Title: Quantum Foundations Lecture

Speakers: Lucien Hardy

Collection: Quantum Foundations

Date: January 31, 2024 - 10:15 AM

URL: https://pirsa.org/24010069

Decision theory   L. Savage Found. of Stat.

In

Probability is a subjective belief telling agents how to behave (make decisions)

states, s $\xrightarrow{\text{bets}}$ rewards, r
(outcomes)

$b(s)$ is the reward.

b_1, b_2 ...

...ple Found. of Stat.

telling agents how to

$b_1 > b_2$

$b_3 < b_4$

$b_5 \sim b_6$

Impose some principles of rational behavior.

1- $b_1 > b_2$, and $b_2 > b_3$ then $b_1 > b_3$

Impose some principles of rational behavior.

1- $b_1 > b_2$, and $b_2 > b_3$ then $b_1 > b_3$

$b_1(s) > b_2(s) \ \forall s$ – $b_1 > b_2$

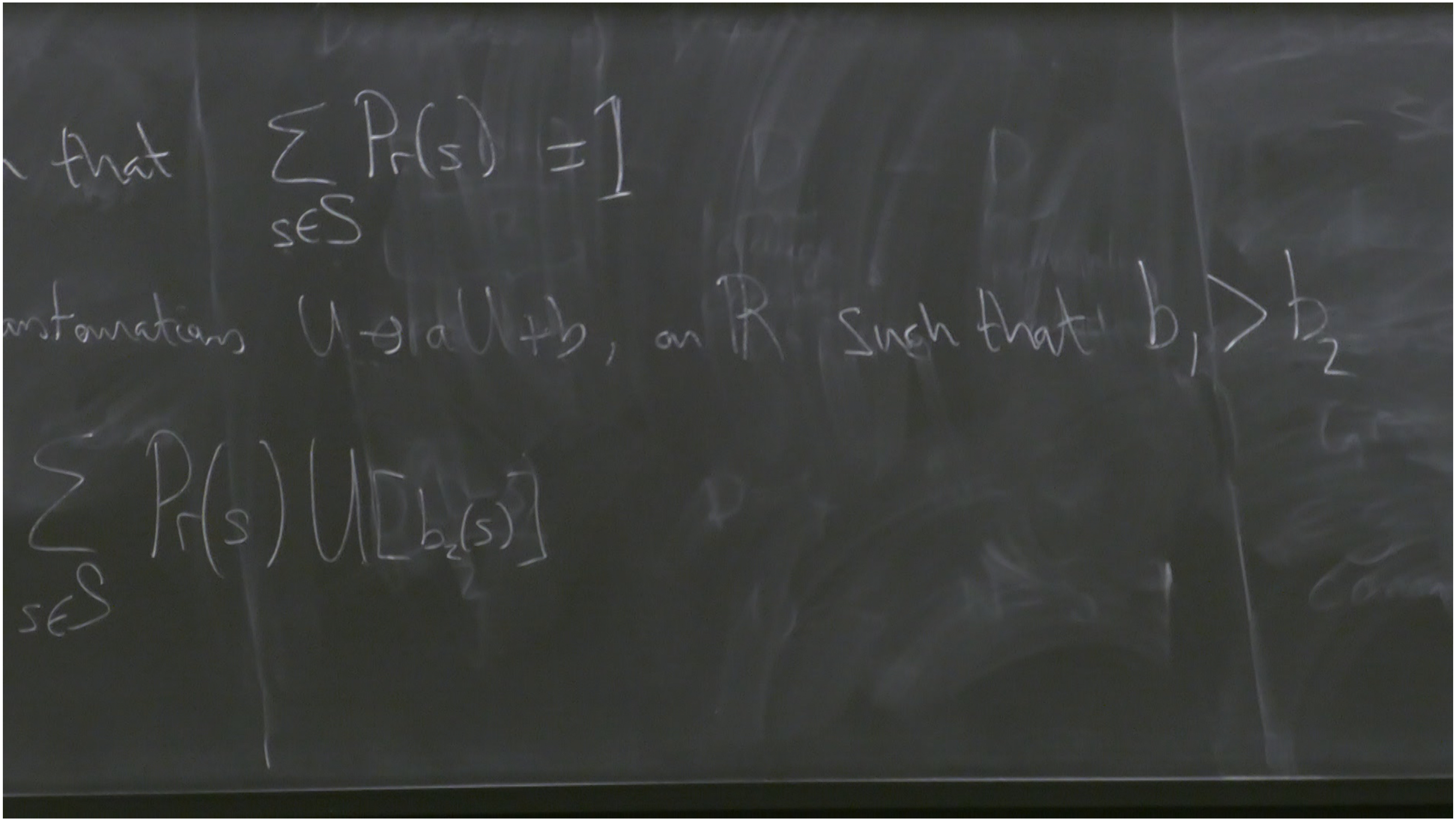
Can get a representation theorem that says:

