Title: Real world interpretations of Quantum Theory

Date: Sep 27, 2007 04:00 PM

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Abstract:

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Real World Interpretations of Quantum theory

Motivations

 new fundamental ontology- new realist interpretation (or small class of interpretations) of the quantum theory of a closed system to consider alongside de Broglie-Bohm, modal, dynamical collapse).

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Taking branching seriously: "real world" interpretations (AK, arXiv:0708.3710)

A new proposal for solving the measurement problem.

Respects Lorentz invariance and conservation laws.

No immediately evident "tails problem".

Adds minimal extra structure to q.m., namely a preferred factorisation $H_a \otimes H_g$ and a preferred (possibly hypersurface dependent) projective decomposition on H_g .

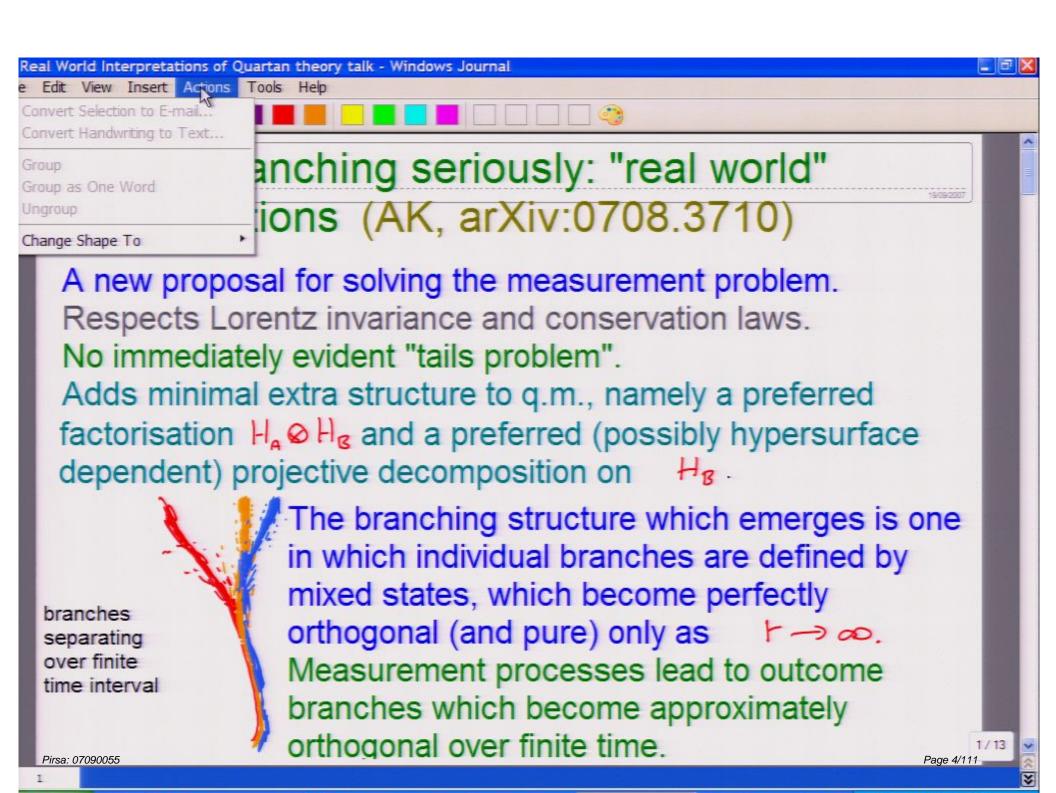
branches separating over finite time interval

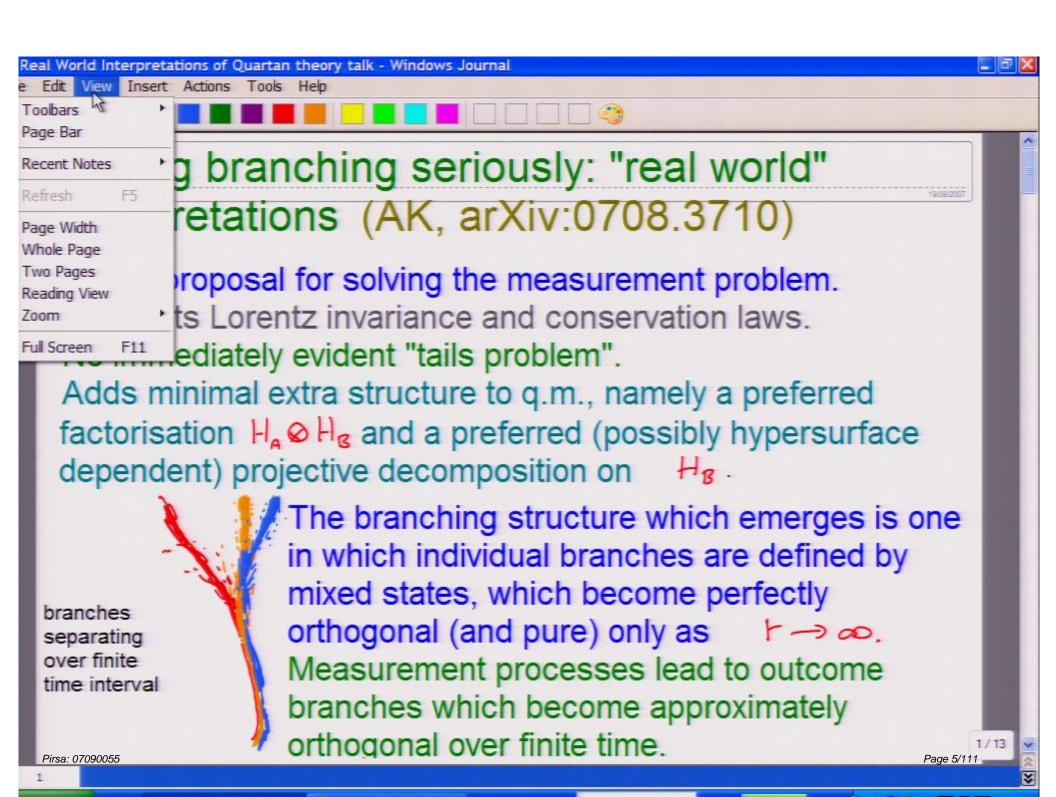
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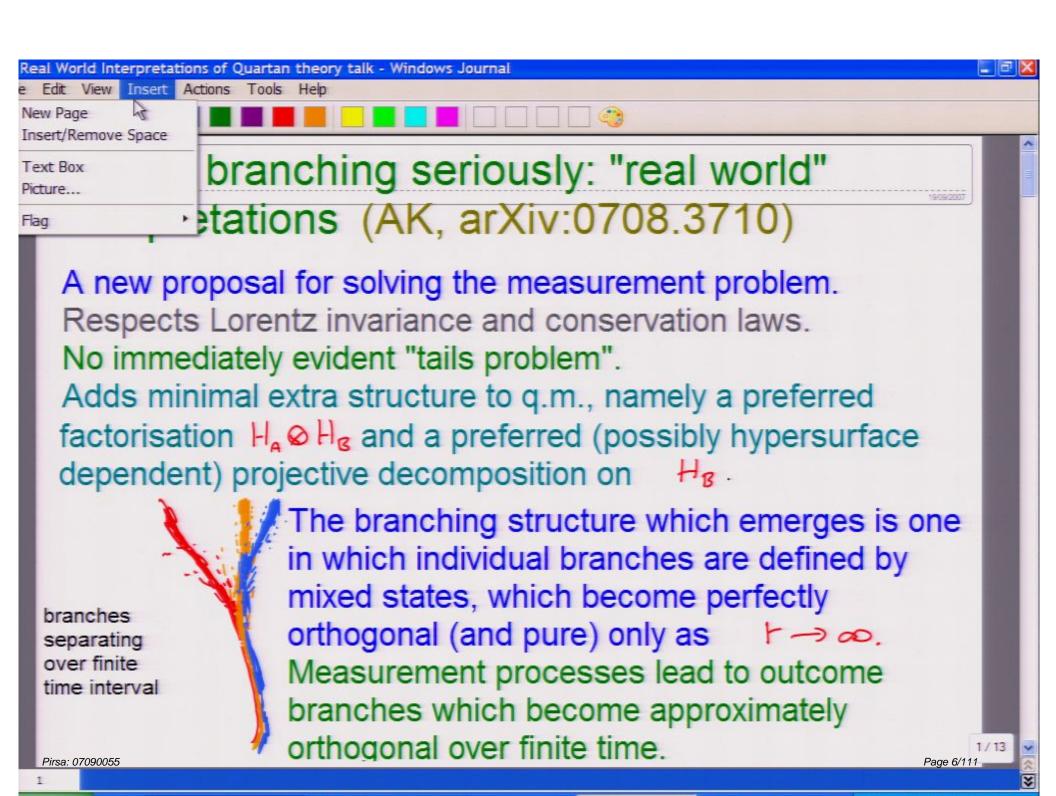
The branching structure which emerges is one in which individual branches are defined by mixed states, which become perfectly orthogonal (and pure) only as $r \to \infty$. Measurement processes lead to outcome branches which become approximately orthogonal over finite time.

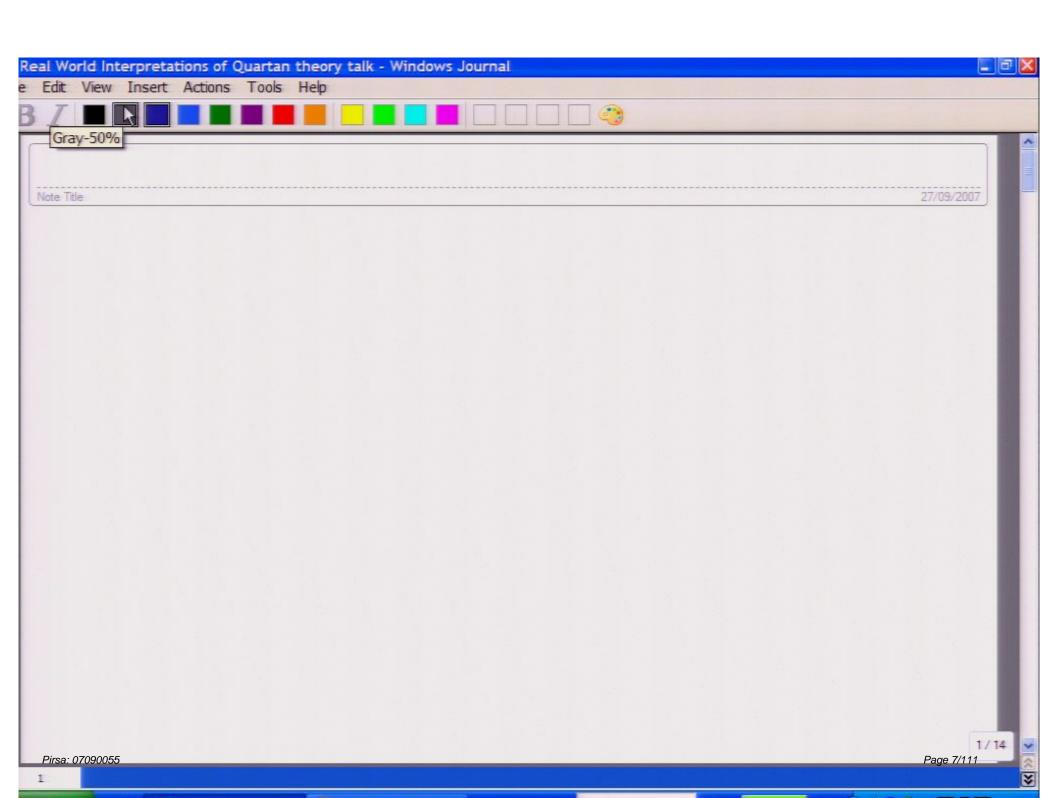
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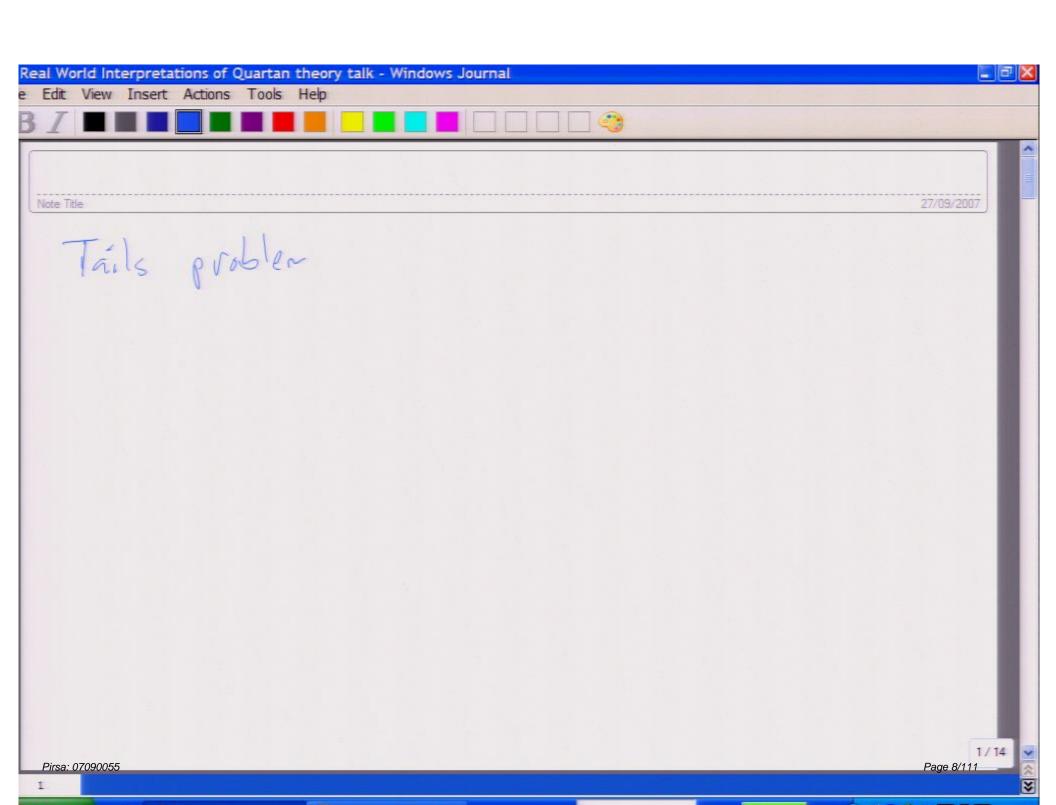
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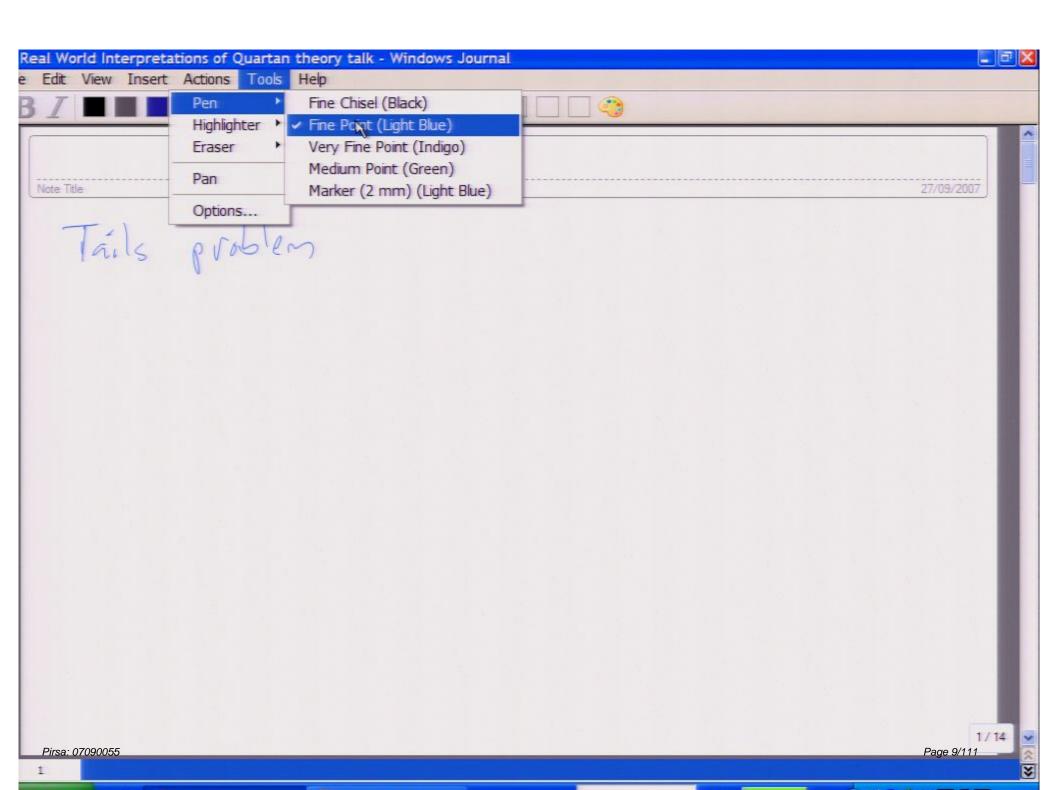


