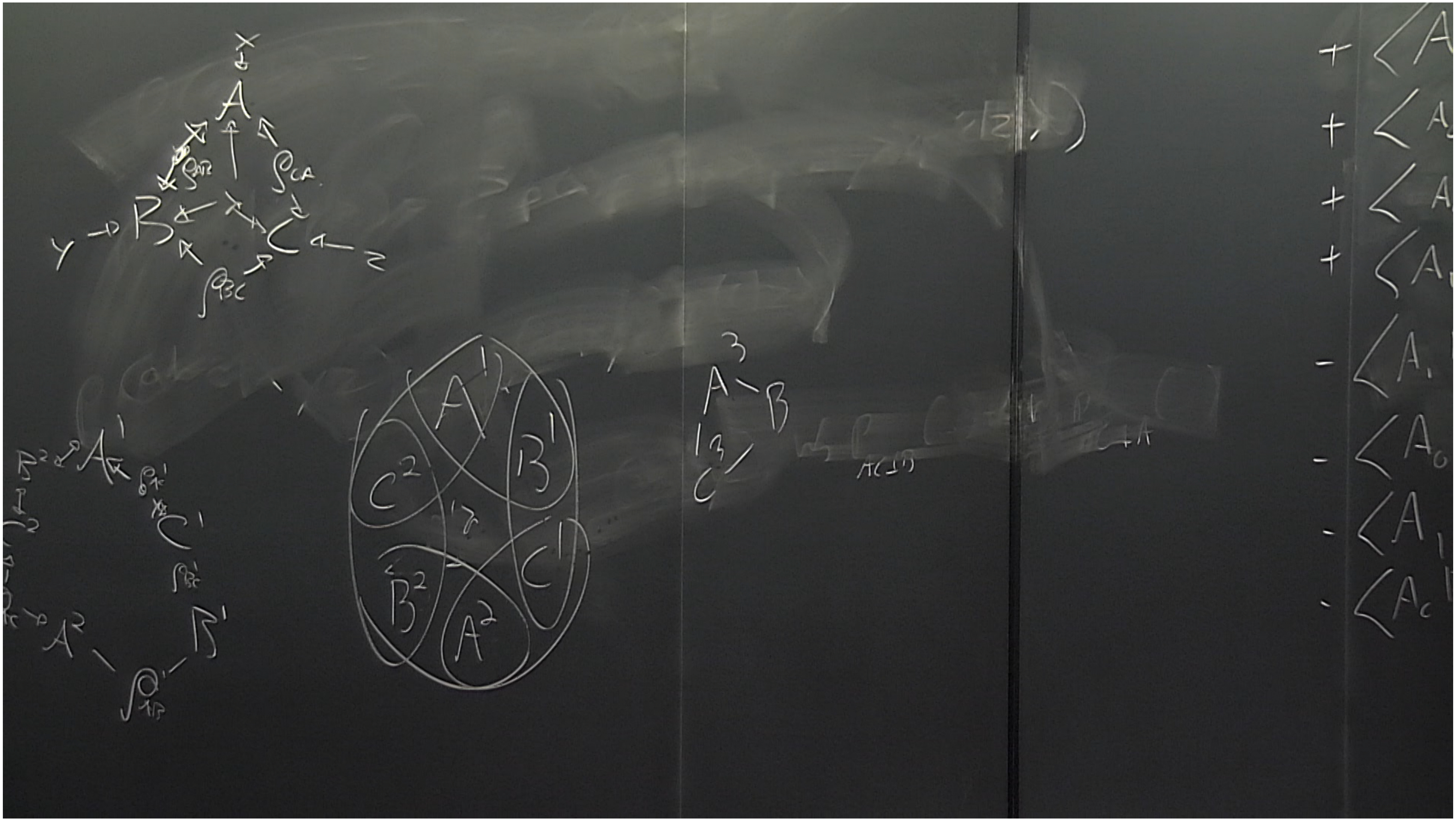
$$
\begin{aligned}
&+\langle A_1 B_0 C_0\rangle \\
&+\langle A_0 B_1 C_0\rangle \\
&+\langle A_0 B_0 C_1\rangle \\
&+\langle A_1 B_1 C_1\rangle \\
&-\langle A_1 B_1 C_0\rangle \\
&-\langle A_0 B_1 C_1\rangle \\
&-\langle A_1 B_0 C_1\rangle \\
&-\langle A_0 B_0 C_0\rangle \quad \le 4
\end{aligned}
$$

$$4\sqrt{2}$$


$\rho^{Q}_{AB\perp C} =$
$\rho^{NS}_{AB \perp C}$
$\rho^{Sg}_{AB\perp C}$


lassical Correlations
Inflation
|ψB⟩⟨ψB|
A
B
C
p(abc|xyz)
ρABC =
A
B
C
p(ab|xy
p(abc|xy
p(abc|x