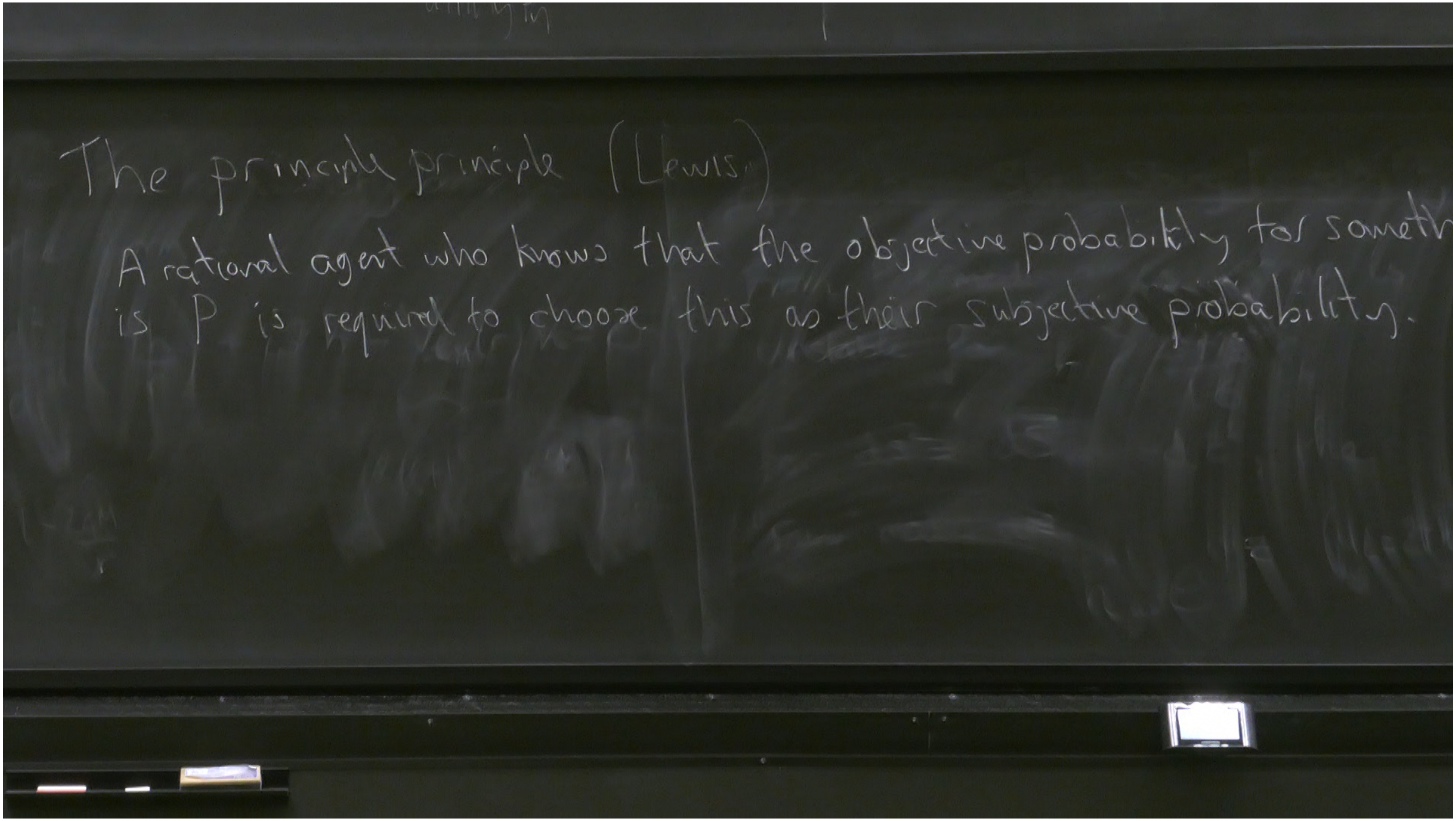
① $\exists$ a unique $Pr(s) \geq 0$ such that $\sum_{s \in S} Pr(s) = 1$