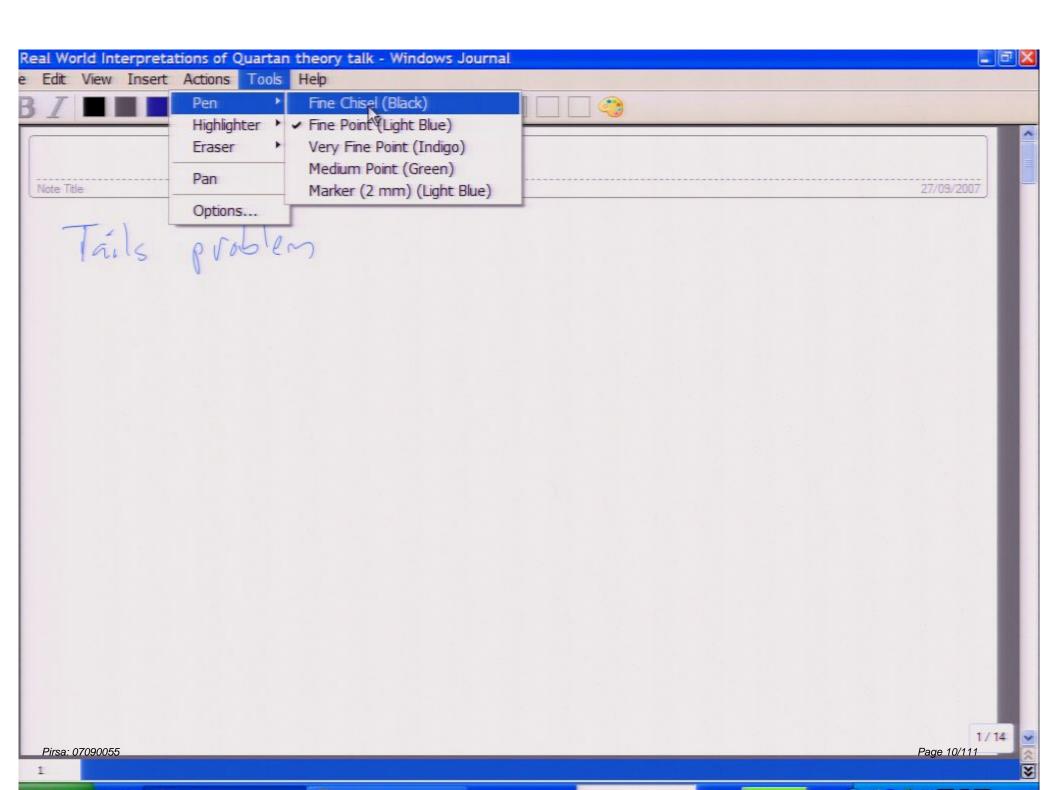


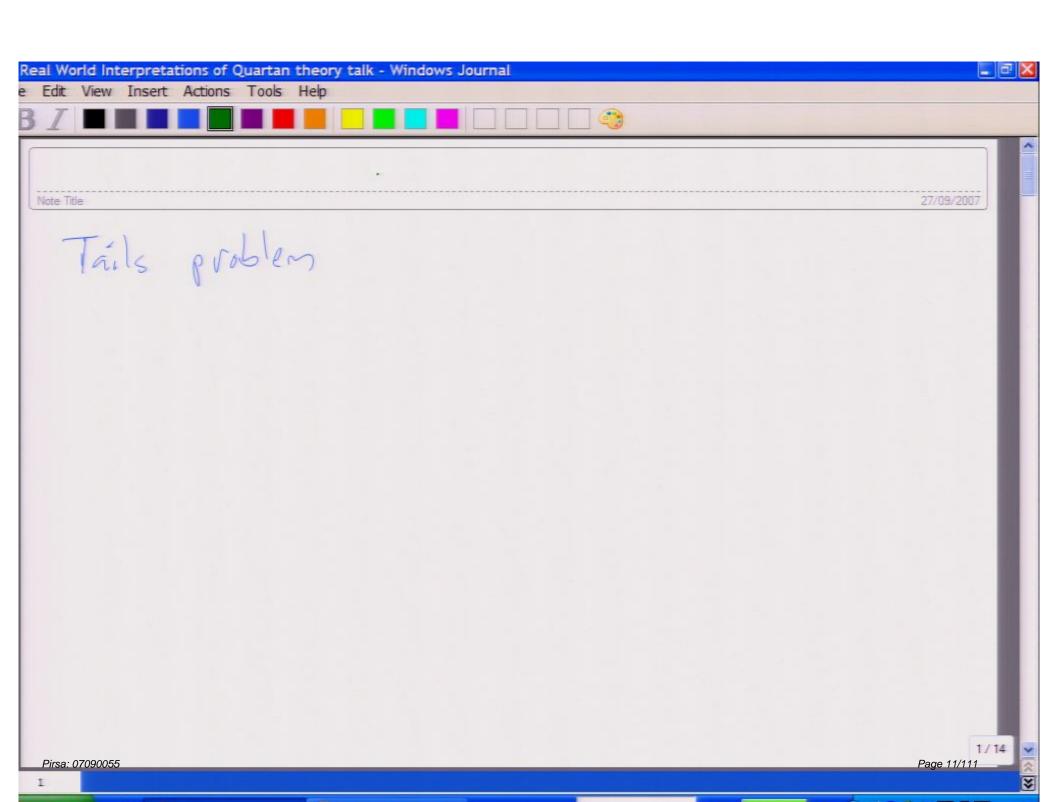


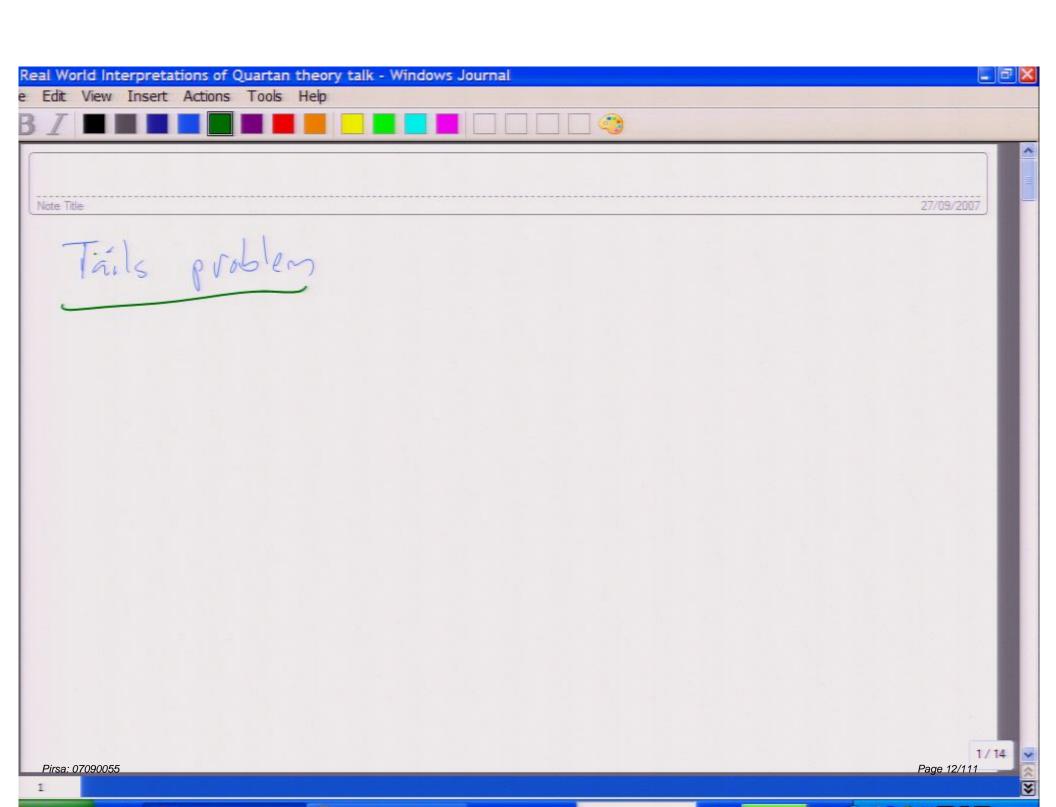


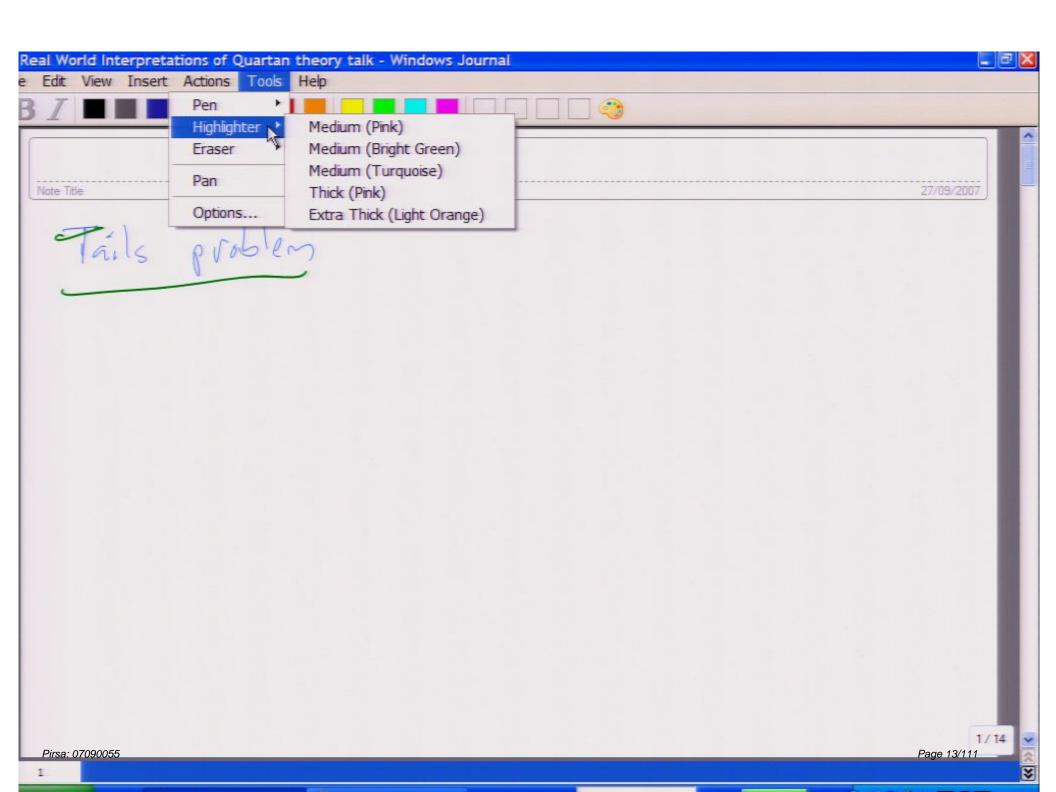


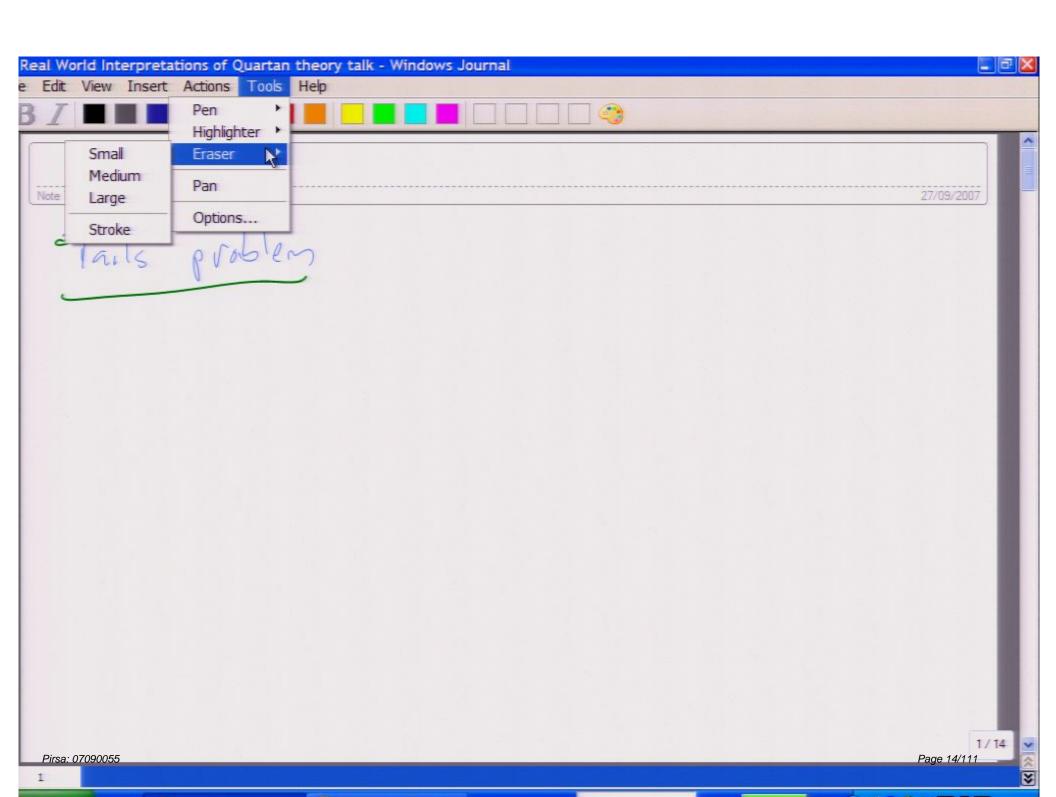


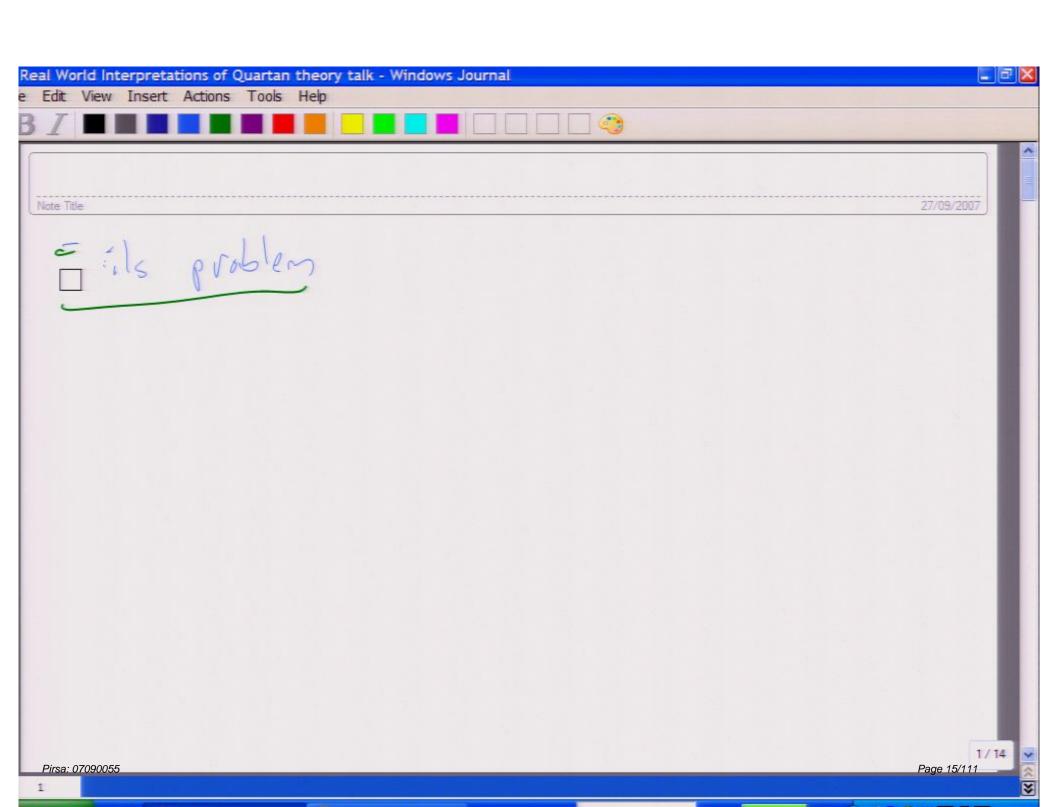


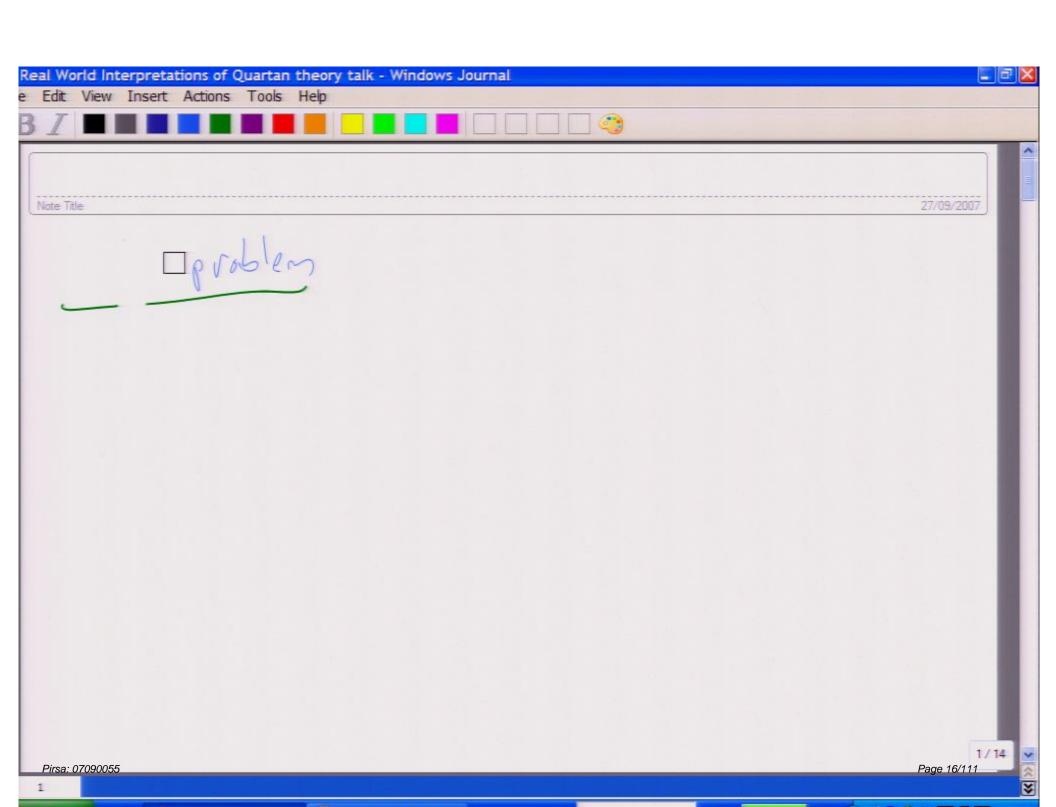


