BASIC CONCEPTS OF QUANTUM COMPUTATION

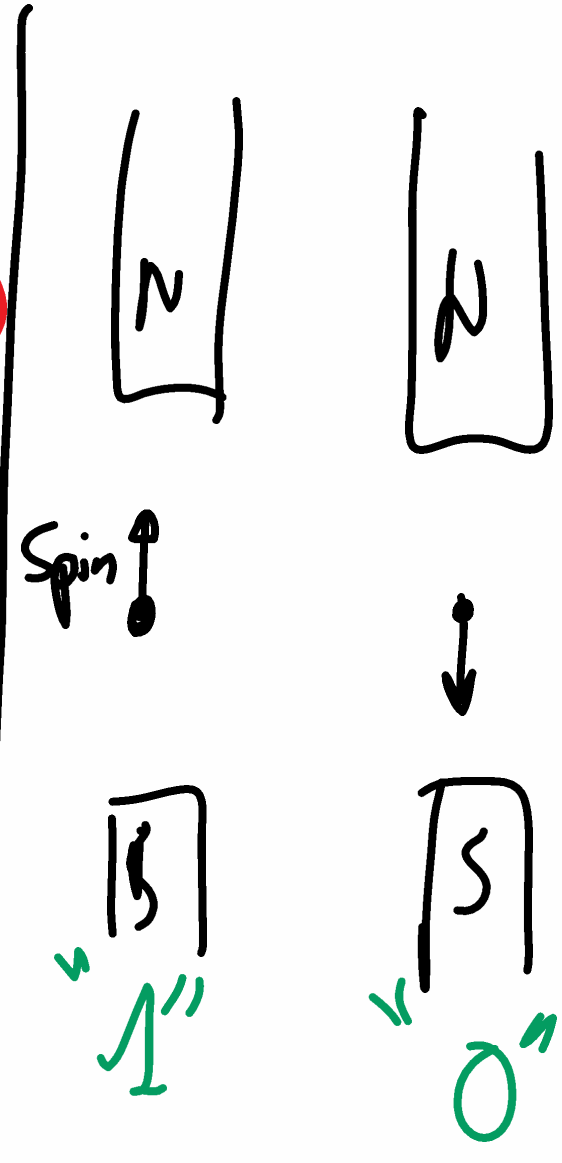
Tue 30 Oct 2018

Fundamental ingredients of Classical Computers/Computation:

- Distinction of High/Low voltage (the 0's & 1's "States")
- Switch On/off (transistor)

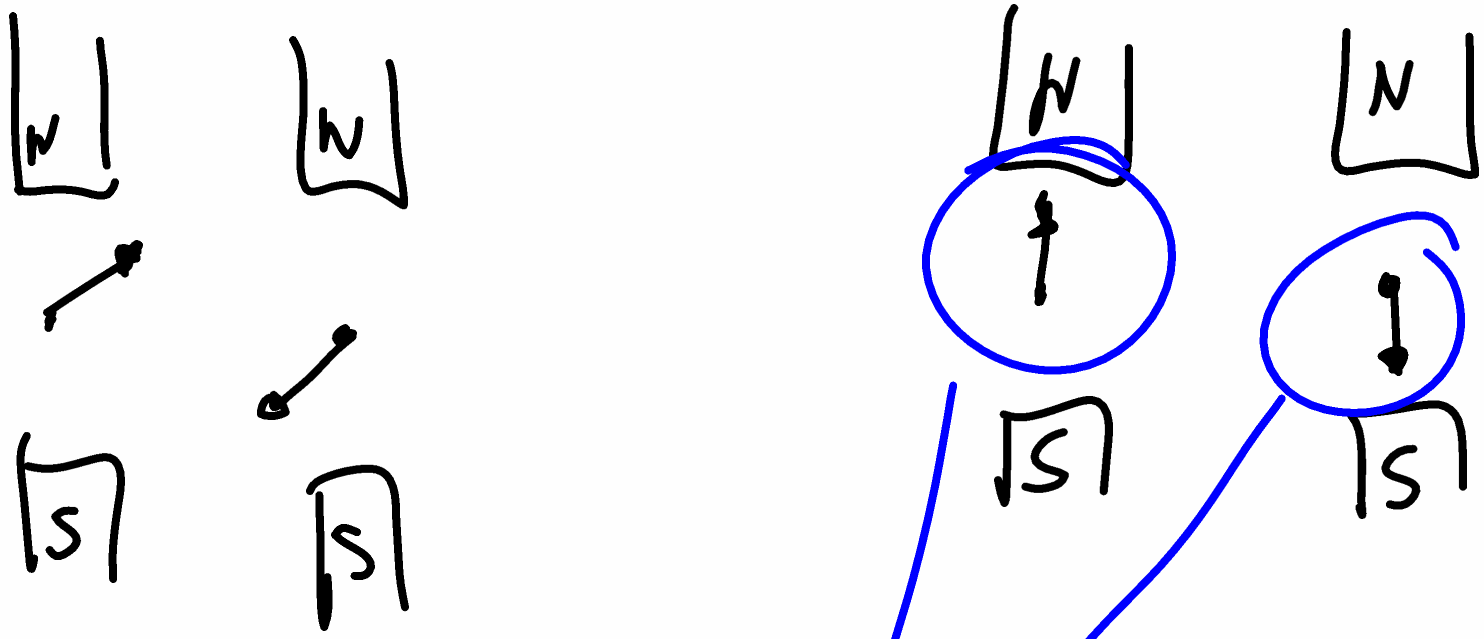
THE QUANTUM WORLD

Examples of "2-values"