② $\exists$ a unique fn, U, up to affine transformations $U \to aU + b$,

iff

$$\sum_{s \in S} Pr(s) \underbrace{U}_{\text{utility fn}}[b_1(s)] > \sum_{s \in S} Pr(s)\, U[b_2(s)]$$


that $\sum_{s \in S} \Pr(s) = 1$
nsformations $U \to aU + b$, on $\mathbb{R}$ such that $b_1 > b_2$
$\sum_{s \in S} \Pr(s)\, U[b_2(s)]$


The principle principle (Lewis)
A rational agent who knows that the objective probability for someth
is P is required to choose this as their subjective probability.

...vis.)

...t the objective probability for something happening

...his as their subjective probability.

How Wallace's proof works.

(a) If two events have the same |amplitude| then agents are rationally required to give them the same probability (Equivalence rule)

(b) Prove that the equivalence rule $\Rightarrow$ Born rule

$$\left(\alpha|+\rangle + \beta|-\rangle\right)\,\Big|\begin{smallmatrix}\text{meas}\\ \text{apparatus}\end{smallmatrix}\Big\rangle\,|\text{agent}\rangle$$

bet on spin up

$$\longrightarrow \alpha|+\rangle\Big|\begin{smallmatrix}\text{spin}\\ \text{up}\end{smallmatrix}\Big\rangle|\$1\rangle + \beta|-\rangle\Big|\begin{smallmatrix}\text{spin}\\ \text{down}\end{smallmatrix}\Big\rangle|\$0\rangle \longrightarrow$$

bet on spin down

$$\longrightarrow \alpha|+\rangle\Big|\begin{smallmatrix}\text{spin}\\ \text{up}\end{smallmatrix}\Big\rangle|\$0\rangle + \beta|-\rangle\Big|\begin{smallmatrix}\text{spin}\\ \text{down}\end{smallmatrix}\Big\rangle|\$1\rangle \longrightarrow$$

$$|\text{meas apparatus}\rangle\,|\text{agent}\rangle$$

$$\ldots\rangle|\text{spin up}\rangle|\$1\rangle + \beta|-\rangle|\text{spin down}\rangle|\$0\rangle \xrightarrow[U]{\text{Controlled}} \alpha|\text{junk}\rangle|\$1\rangle + \beta|\text{junk}\rangle|\$0\rangle$$