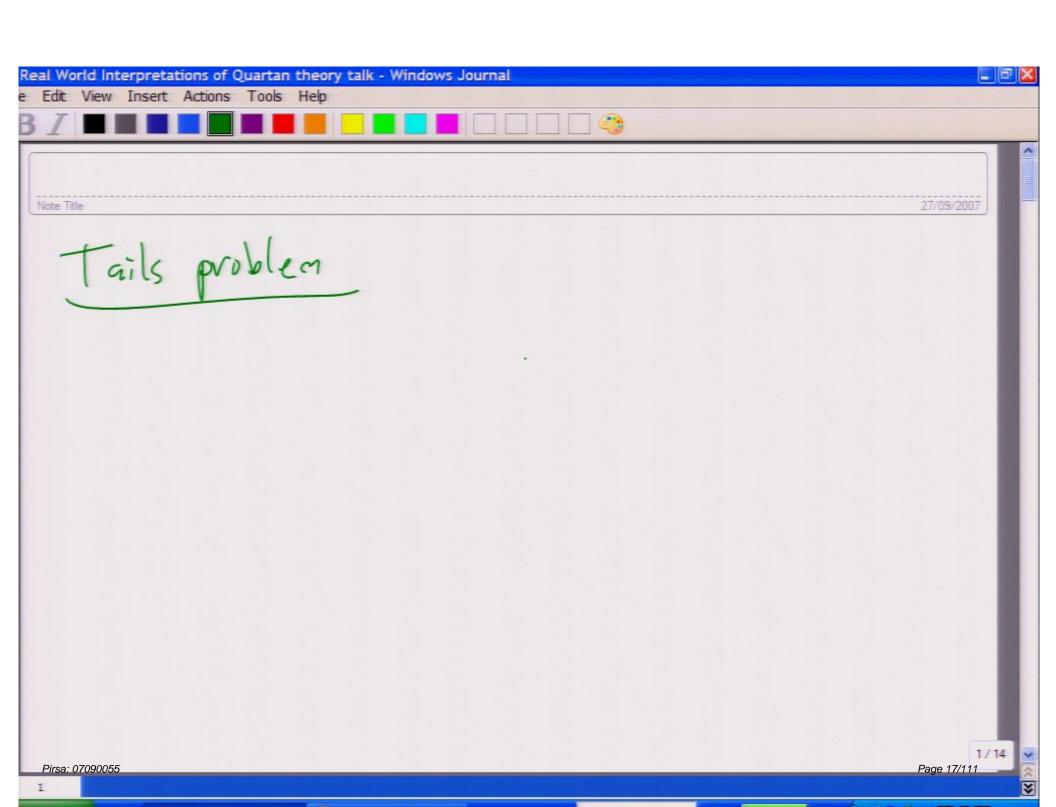


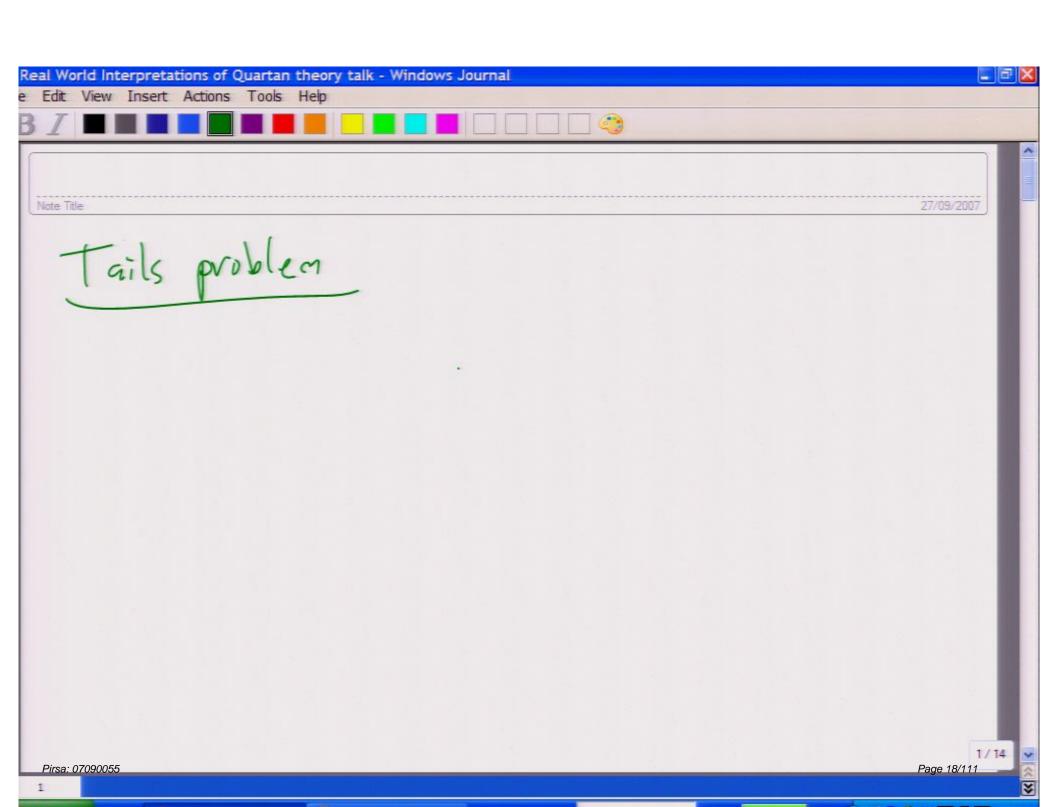


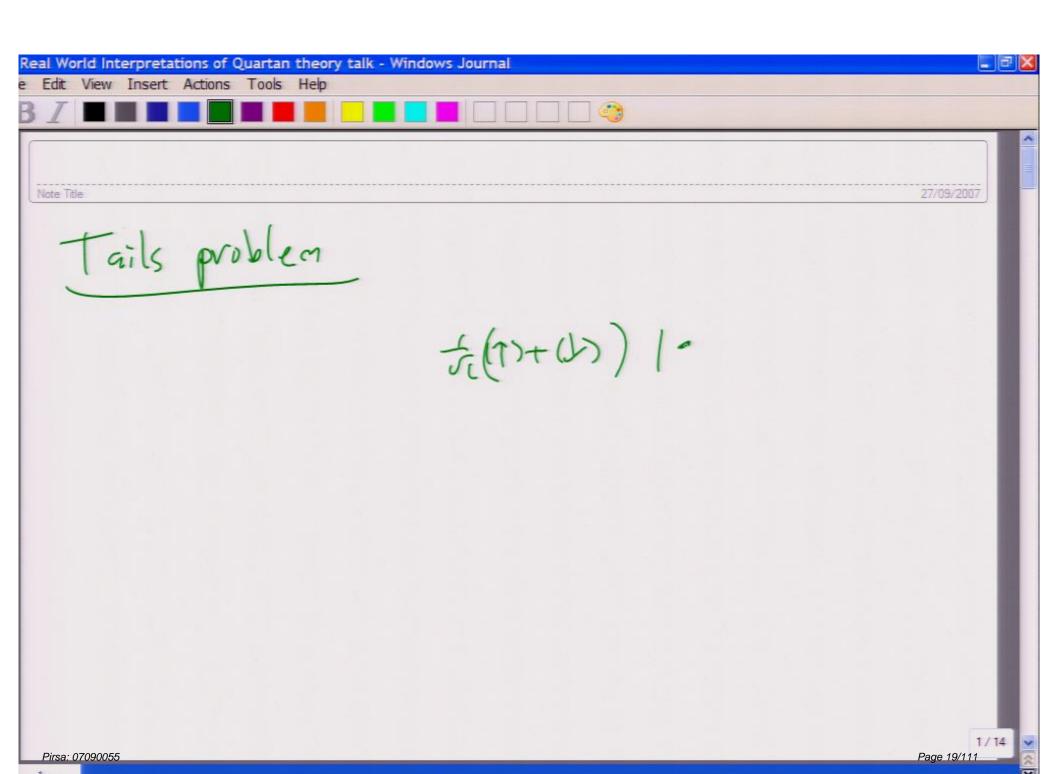


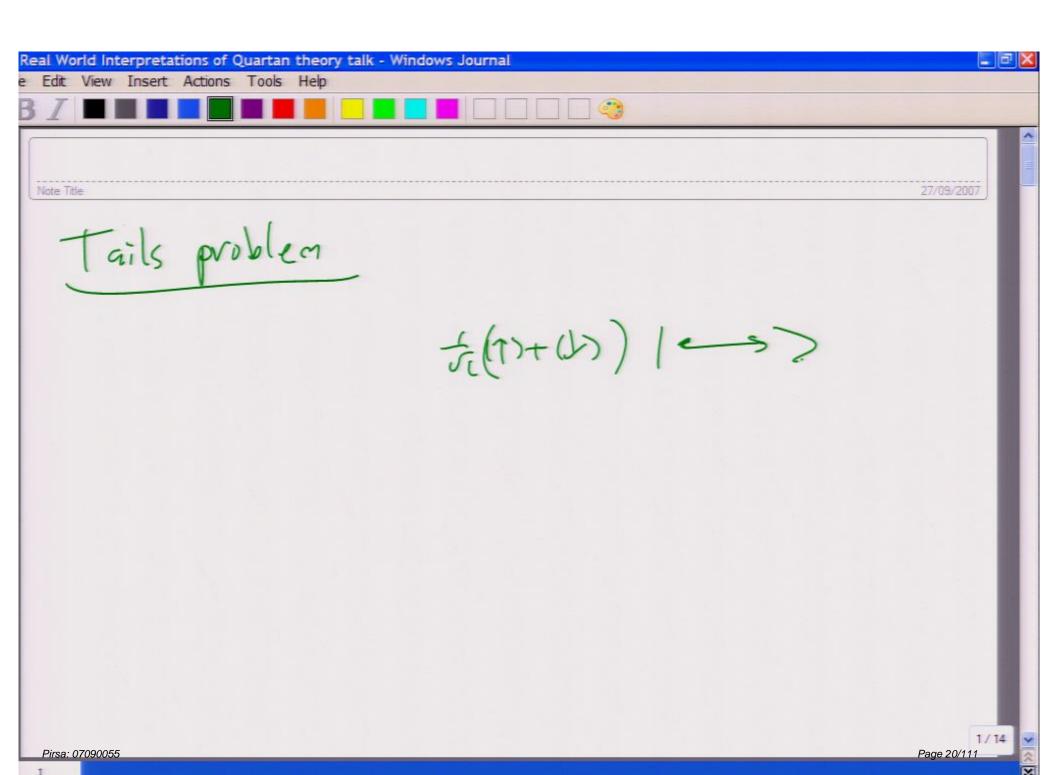


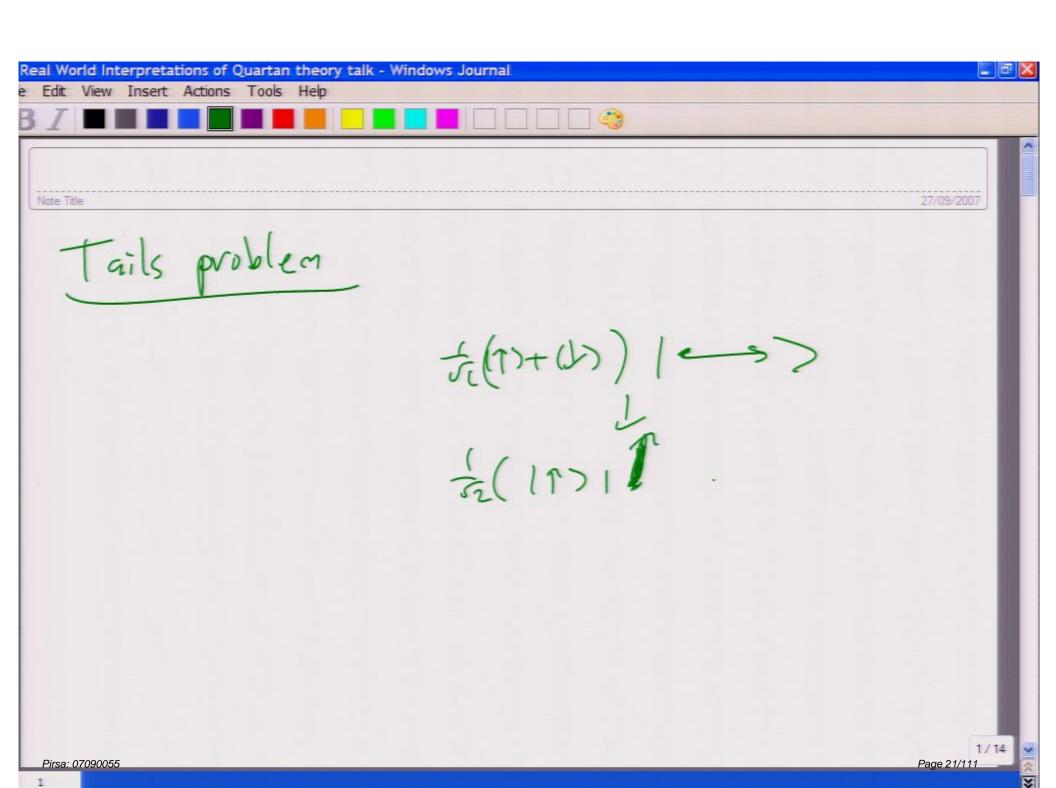


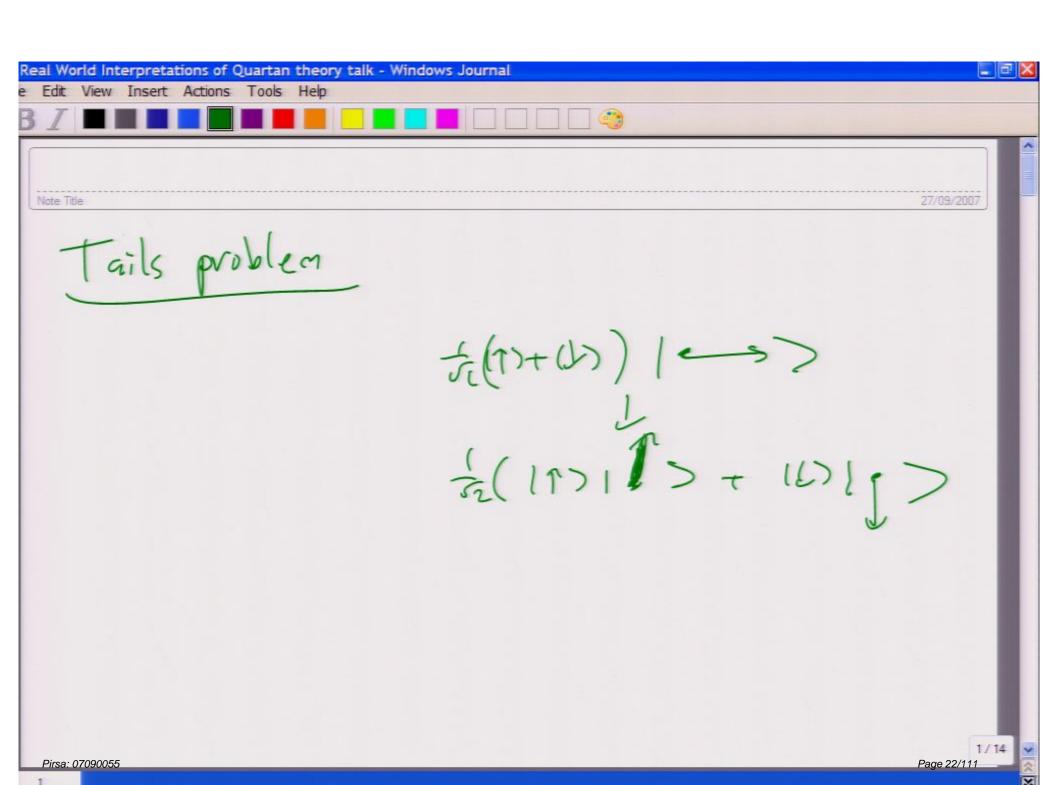


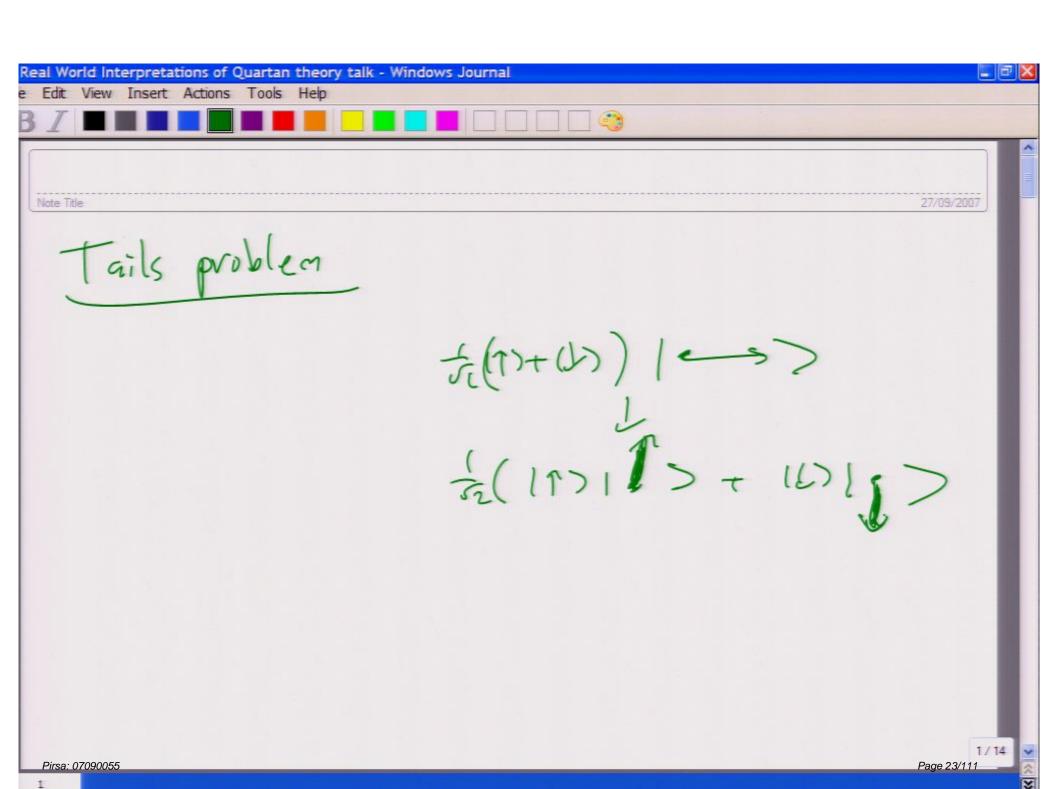