Perspectives & Quantum Inflation

$$|\psi_{AB}\rangle = |\psi_A\rangle \otimes |\psi_B\rangle$$

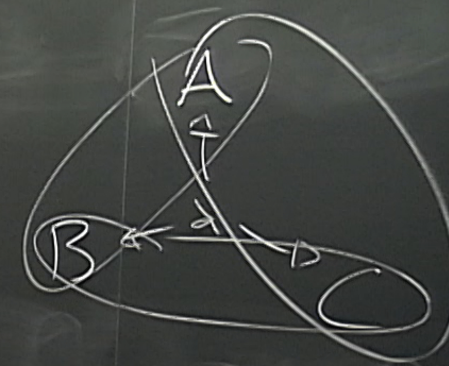
$$\rho^{SEP}_{AB} = \sum_i w_i |\psi_{A_i}\rangle\langle\psi_{A_i}| \otimes |\psi_{B_i}\rangle\langle\psi_{B_i}|$$

$$\in \rho^{SEP}$$

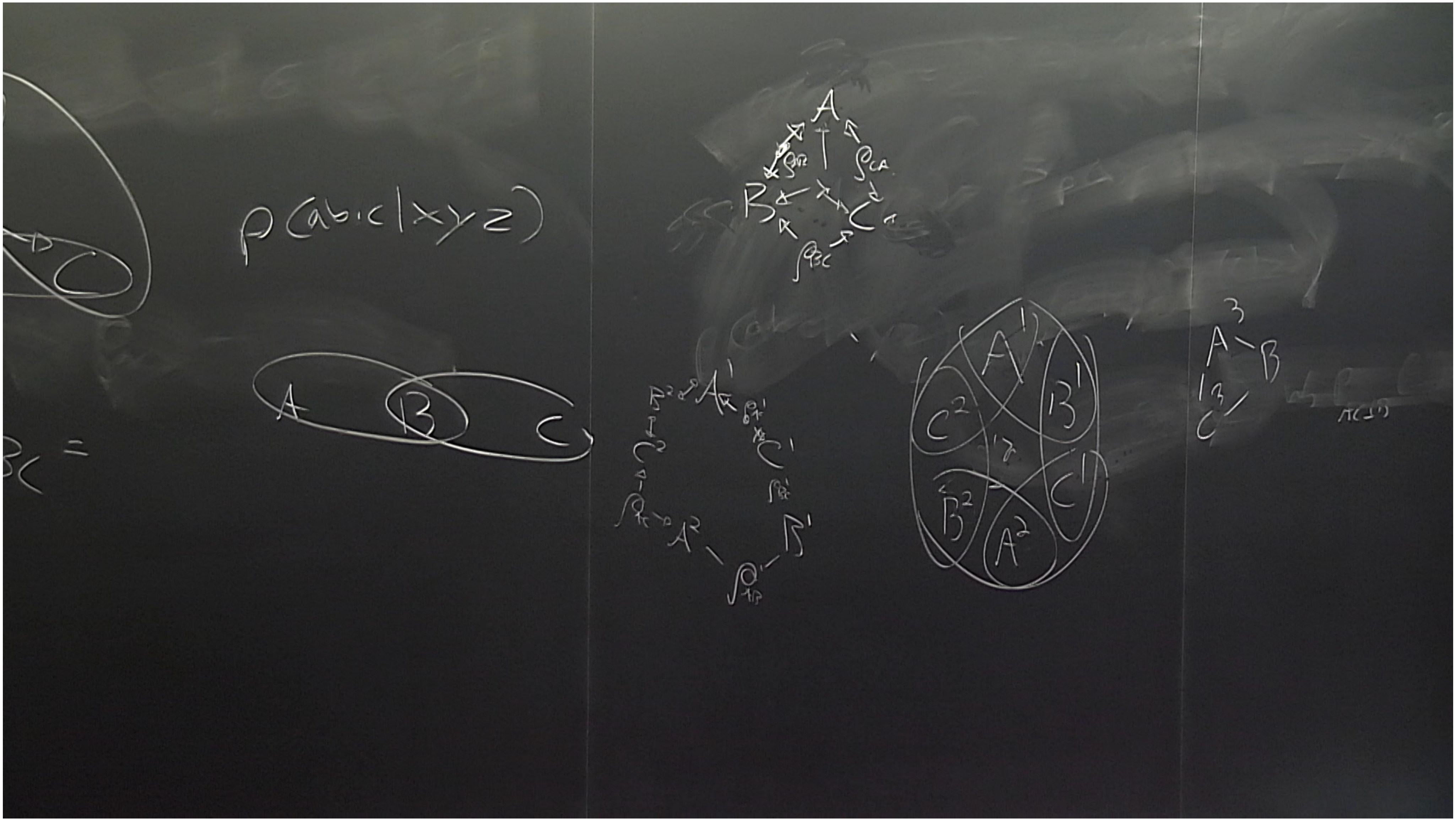
?

