14/5/2013
Ouw 1

What is quantum probability? Why do we need it?

QP : P = Non Eucl : Eucl geometry.

Question: Is there a notion of curvature that connects and associate a quantity to this ratio?

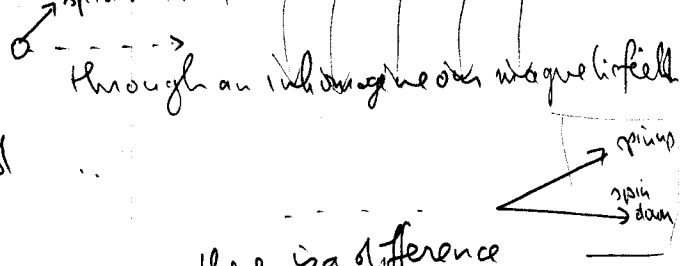
von Neumann's collapse postulate.

Given a state ψ, define the projection $P_\psi = |\psi\rangle\langle\psi|$ on $\mathbb{C}\psi$,
density matrix ρ : $\rho \geq 0$ and $\mathrm{tr}\,\rho = 1$
an observable X written as $\sum_{\lambda \in \sigma(X)} \lambda E_\lambda$:

a measurement of X yields λ with probability $p_\lambda = \mathrm{tr}(\rho E_\lambda)$
$= \langle E_\lambda \psi, \psi \rangle$.

If the observed value is λ, the state collapses to $\tilde{\rho}_\lambda = \frac{E_\lambda \rho E_\lambda}{\mathrm{tr}(\rho E_\lambda)}$.

Ex: Stern-Gerlach experiment:



Only two values are observed ..
$H = \mathbb{C}^2$
$X = \lambda_+ E_+ + \lambda_- E_-$
"spin up" "spin down"

ρ becomes $\tilde{\rho}_{\lambda\pm} = \frac{E_\pm \rho E_\pm}{\mathrm{tr}(\rho E_\pm)}$

there is a difference between preparation and a measurement.

⚠ at the end of Stern-Gerlach, the particle is destroyed.

≈ having a deck of cards, then a partial information, you go to the conditional expectation.

References: Parthasarathy (founder of the field with Hudson)

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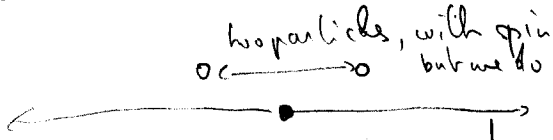
The extreme points in the classical case are Dirac:
they provide deterministic outcomes.
This is not the case in the q case, unless ψ is an $\overrightarrow{ev}$ of the observable X.
the state is prepared corresponds to

Ex: Aspect experiment.



If you do an experiment on one particle, this produces an effect also on the other side! This cannot be due to hidden information.

→ this may be seen as a consequence of the Kochen-Specker theorem, which is quite obvious mathematically.