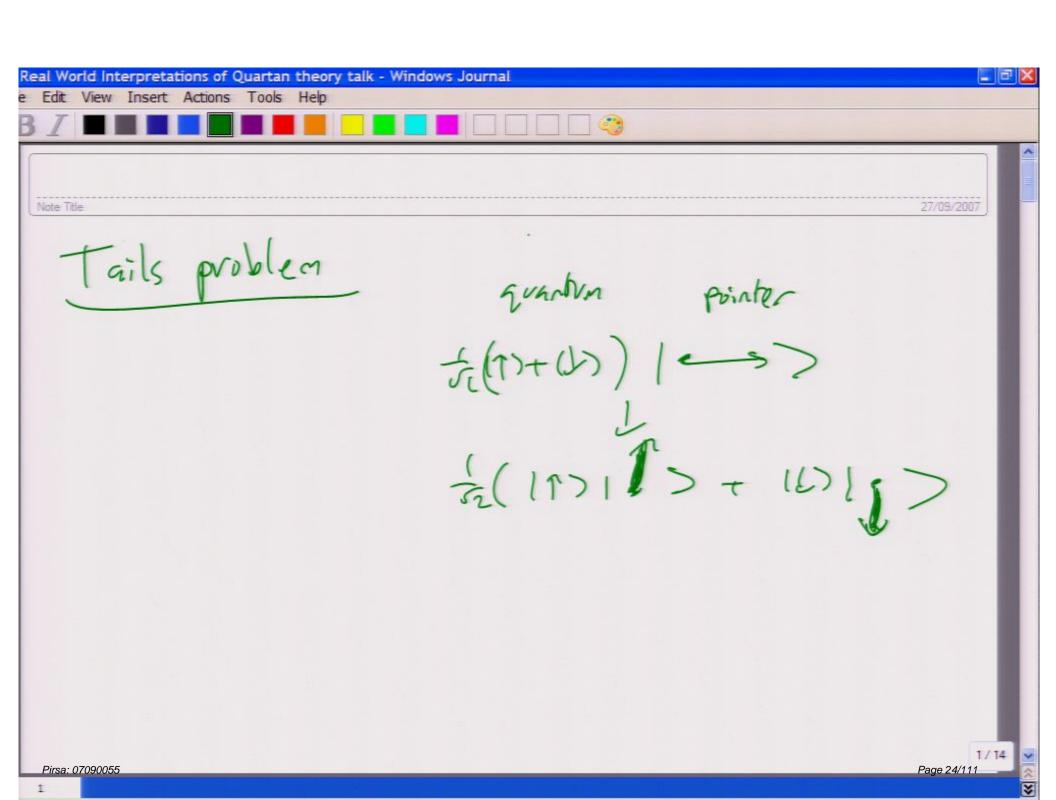


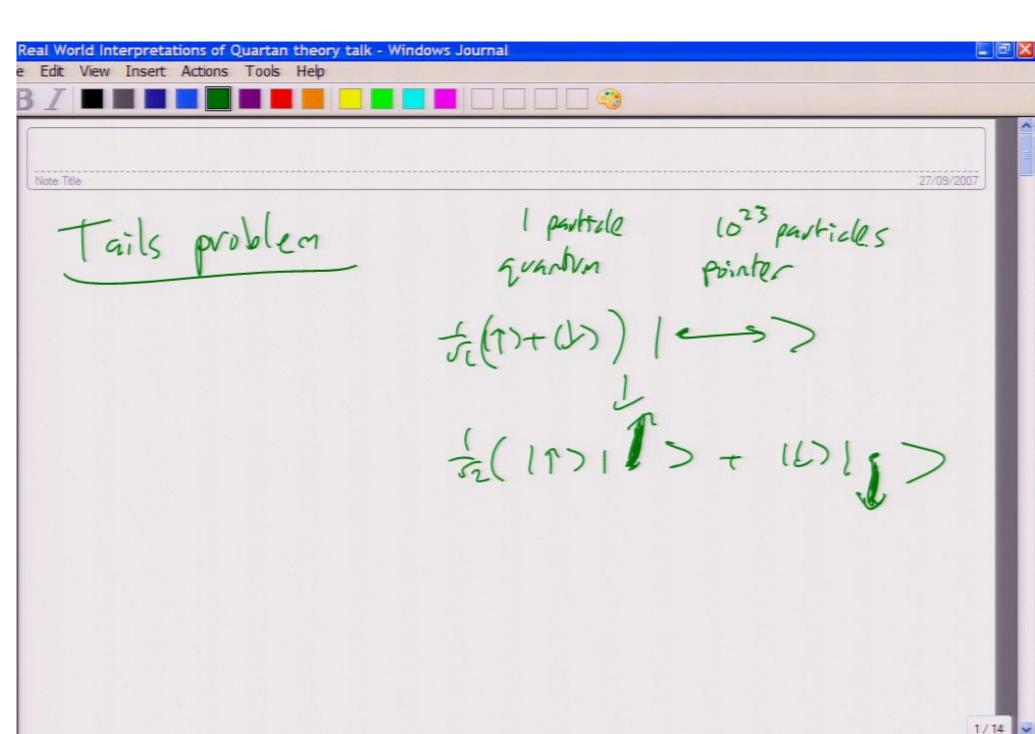






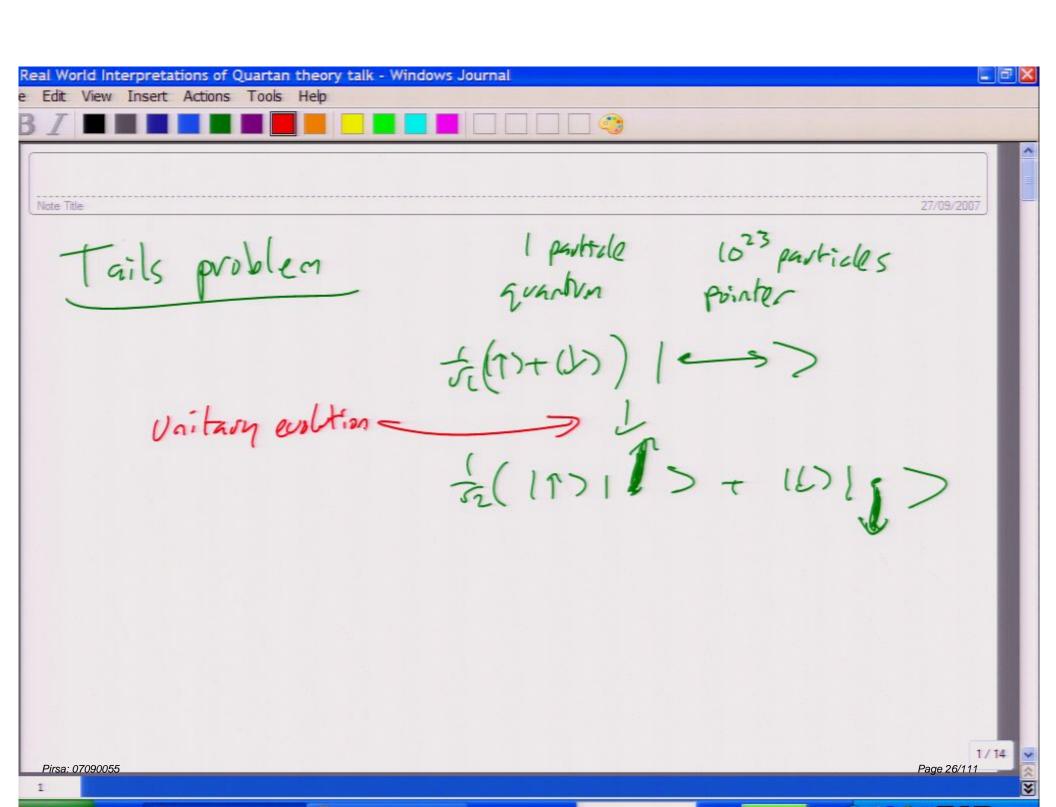


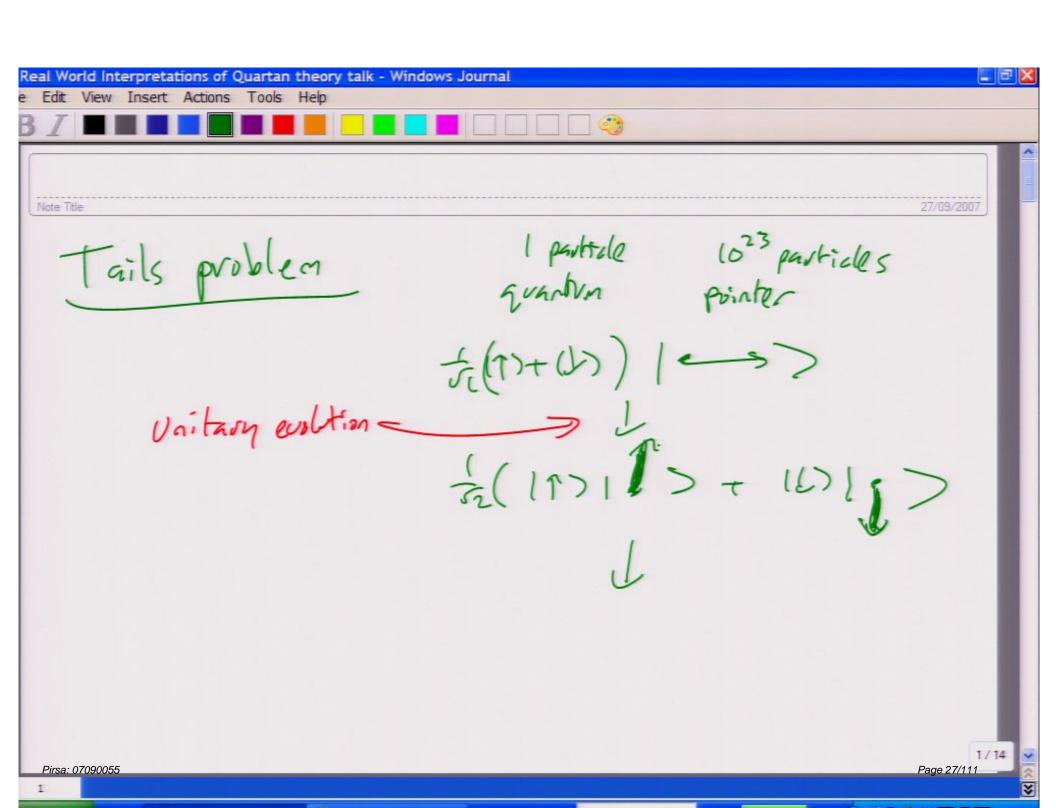


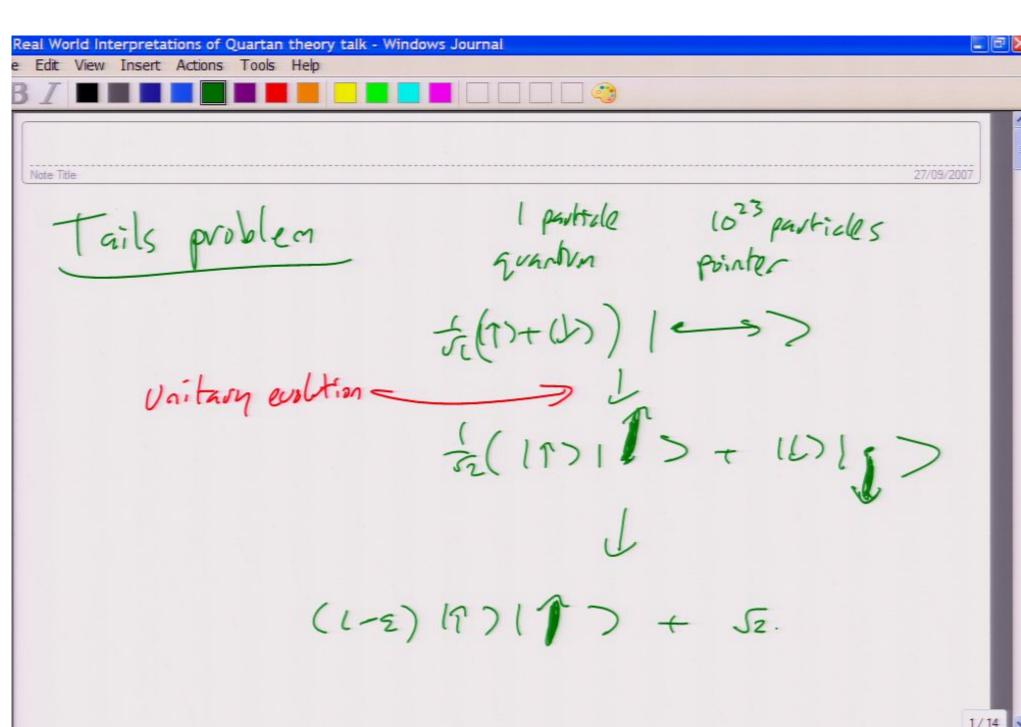


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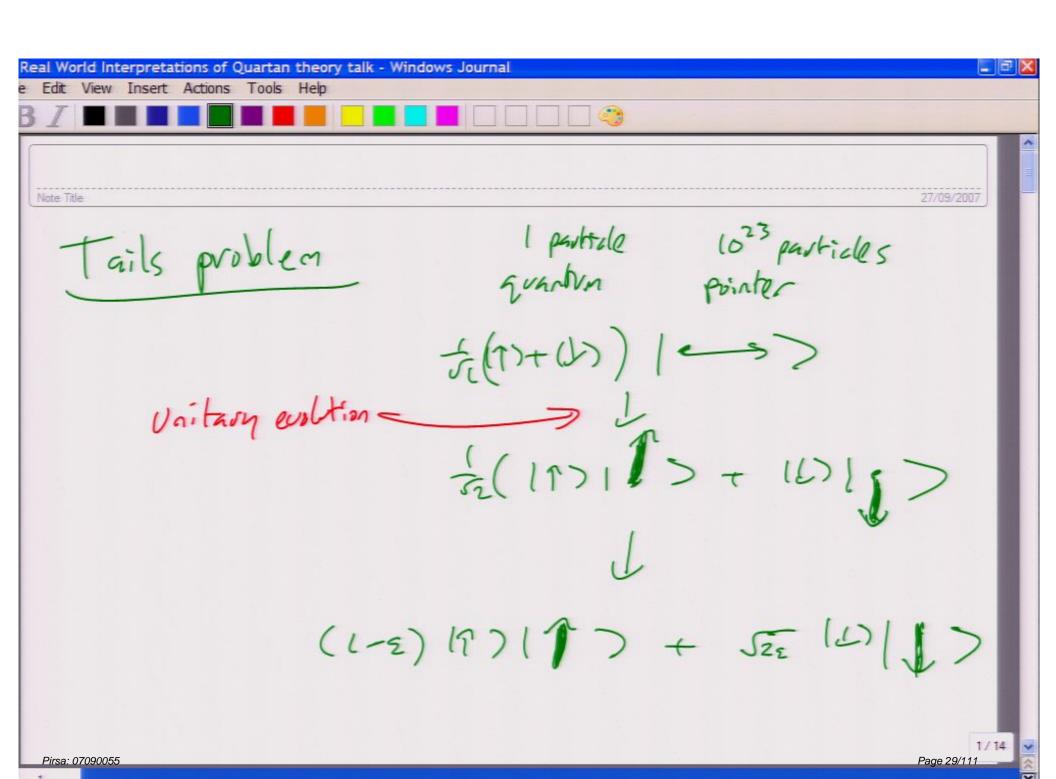