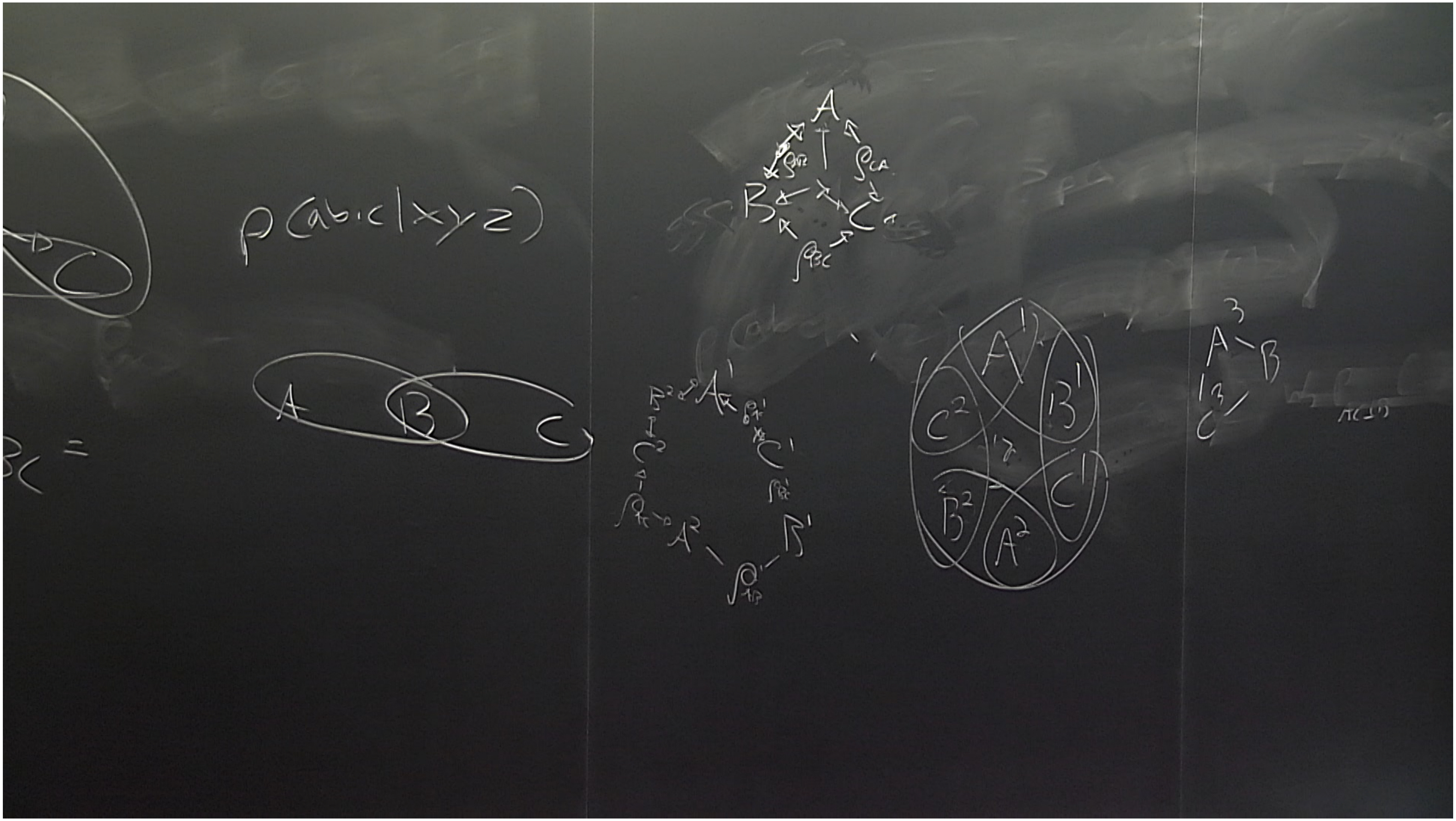
$$\rho_{AB+C}$$

$$\rho_{ABC_1C_2C_3}$$

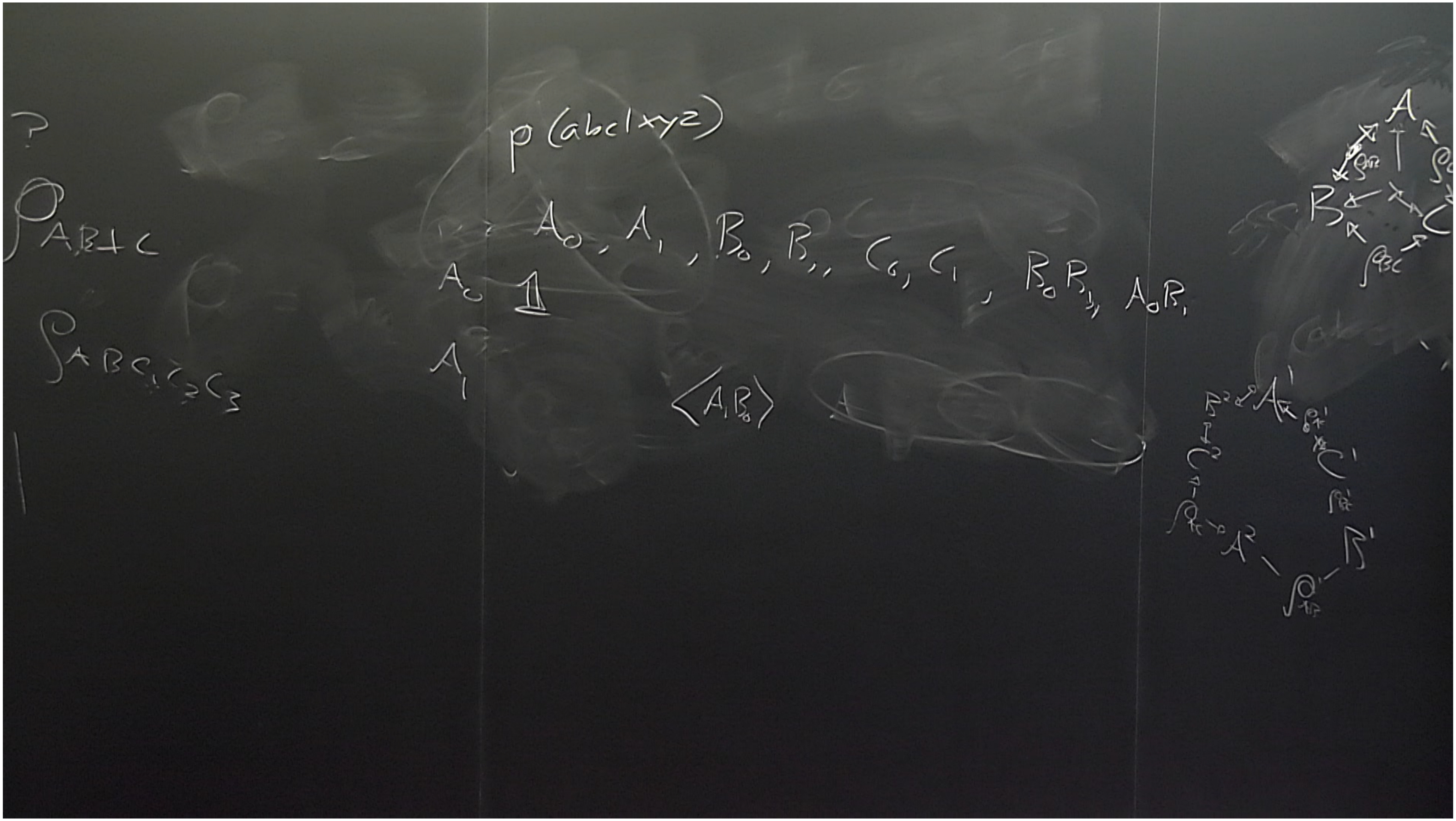


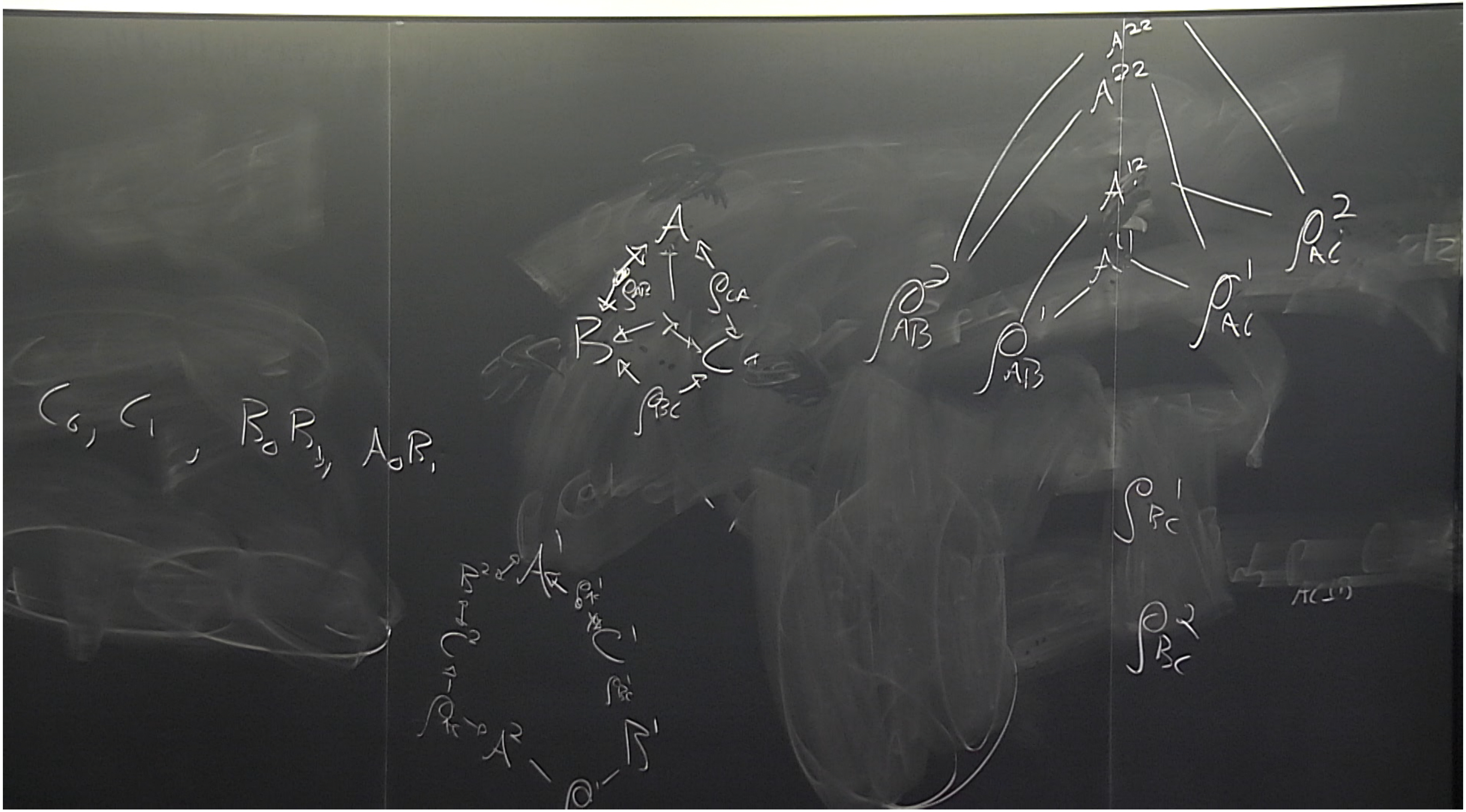
$$\rho_{ABC} =$$





$p(ab:c|xyz)$
A
B
C
ρ_{AB}
ρ_{CA}
ρ_{BC}
A^1
B^1
C^1
A^2
B^2
C^2


p(abc|xyz)
ρ_AB+C
A_0, A_1, B_0, B_1, C_0, C_1, B_0B_1, A_0B_1
A_0
A_1
ρ_ABC_1C_2C_3
⟨A_1B_0⟩


$C_0, C_1, B_0 B_1, A_0 B_1$
A
B
C
ρ_{AB}
ρ_{CA}
ρ_{BC}
A^{22}
A^{22}
A^{12}
A^{11}
ρ_{AB}^2
ρ_{AB}^1
ρ_{AC}^1
ρ_{AC}^2
ρ_{BC}^1
ρ_{BC}^2
A^1
B^2
C^2
C^1
A^2
B^1