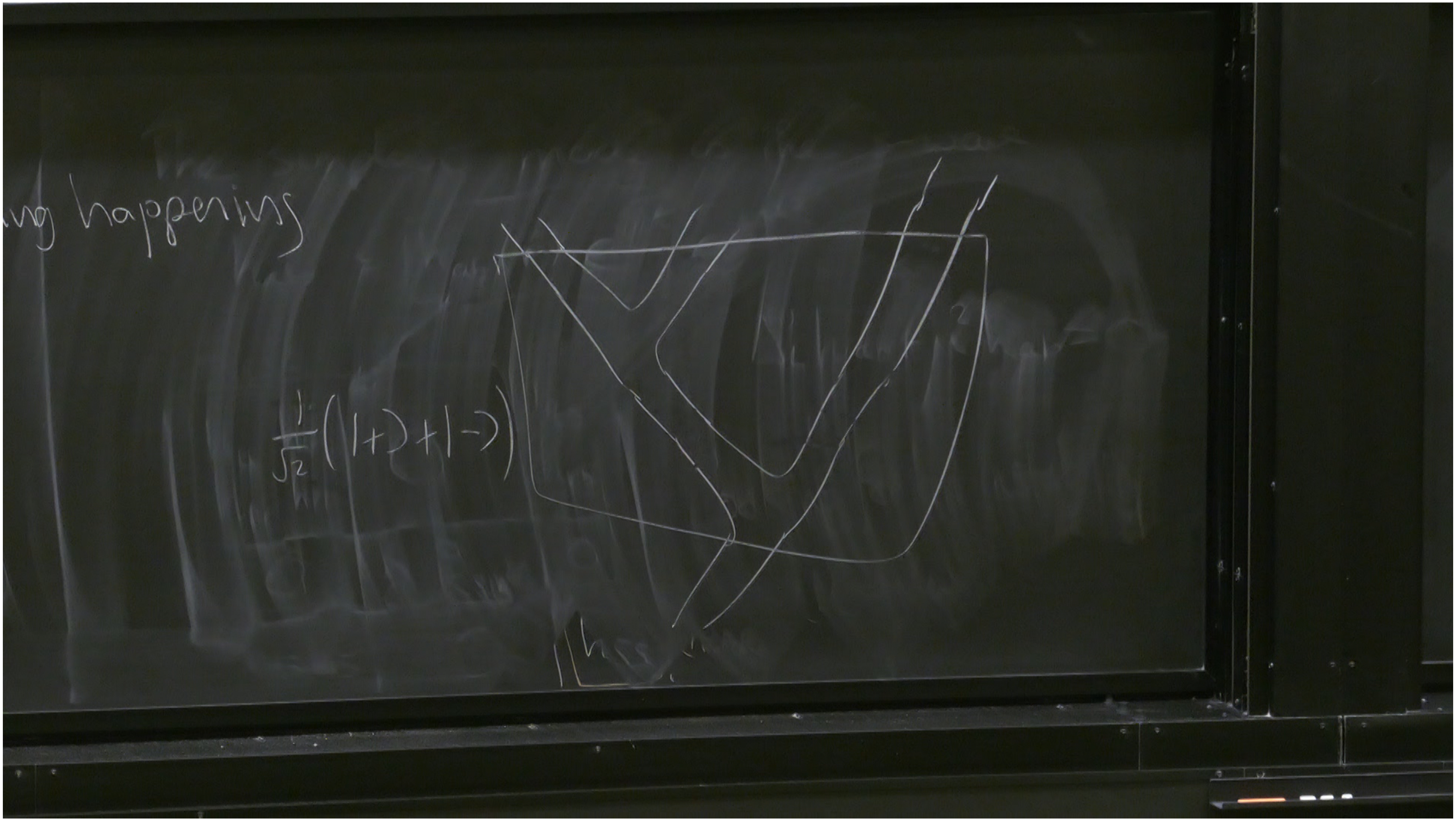
$$\ldots\rangle|\text{spin up}\rangle|\$0\rangle + \beta|-\rangle|\text{spin down}\rangle|\$1\rangle \xrightarrow[U']{\text{Controlled}} \alpha|\text{junk}\rangle|\$0\rangle + \beta|\text{junk}\rangle|\$1\rangle$$

If $\|\alpha\| = \|\beta\|$

same physical state $|\psi\rangle$ $\rightarrow$ same objective probabilities.