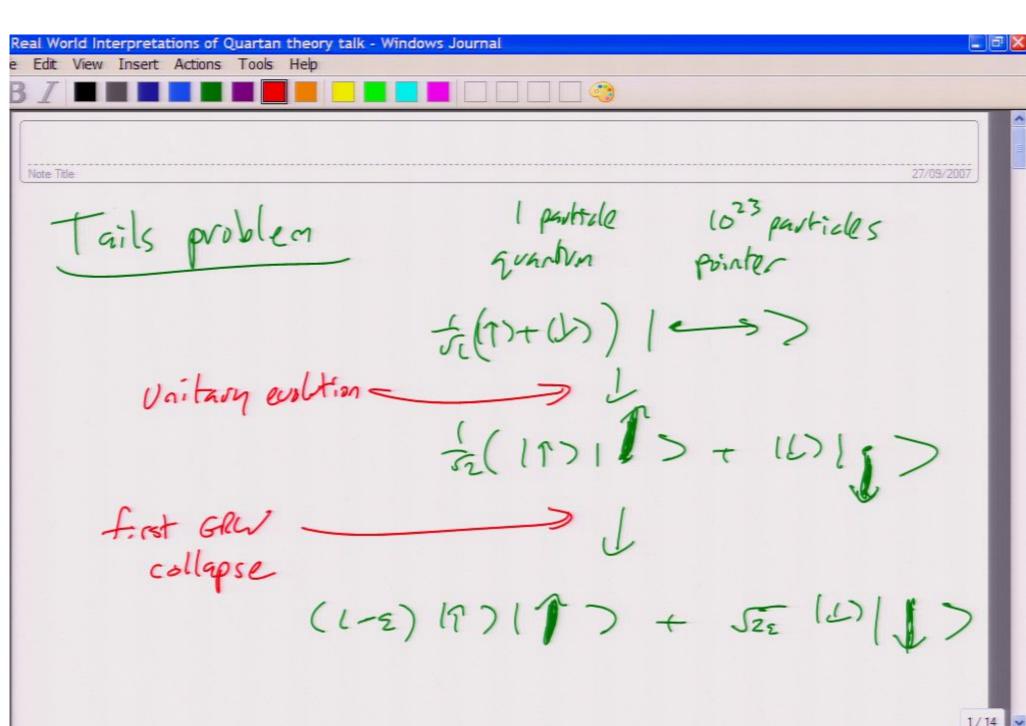




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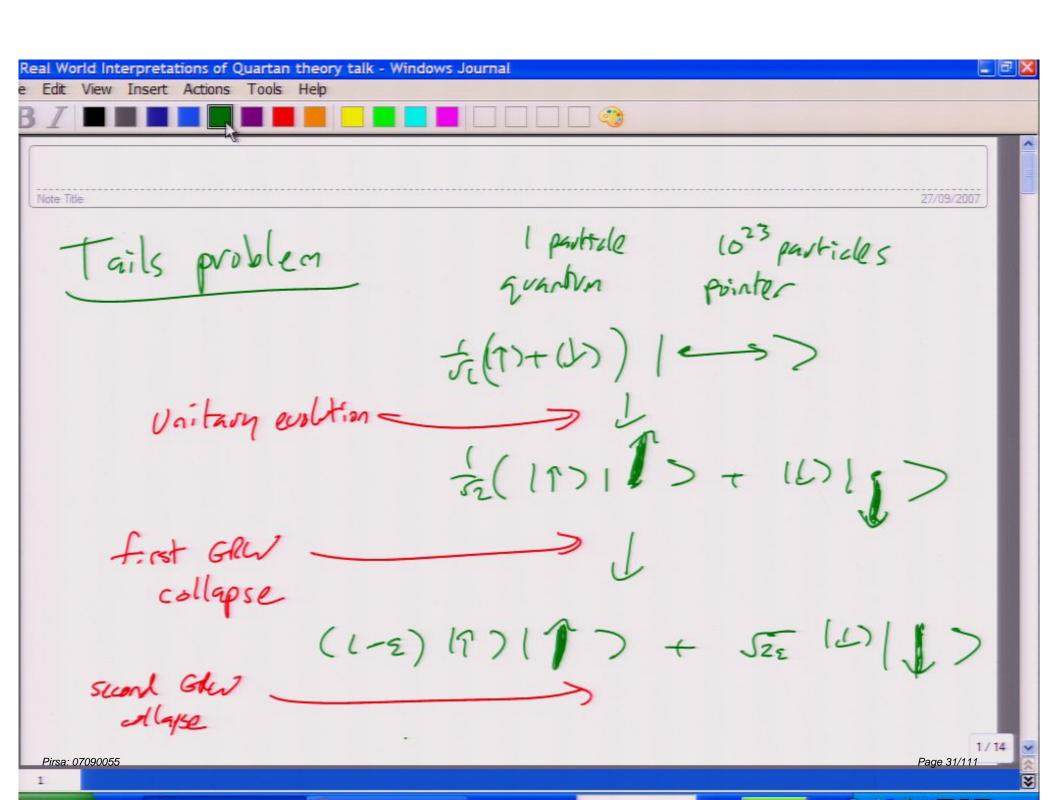
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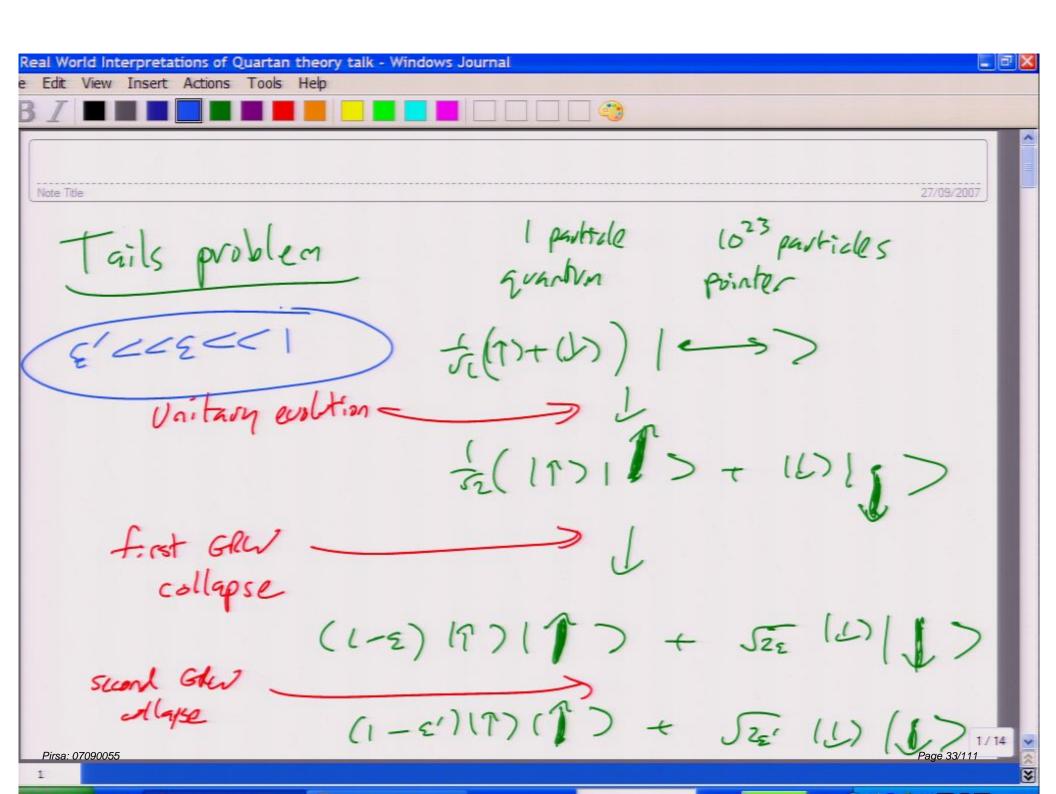


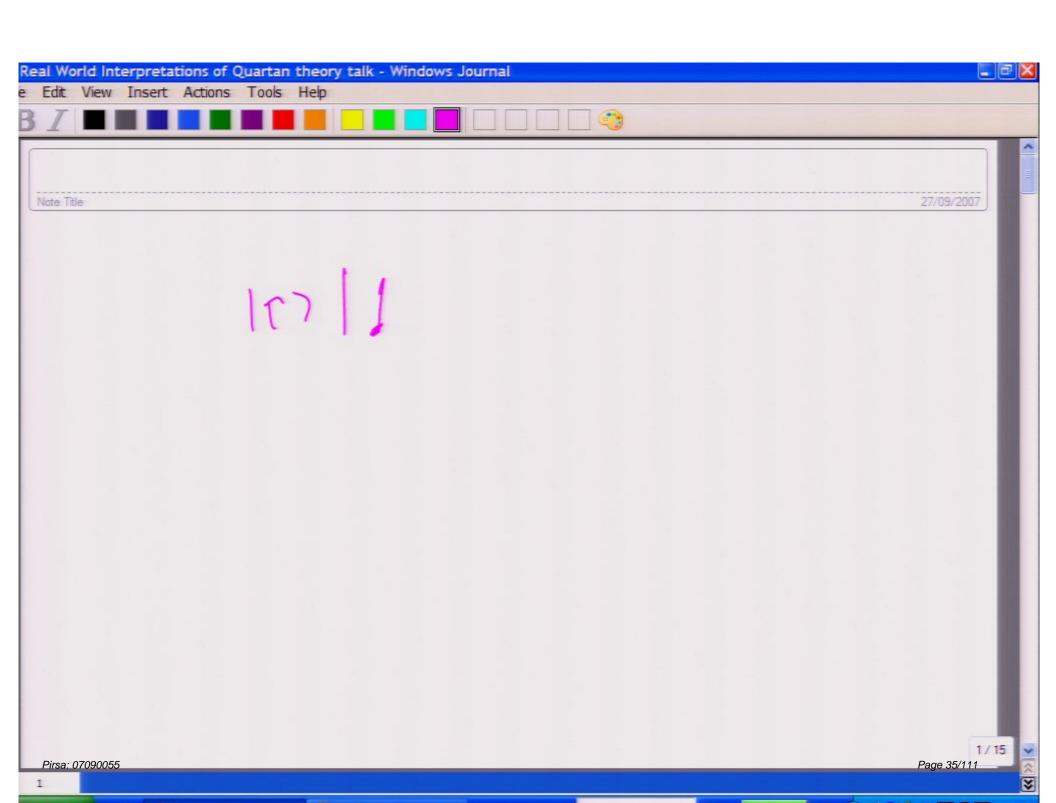


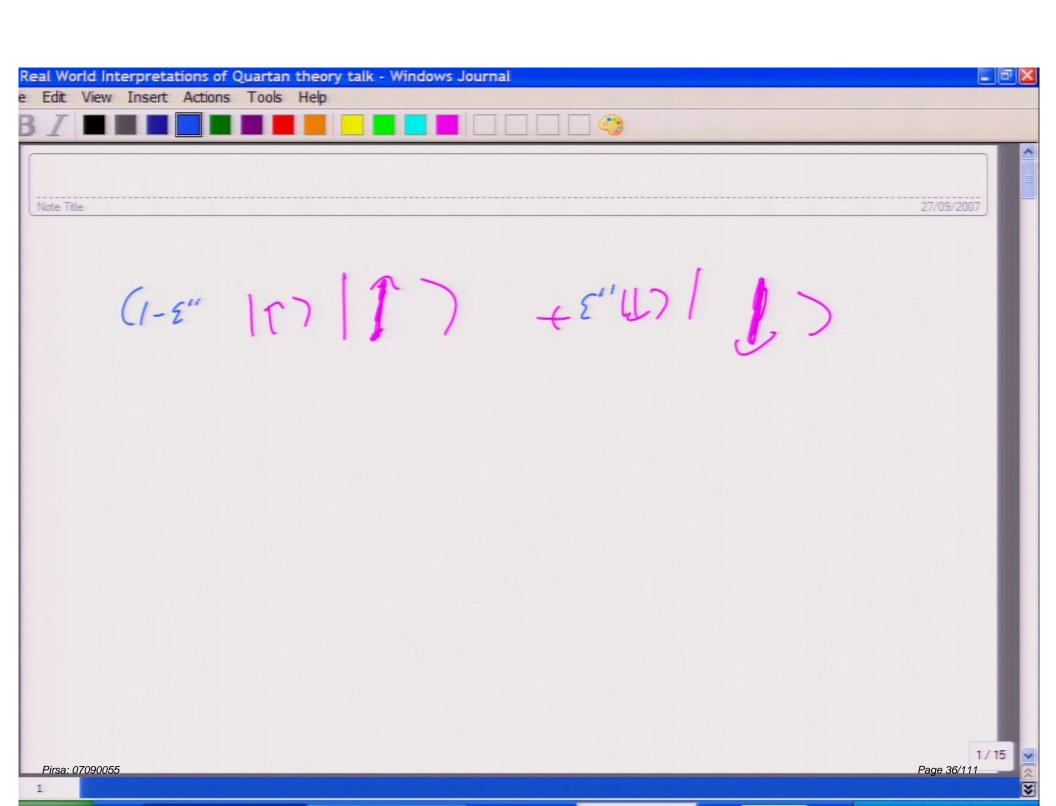
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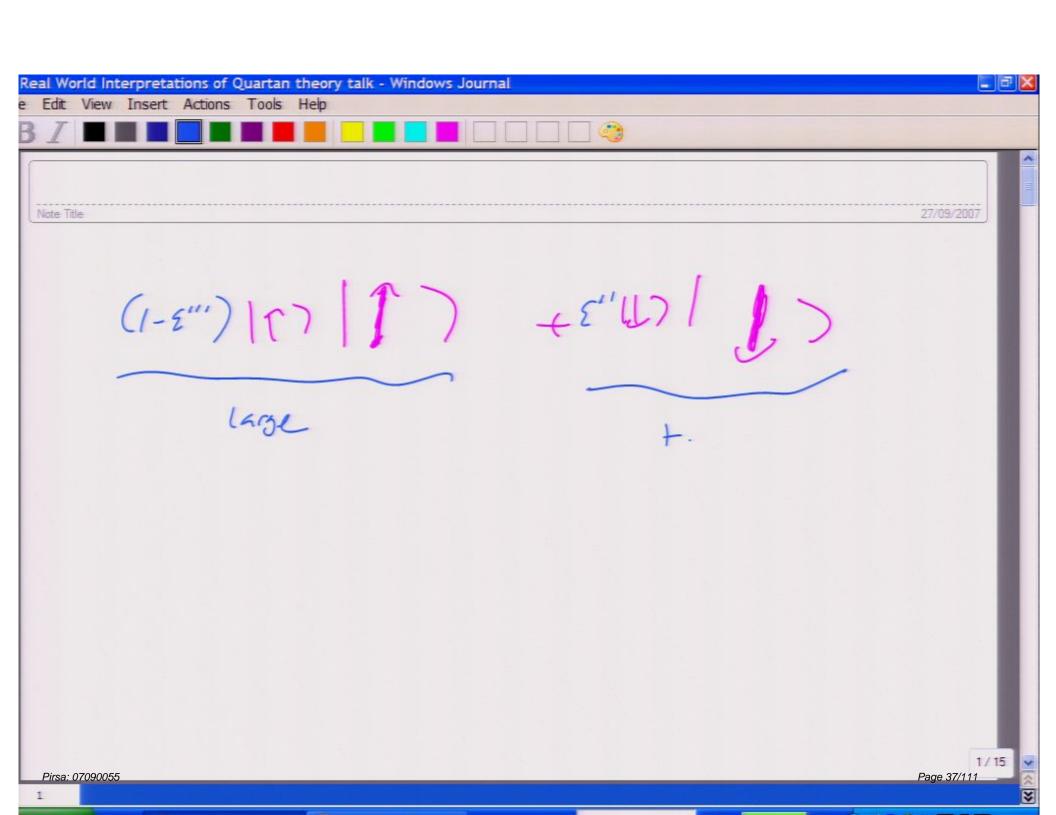
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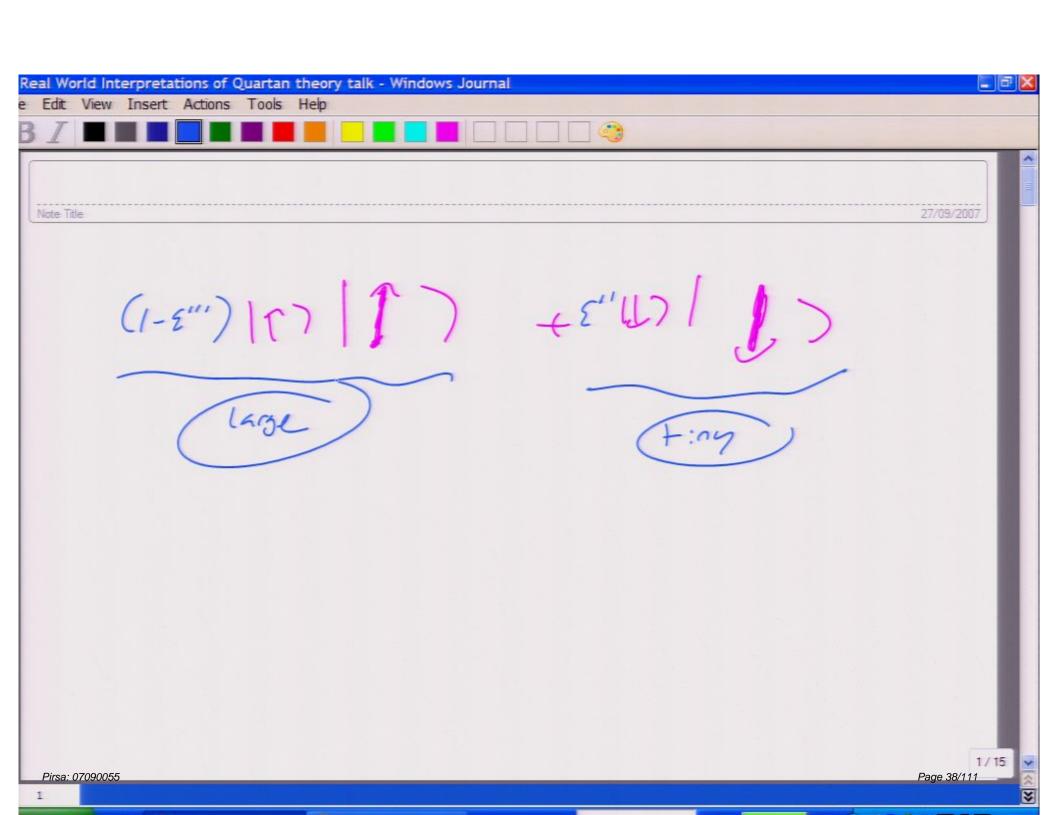


