Probability in Many-Worlds Theories

1000 SG, $|c_{up}|^2 = \frac{1}{3}$, $|c_{down}|^2 = \frac{2}{3}$.

$\uparrow\downarrow\downarrow\uparrow\downarrow\uparrow\downarrow\downarrow \ldots$

Rule for counting worlds. (for Sm)

The "fraction of worlds" $f(P)$ with property P in the splitting given by $\Psi = \sum c_\alpha \Psi_\alpha$ and $m(x) = \sum_\alpha |c_\alpha|^2 m_\alpha(x)$ is

$$f(P) = \sum_{\alpha \in M} |c_\alpha|^2$$

where M is the set of worlds α with property P.

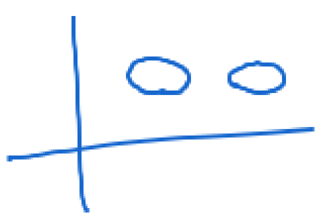
Ex P = freq. of $\uparrow$ lies in $[30\%, 36\%]$

__Comparison to BM__: Ψ_0, $Q_0 \sim |\Psi_0|^2$

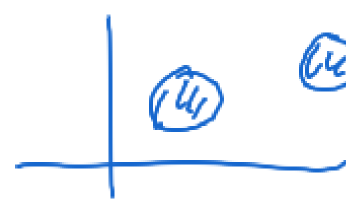
$\Rightarrow Q_t \sim |\Psi_t|^2$, P true for some Q_t
false for some Q_t.

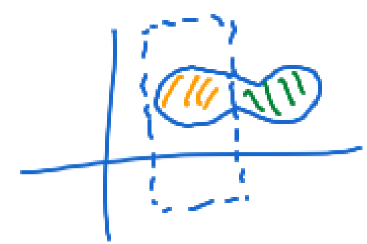
typicality reasoning.
(Everett 1955)

__Robustness__ against re-drawing boundaries between branches



$\|P_\alpha \Psi\|^2$





Problem with the rule for counting worlds

Is there room for such a rule among the laws of physics?

I tend to conclude: in the end, Sm fails.

Comparison: Bell's MW #1: OK.
Bell's MW #2. $Q_t \sim |\Psi_t|^2$, indep. of past.
OK as well.

Other reasonings for justifying probabilities

D. Deutsch (1999): rational behavior
L. Vaidman (1998): I can be ignorant of which world I am in.

Nonlocality

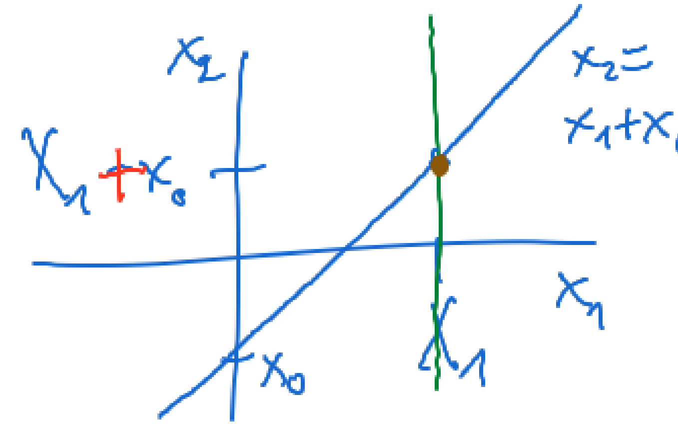
The Einstein-Podolsky-Rosen Argument

EPR 1935 argued for

<u>claim</u>: There are additional variables beyond the wave fct.

"<u>Pf</u>" 2 particles in 1 d with wf

$$\Psi(x_1,x_2) = \delta(x_1 - x_2 + x_0)$$



$x_0 \in \mathbb{R}$ const.

Alice measures of x_1, outcome $X_1 \sim$ uniform.

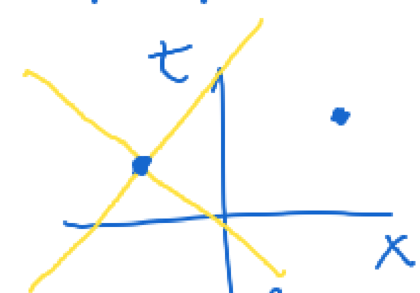
$$\Psi'(x_1,x_2) = \delta(x_1 - X_1)\,\Psi(x_1,x_2) = \delta(x_1 - X_1)\,\delta(x_2 - X_1 - x_0)$$

Now Bob measures x_2, obtains $X_2 = X_1 + x_0$
with certainty

$\Rightarrow$ before Bob's measurement, particle 2 had
a definite position.

EPR assumption: "no real change can take place in the 2nd system in conseq. of [a measurement on] the first system."

(a special case of locality)



$\Rightarrow$ before Alice's measurement, particle 2 had a definite position. $\square$

Variant: squ.-integrable

$$\underbrace{\left(P_B \otimes I\right)}_{P_{B\times\mathbb{R}}}$$