

8.04 QUANTUM PHYSICS I



L1 INTRODUCTION TO SUPERPOSITION

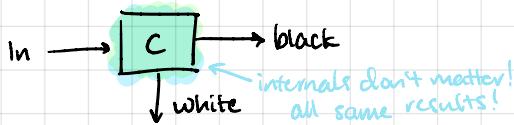
SOME EXPERIMENTS

* two parts of e^- :

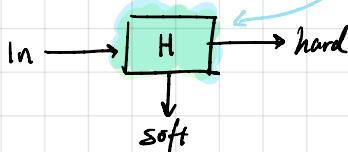
* color : {black, white}

* hardness : {hard, soft}

* it is possible to build a "color box":



* similarly, "hardness box":



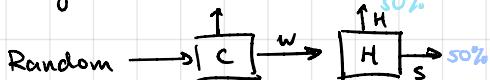
* key prop of boxes: repeatable



* props are persistent

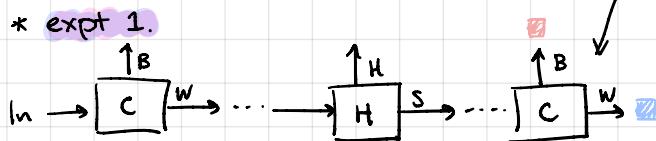
QUESTIONS

* are C & H be related/correlated? NO
* e.g. if e^- is W — is H determined?



* same result if H, then C.

EXPT 1.



* predt: 100% W, 0% B

* actl: 50% W, 50% B

⇒ properties can "change" but not when measuring same consecutively.

⇒ +/i s/t intrinsically unpredictable abt our measurements

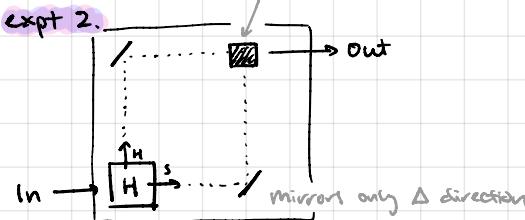
SOME CONSEQUENCES

* we cannot build a color & hardness box.

* the uncertainty principle. +/a certain measurable props that are fundamentally incompatible w/ e^- i.e. it is meaningless to say an e^- is H and W.

* this applies to **EVERYTHING!**

* expt 2. combines because



* (send in one e^- at a time)

* [I] In: W Measure @ Out: Hardness

* Prdt: 50% H, 50% S

* result: Prediction Correct!

* [II] In: H Measure @ Out: Color

* Prdt: 50% B, 50% W

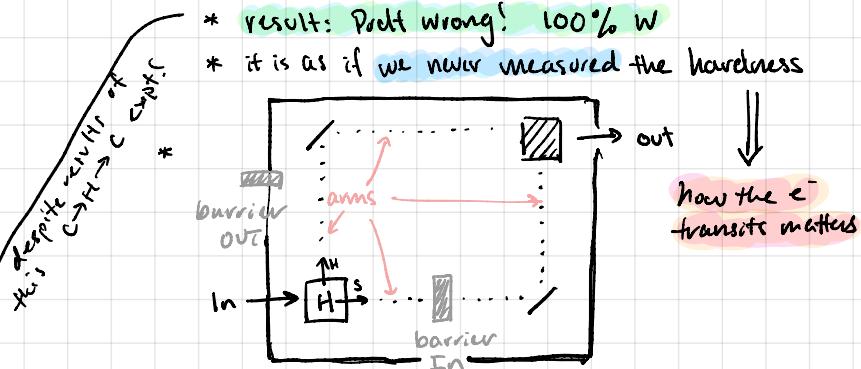
* result: Prdt correct!

* [III] In: W Measure @ Out: Color

* Prdt: 50% B, 50% W

* result: Prdt wrong! 100% W

* it is as if we never measured the hardness



* [IV] In: W, Measure @ Out: Color, Wall in S

* Prdt: 50% W, 50% B

* we know H ⇒ color now uncertain

* can also prdt that e^- don't know abt barrier ⇒ 100% W.

* question:

* arms are millions of km long: how does an e^- know whether or not the barrier is in?

* In Expt 2.III, which path did the e^- take?

* H? NO, b/c 2.IV has diff. results.

* S? NO

* both? NO ← it is both, but not

* neither? NO in a measurable way w/ detector (i.e. $\frac{1}{2} e^-$)

* what is the e^- doing in the expt?

⇒ it is in "superposition"

* it is in a superposition of H & S.

* having definite color means it is in superposition of H & S.