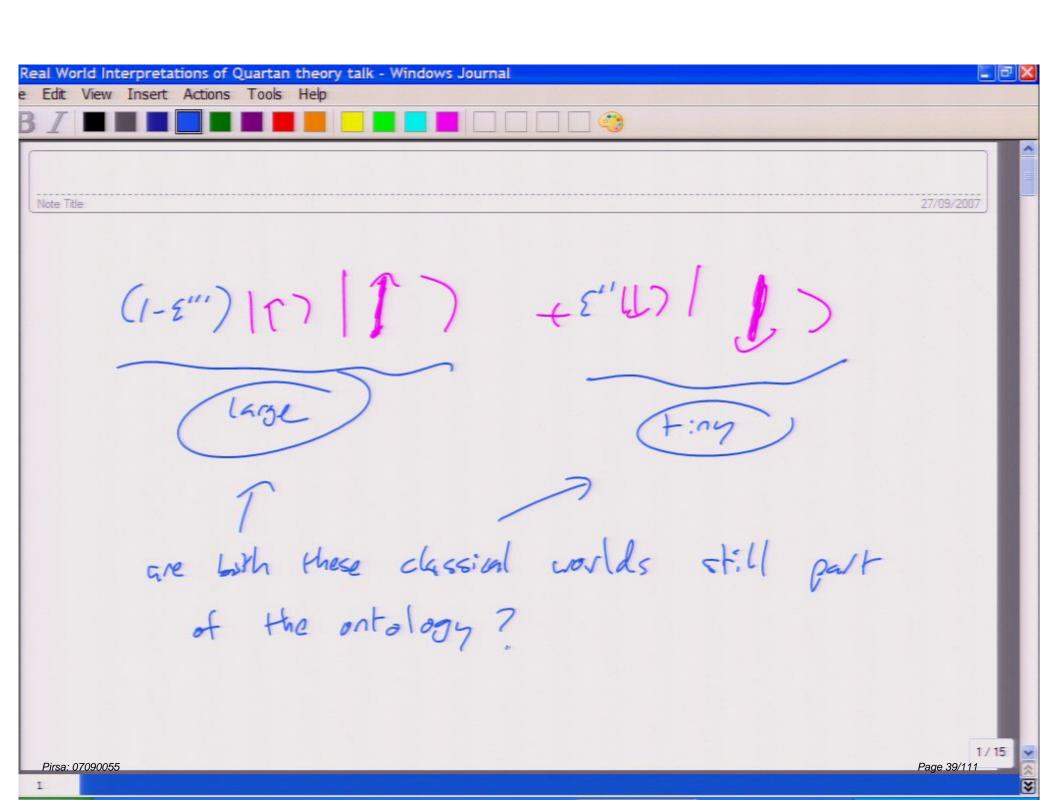


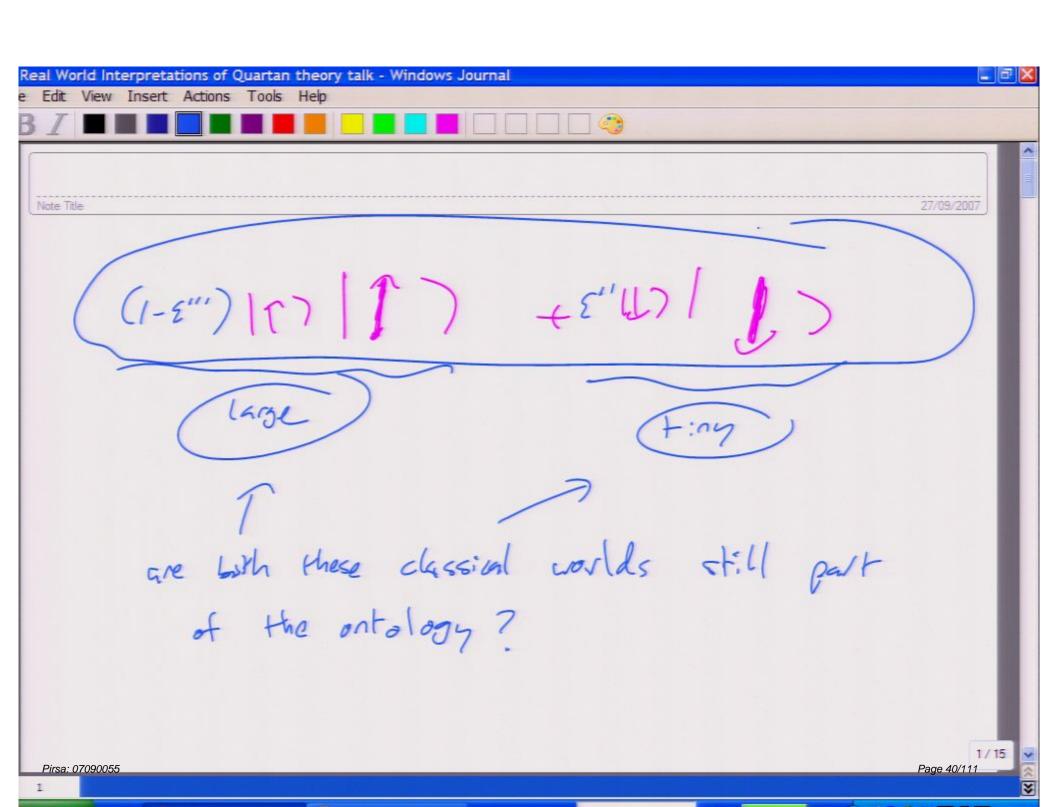


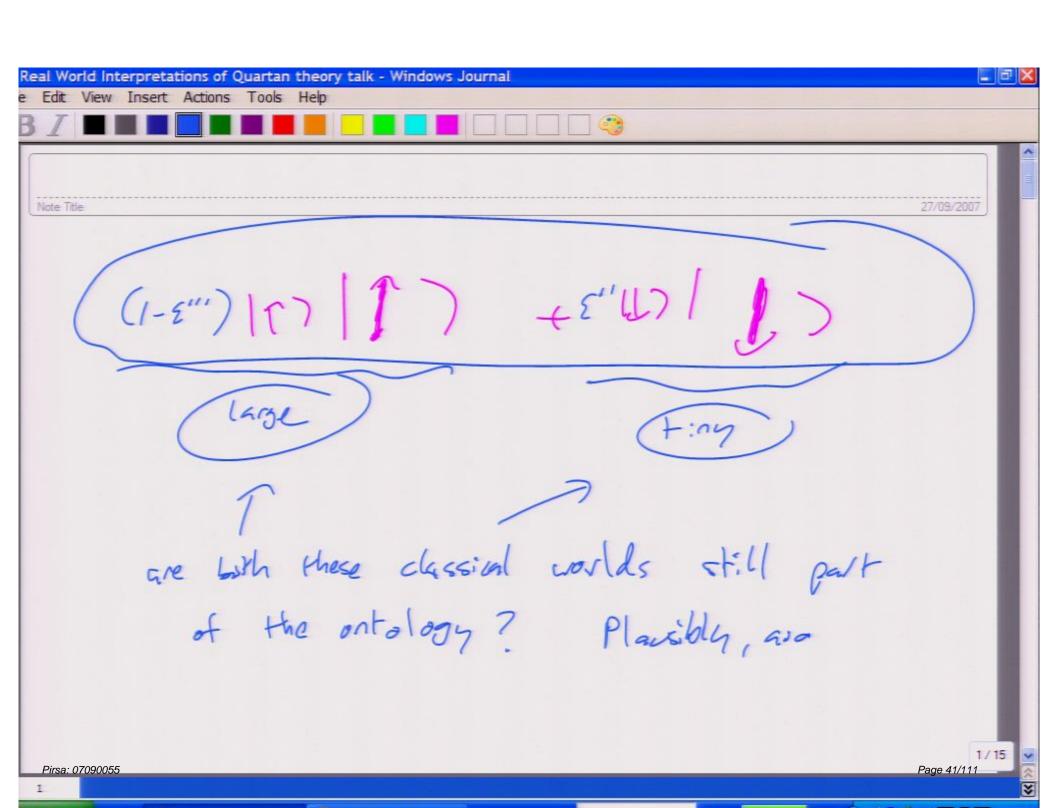


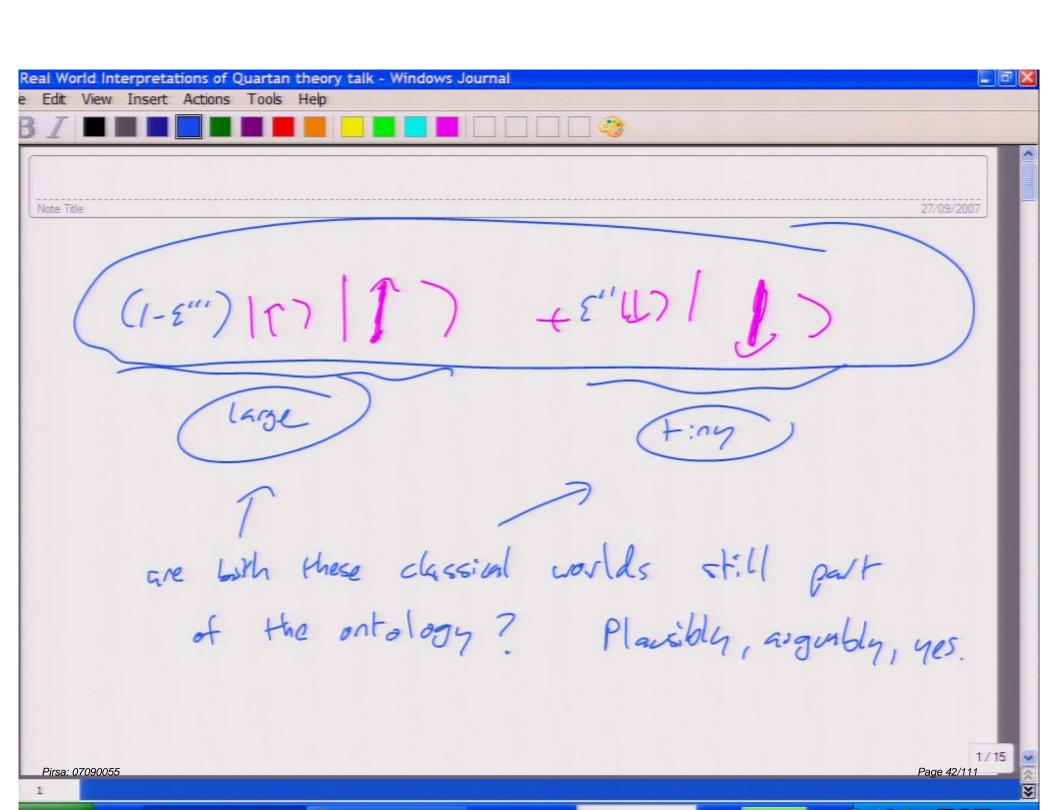












orthogonal over finite time.

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Real World Interpretations of Quantum theory

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2) (for Everettians, ontological agnostics, epistemic programmists and others) what one might, abusing the language a little, call a new phenomenology- a mathematical account of the quasi classical world that we appear to live in

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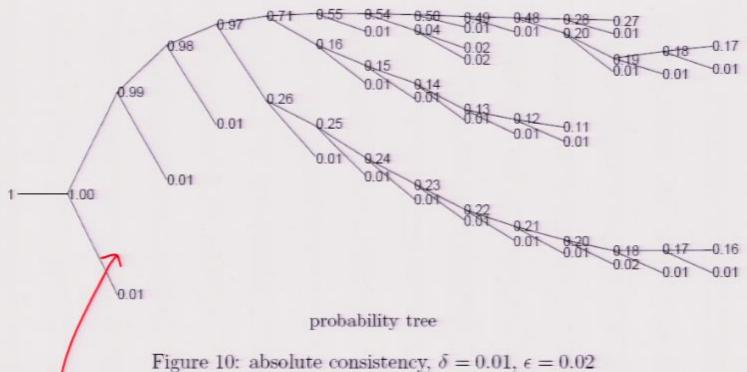
I.e. the idea is to solve the problem that a mathematical measure of quasi classicality which selects a unique quasiclassical consistent set would in the consistent histories approach.

Why not produce a set selection rule instead?

That, too, would certainly be very interesting, but it looks very hard to do - no strong reason to believe there really is a simple mathematical, generally applicable characterisation of quasiclassicality.



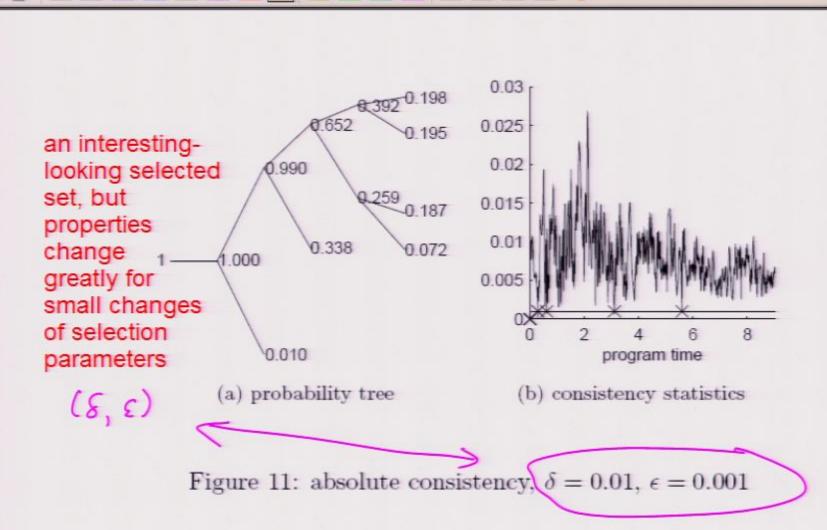
Schmidt-based selection rules illustrate some of the problems



nearly trivial histories are generally selected

 $\mathcal{S} = 0.01 = \min$ min. probability allowed.

It's usually realised in this particular selected set.



. arXiv:quant-ph/9812051 [ps, pdf, other]

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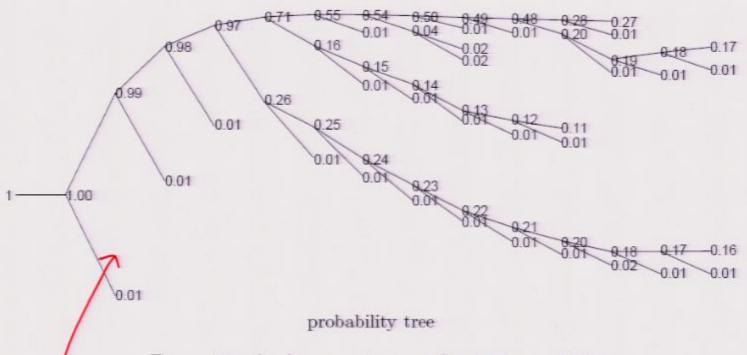


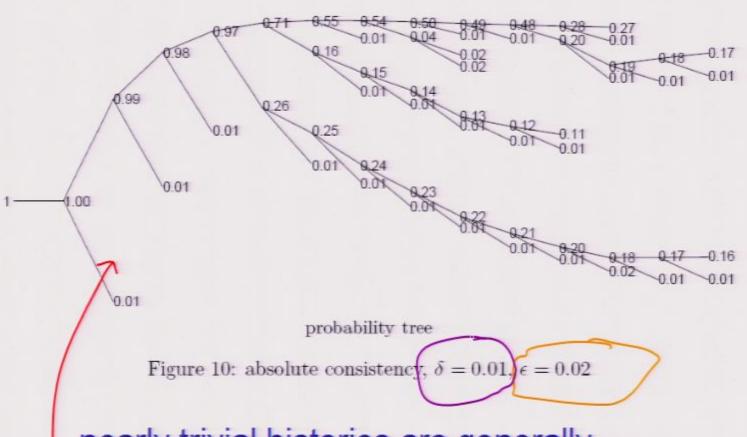
Figure 10: absolute consistency, $\delta = 0.01$, $\epsilon = 0.02$

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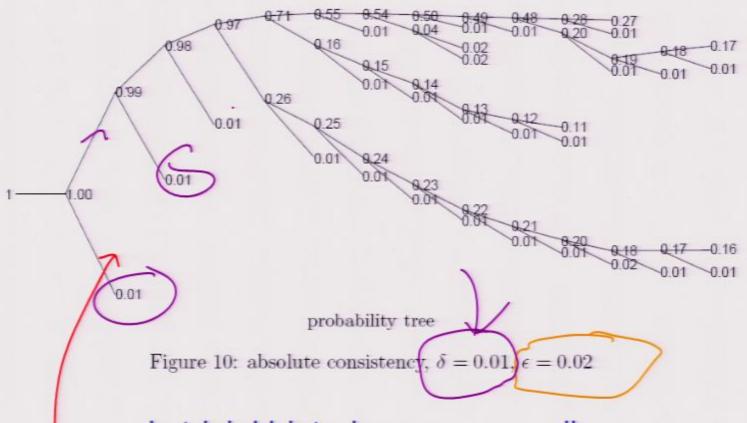
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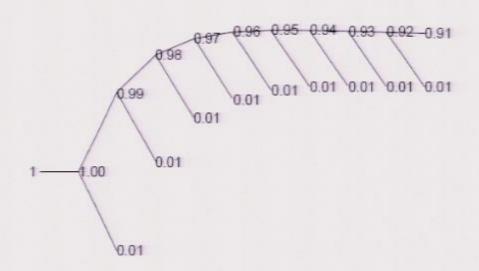


Figure 9: absolute consistency, $\delta = 0.01$, $\epsilon = 0.1$

Another example of the selection algorithm producing a sequence of nearly trivial histories



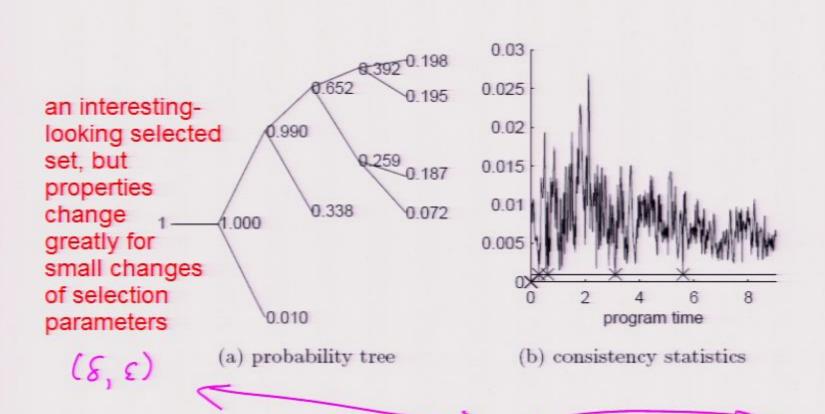


Figure 11: absolute consistency, $\delta = 0.01$, $\epsilon = 0.001$

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- Lorentz covariant, and plausibly adaptable to quantum gravity in a covariant way (beats de Broglie- Bohm, collapse models)
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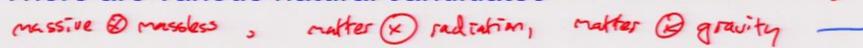
- 5) no evident problem of tails (so maybe beats Everett and collapse models here).
- 6) the ontology/phenomenology is defined by evolving quantum states - i.e. no additional mathematical structures (unlike de Broglie-Bohm or "flash ontology" collapse models).
- 7) clear account of ontology within which we can derive an account of epistemology (beats epistemic approaches (to date)).



What's the idea?

1) Assume a fundamental factorisation $H = H_a \otimes H_B$.

There are various natural candidates— femions & brows,



but relatively few.

2) Assume a preferred basis (possibly t-dependent or hypersurface-dependent) on H₈

Again there are various natural candidates- photon position or momentum bases, Schmidt basis, ... but relatively few.

which is good: the programme is testable

-- in the sense that if we exhaust the natural candidates and none of them work, it's failed.

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3) use the intuition that quasi classical worlds can be separated and labelled by as preferred basis measurement on H_{α} as $t \rightarrow \infty$) which also defines their probabilities by the Born rule:

(something like: different quasi classical evolutions and measurement outcomes can be identified in principle by measuring photon momenta as t > ?