$$\frac{1}{\sqrt{5}}\left(2|+\rangle + |-\rangle\right)|s\rangle$$

$$\frac{1}{\sqrt{5}}\left(\frac{2}{\sqrt{2}}|+\rangle|a\rangle + \frac{2}{\sqrt{2}}|+\rangle|b\rangle + |-\rangle|s\rangle\right)$$


happenings
$\frac{1}{\sqrt{2}}(|+\rangle+|-\rangle)$

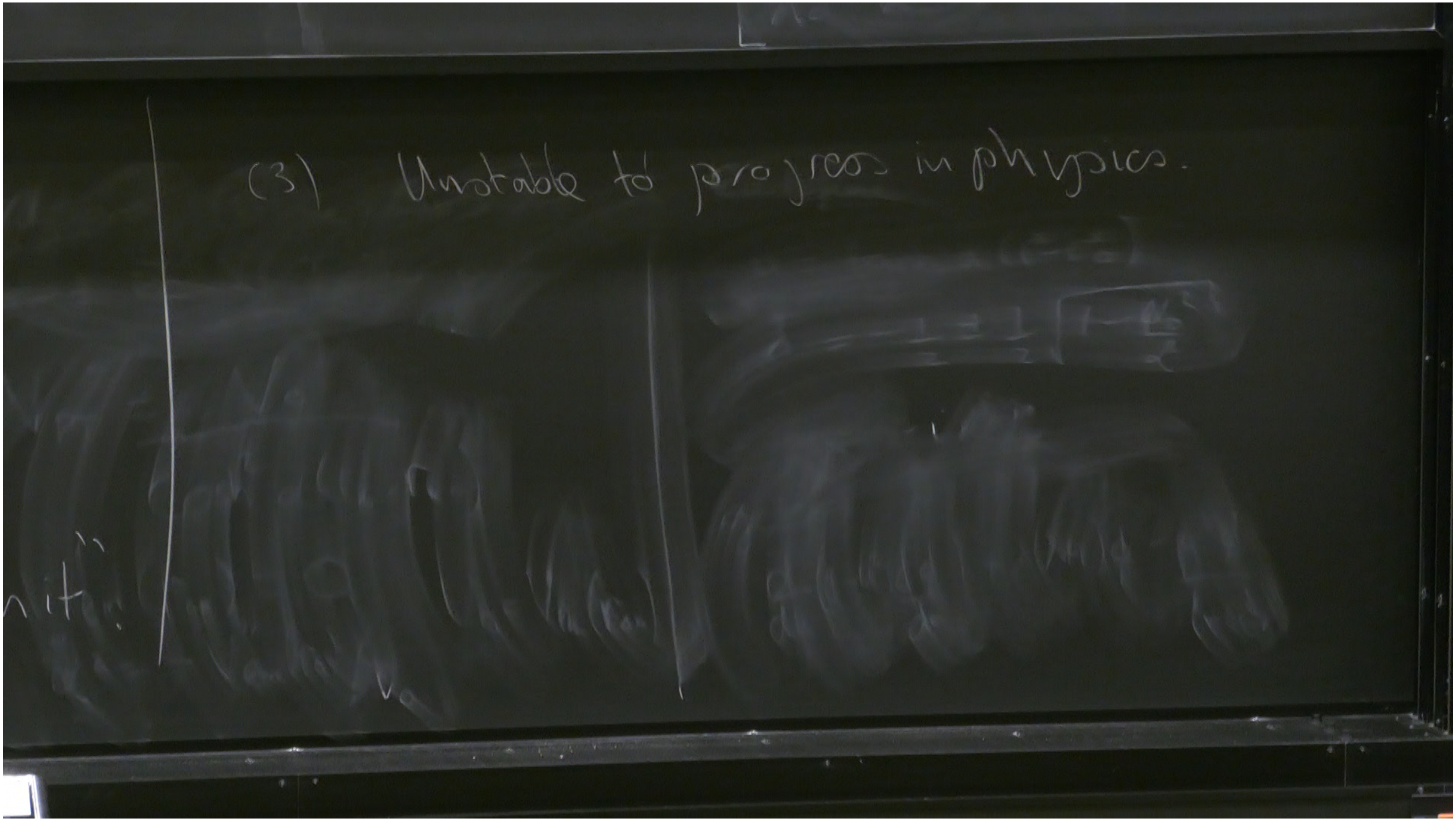
utility fn

Criticisms of MWI

(1) Probability - Conference at PI   pirsa.org/C07025

Kent, Albert, Price,

(2) Distasteful. in stochastic model we "get away with it".


(3) Unstable to progress in physics.