At least in an ever-expanding universe this seems plausible)

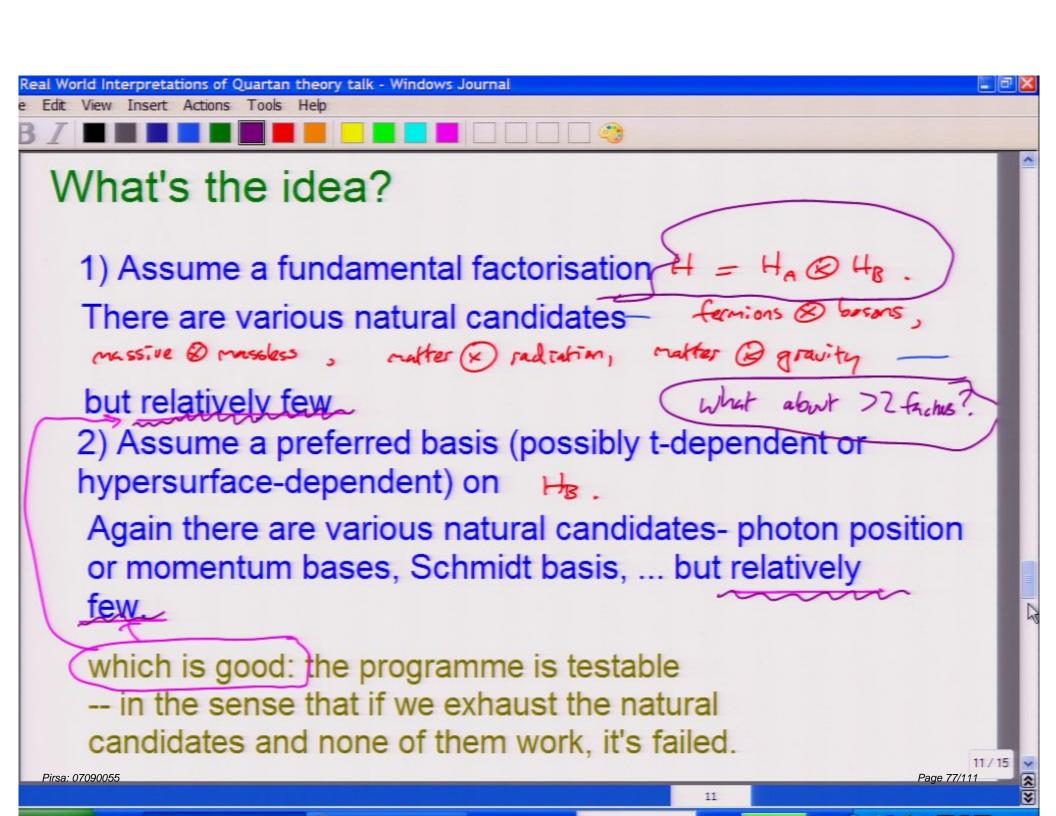
4) Having labelled the branches by their final states, infer their form at finite times by an algorithm using pre-selected data

post-selected data: final branch state: 4: (0) = TOP: 14(0)

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orthogonal for different branches

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5) We define branch states at finite t by considering the outcome probabilities of a measurement on H_B in the preferred basis at time t. (we don't assume all these intermediate measurements actually take place and collapse the state - which would produce a Zeno-esque and rather trivial evolution)

Let P: (3,1) be the probabilities for outcome j on branch i at time t

and
$$(I \otimes P_{j}(r)) \mathcal{U}(r) = \mathcal{U}_{j}(r)$$

or

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5) We define branch states at finite t by considering the outcome probabilities of a measurement on H_R in the preferred basis at time t. (we don't assume all these intermediate measurements actually take place and collapse the state which would produce a Zeno-esque and rather trivial evolution)

Let P:(1,1) be the probabilities for outcome j on branch

and
$$(I \otimes P; (r)) \mathcal{U}(r) =$$

corresponding states.



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Let P:(i,+) be the probabilities for outcome j on branch

(1) at time t

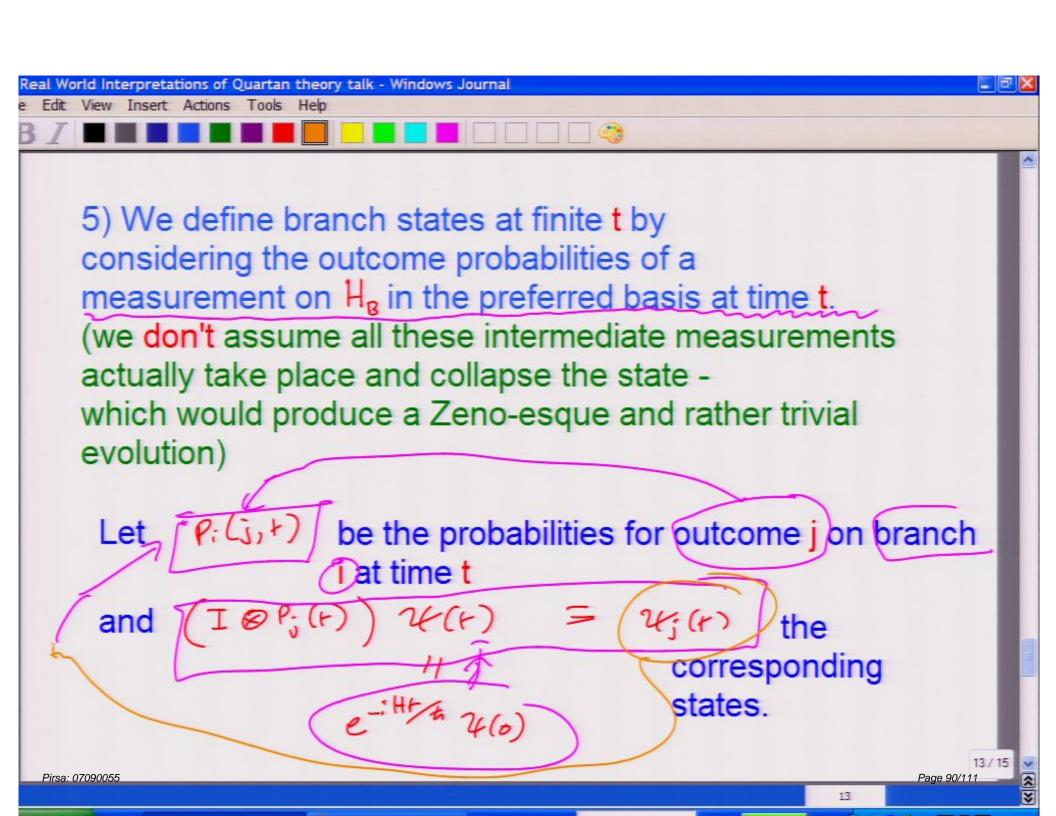
and $(I \otimes P_{j}(F)) \mathcal{U}(F) = \mathcal{U}_{j}(F)$ the corresponding states.

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and $(I \otimes P; (r)) \mathcal{U}(r) = \mathcal{U}; (r)$ the corresponding states.

Pirsa: 07090055

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Insert Actions Tools

Then define the real state

Hadly whose Intuition: we're selecting here states on "environment" component is consistent with the branch final state's. (E.g. distribution of photon momenta at time t is Pirsa: 07/09/055 nsistent with that at time <a>)



Insert Actions Tools

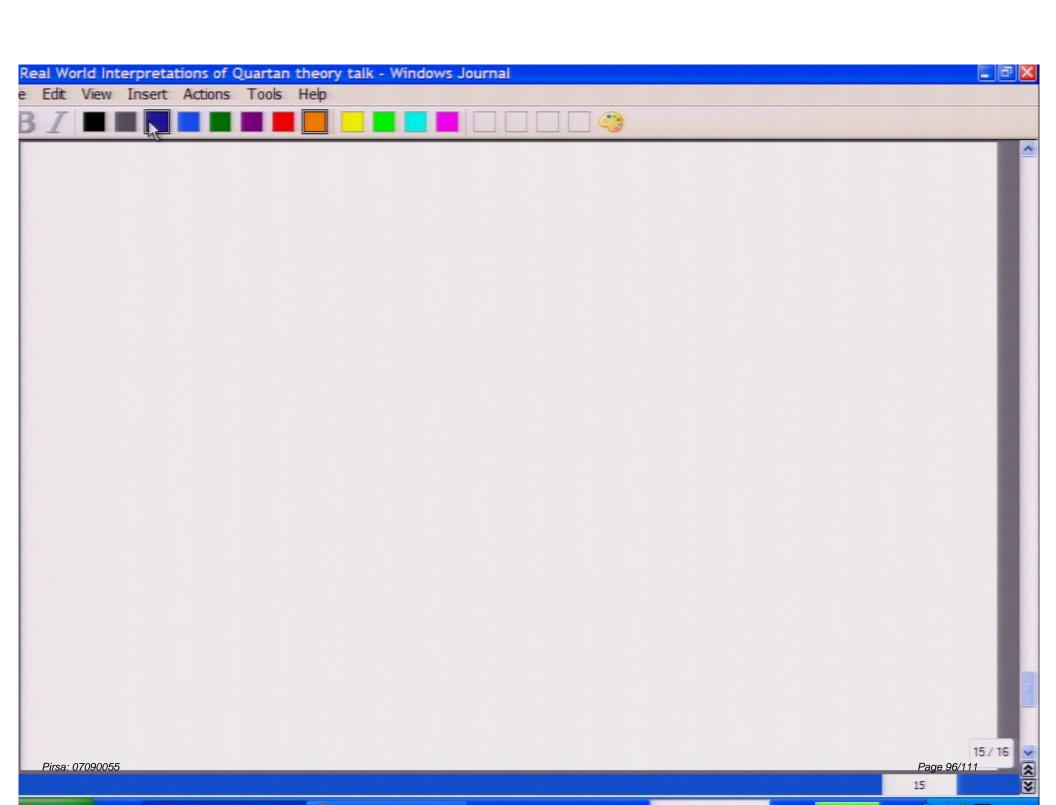
Then define the real state

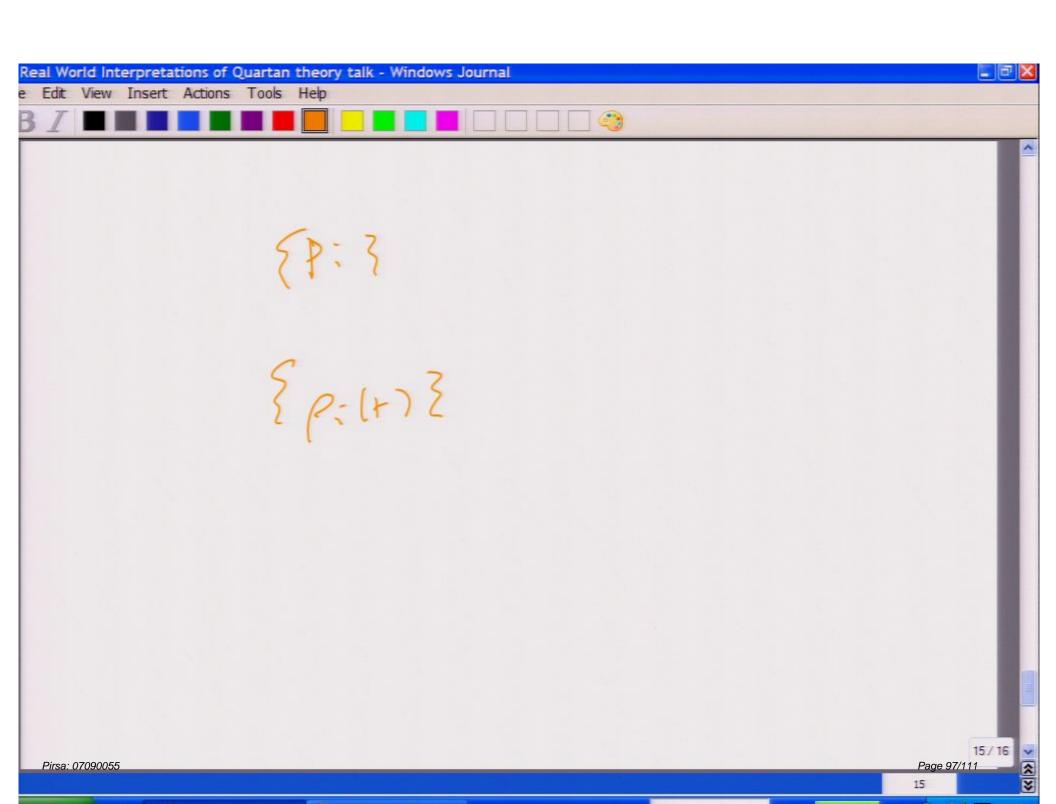
14;(1) (4)

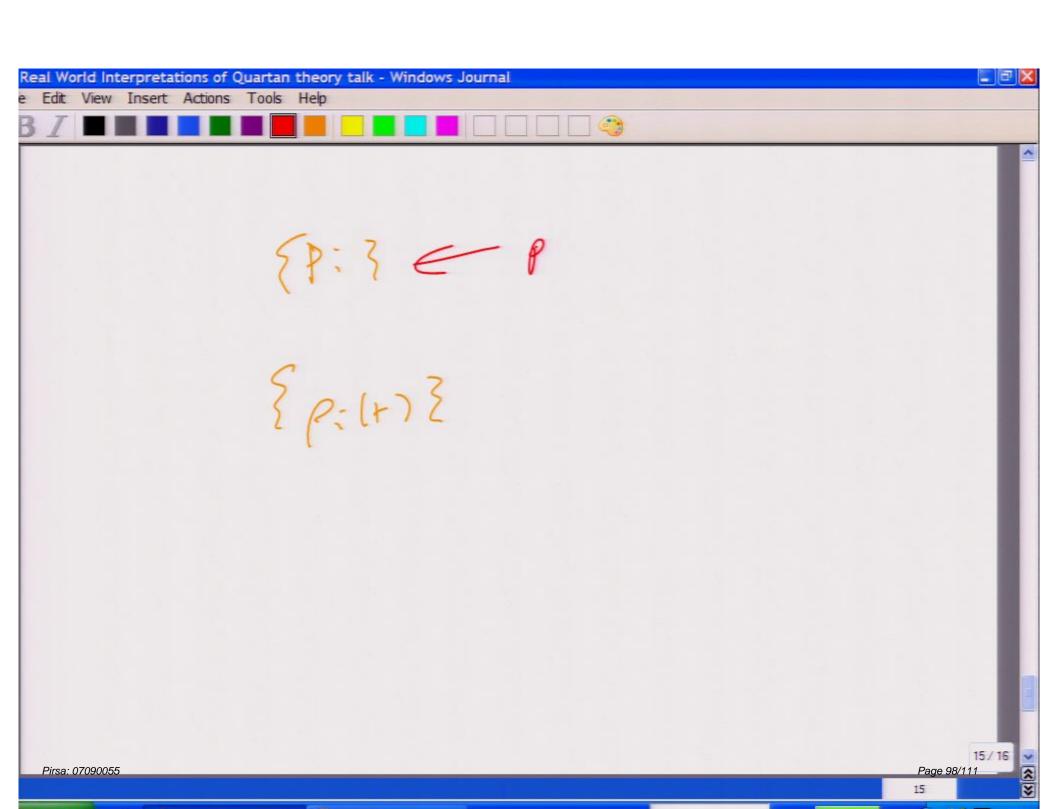
Hawly whose Intuition: we're selecting here states on "environment" component is consistent with the branch final state's. (E.g. distribution of photon momenta at time t is Pirsa: 07090055

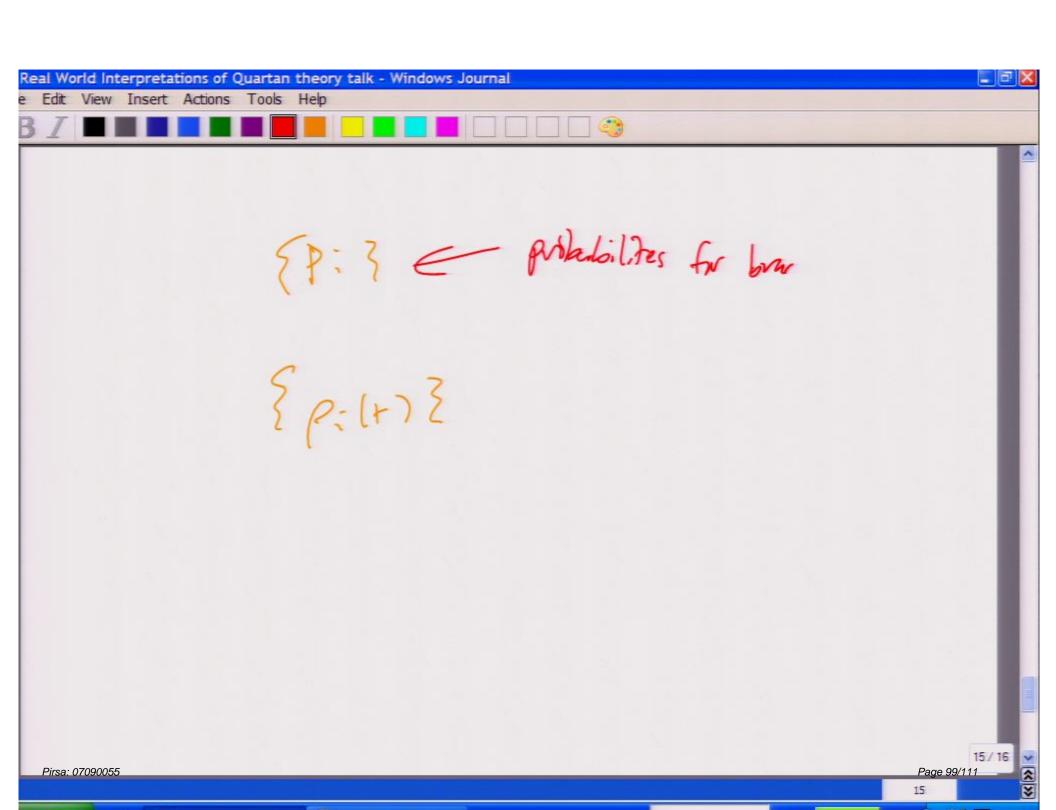
factor

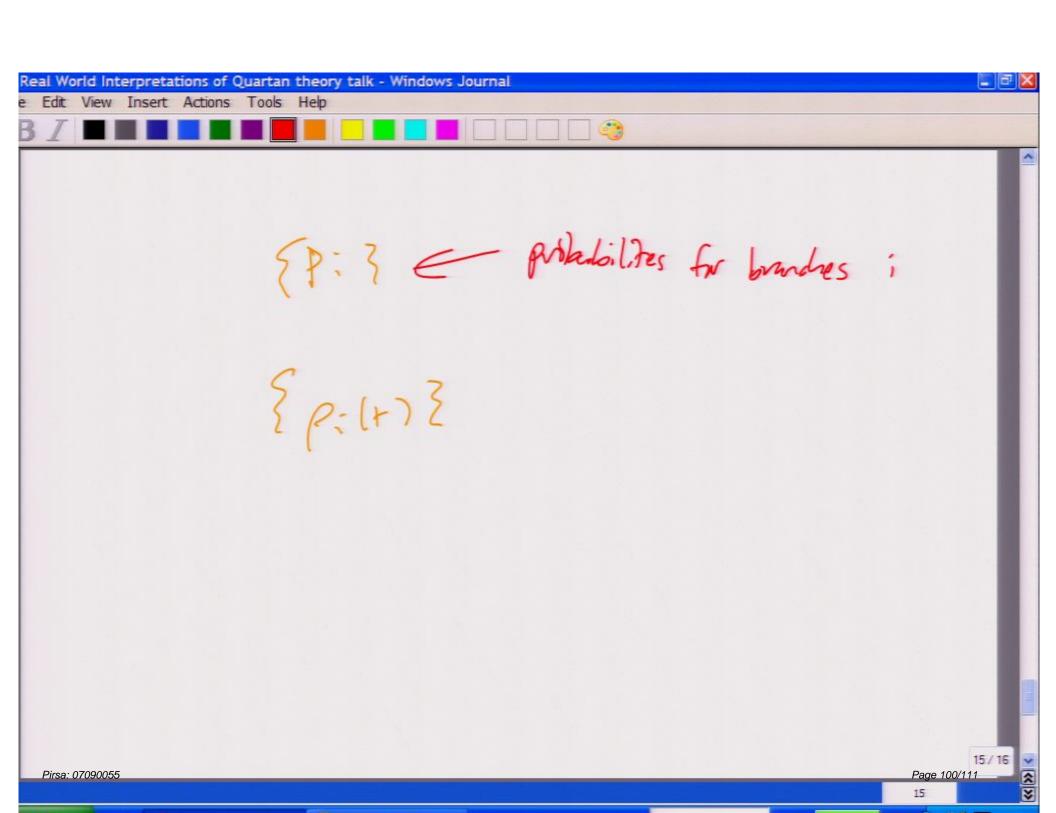
collapses on position space in this factor

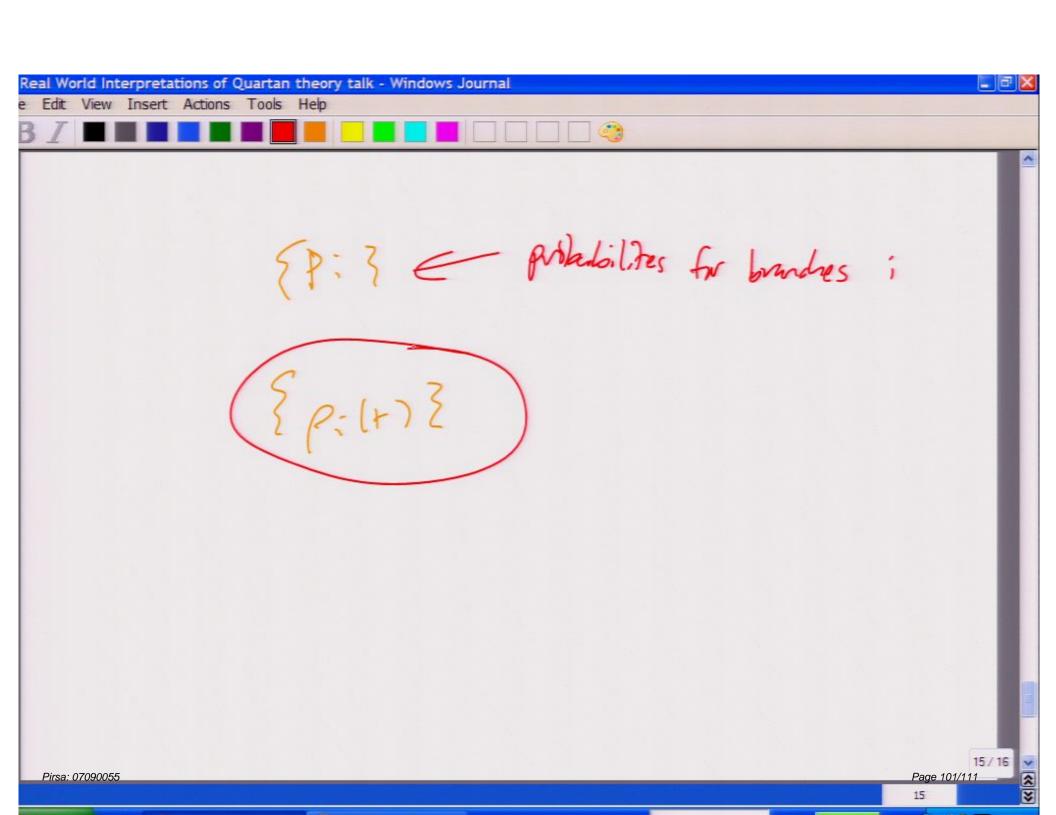


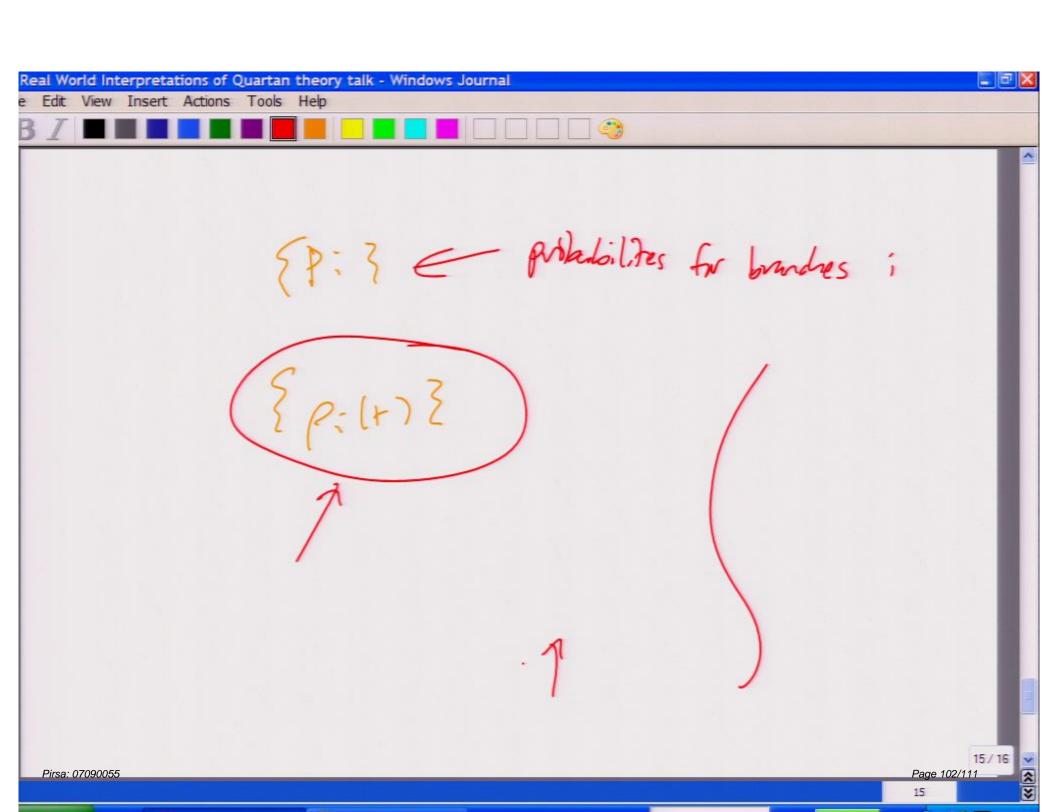


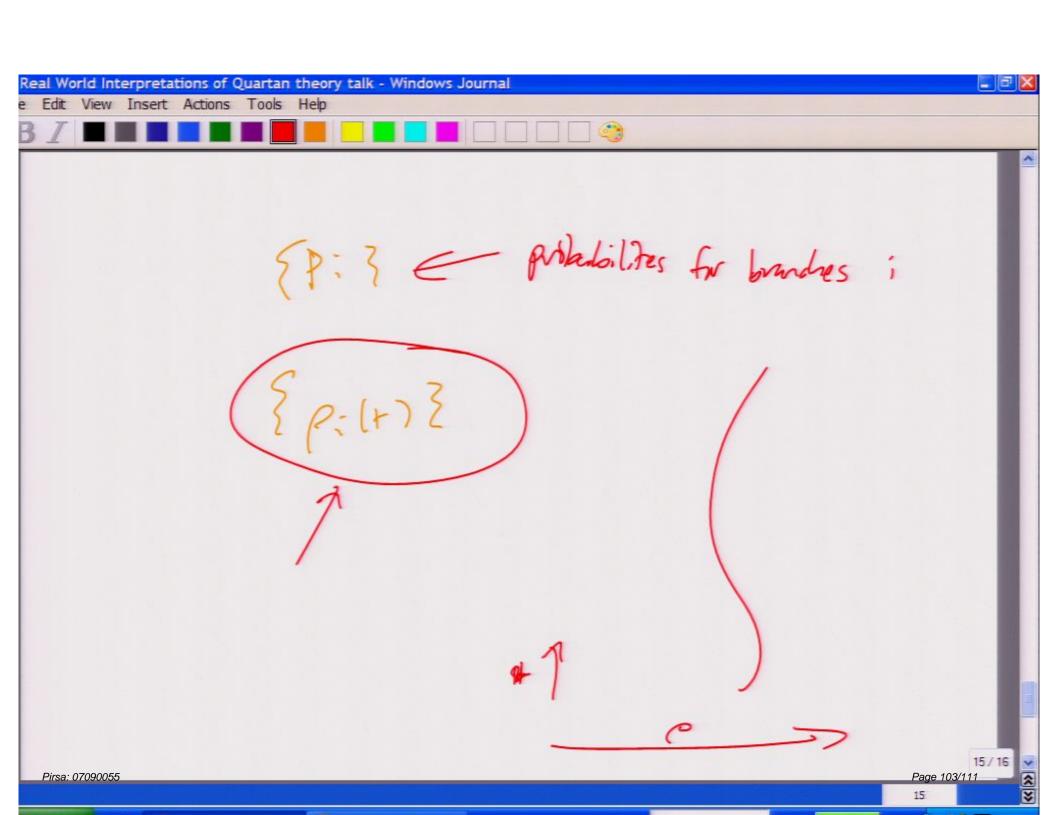


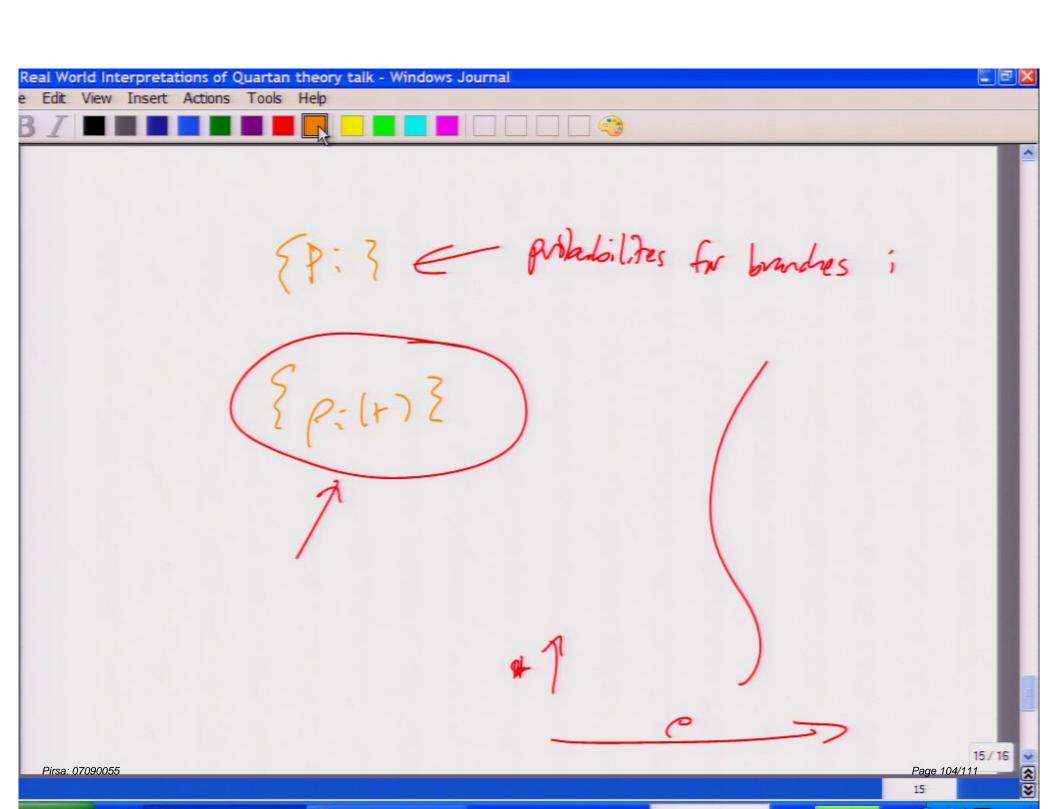


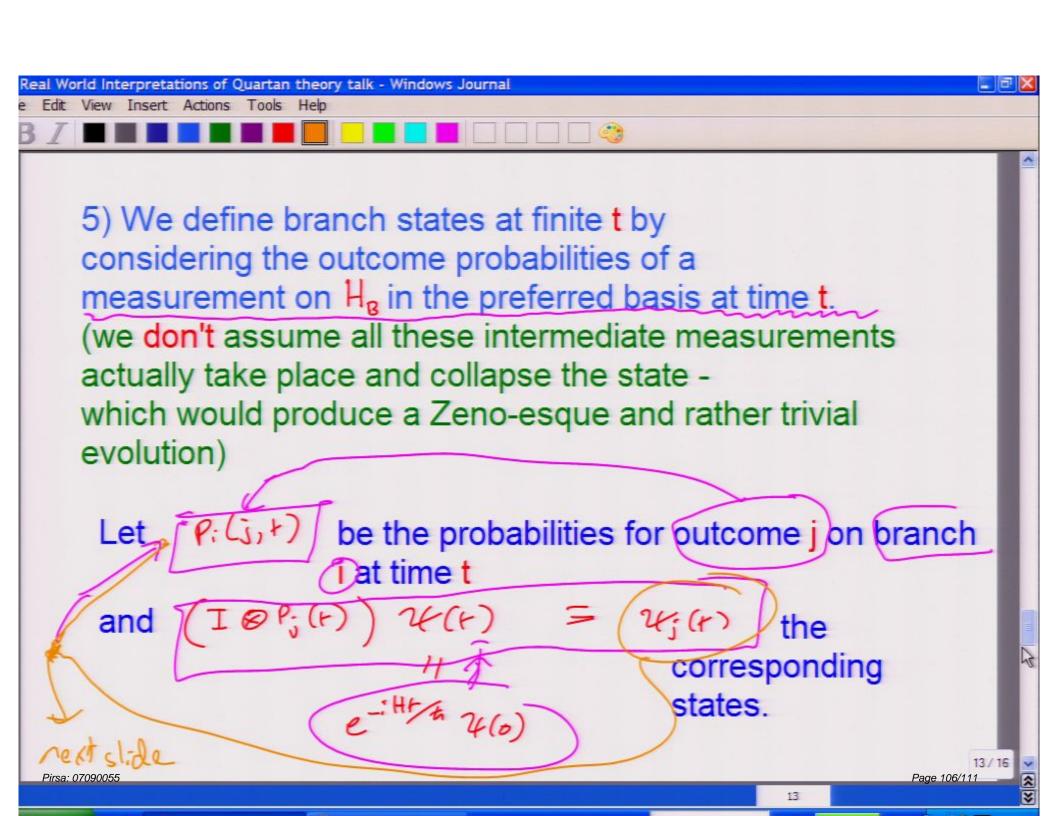


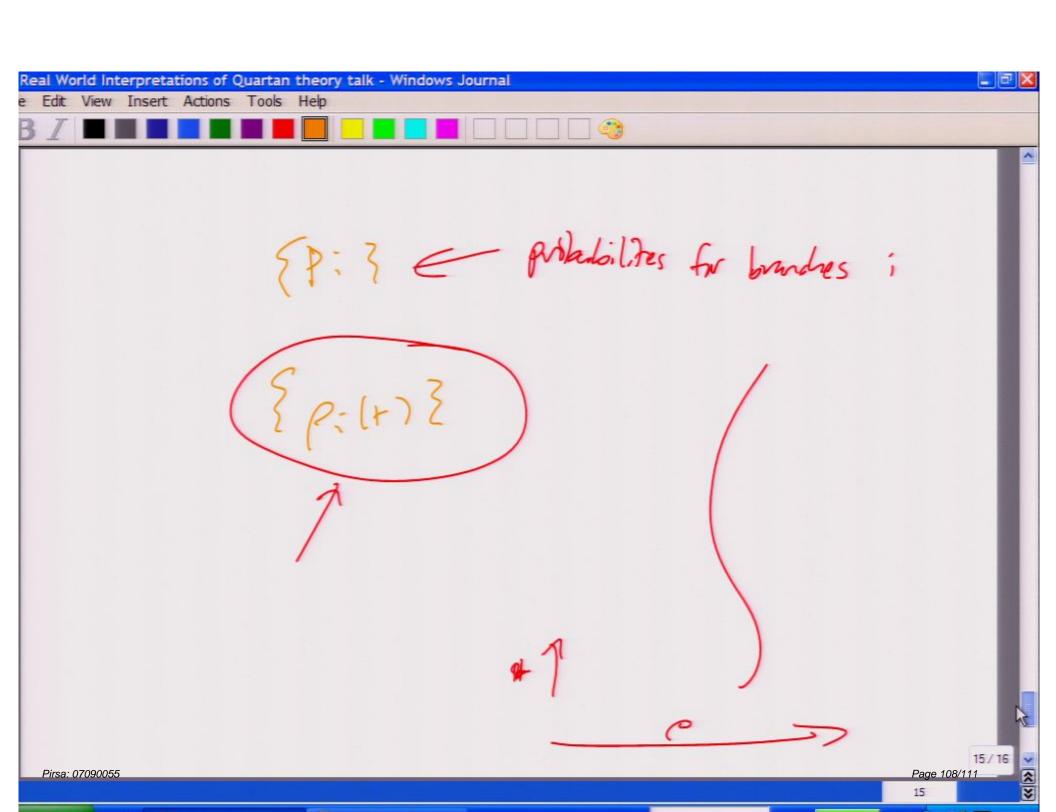












the idea 6 aing

matrix ontology on this

factor.

H= H_A & H_B Collapses on positi

collapses on position space in this factor

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the idea being s

matrix ontology on this factor.

H= H_A Ø H_B Collapses on positi

in some hybrid "modal + collapse" models.]

collapses on position space in this factor

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