BASIC CONCEPTS (FACTS) OF THE QUANTUM WORLD

1) A QUANTUM SYSTEM CAN BE IN MANY STATES

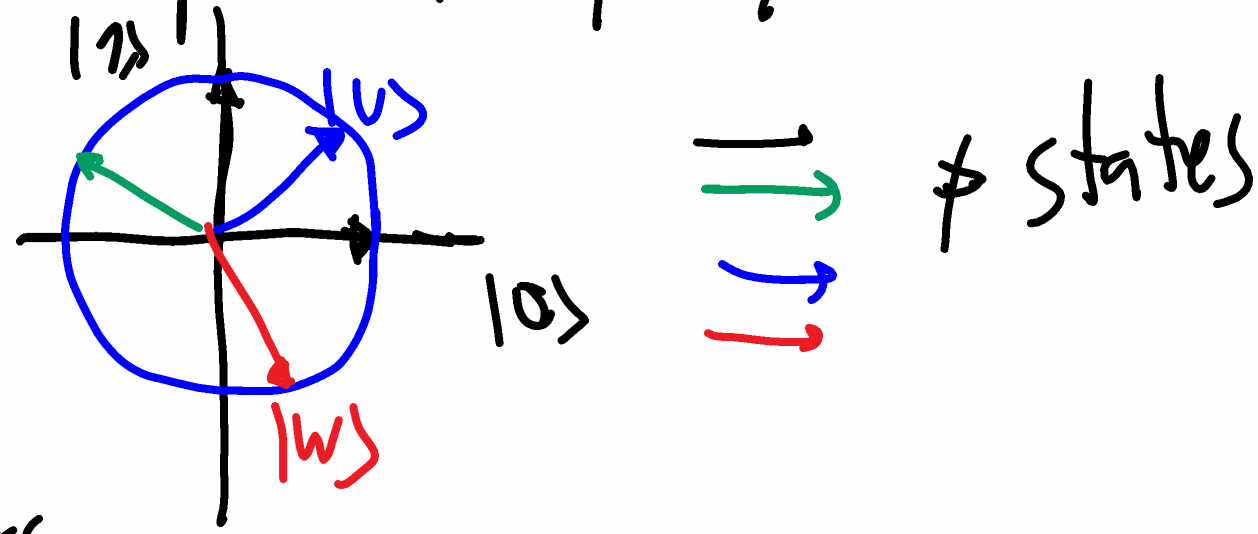


2) There is ALWAYS some FUNDAMENTAL STATES. They are states that never change if we do not interact with system

3) ALL STATES ARE VECTORS OF LENGTH = 1

THE FUNDAMENTAL STATES ~ PERPENDICULAR DIRECTIONS

Example: Description of spin system



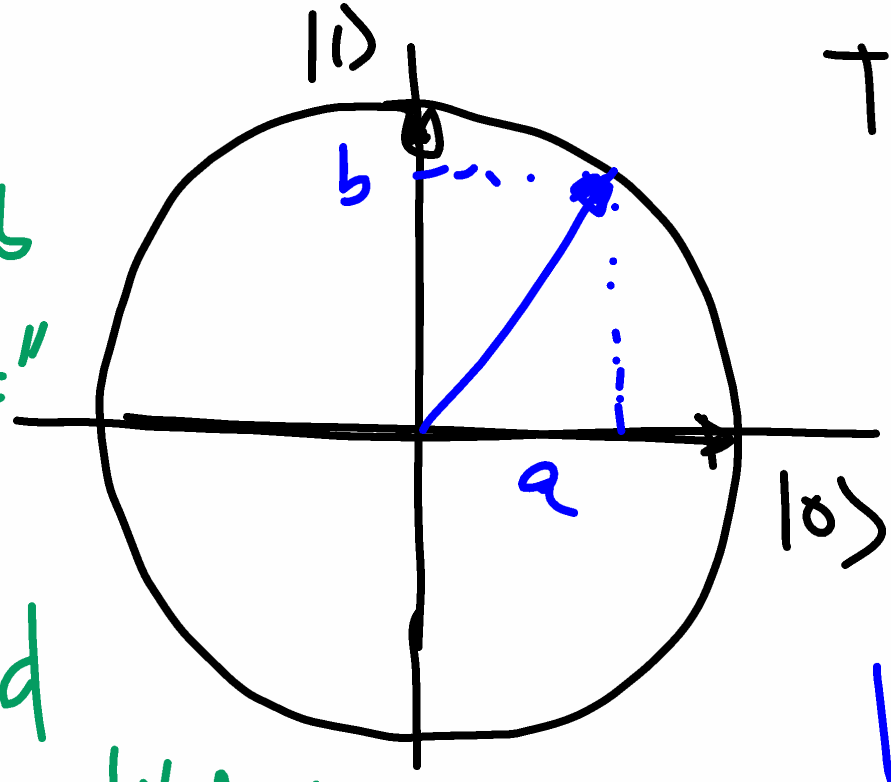
$\Rightarrow$ $\neq$ states

Notation: 0, 1, 2, .. values

(v) $|0\rangle, |1\rangle$ .. vectors

4) QUANTUM SUPERPOSITION (Schrödinger's cat)

State $|V\rangle = a|0\rangle + b|1\rangle$



This is the same as in math when we describe a point (or a vector) by it's coordinates

(a, b)

Actually, a & b are "complex #" NOT real #'s.

a, b are called "probability amplitudes"

V is in a "superposition" of states $|0\rangle$ & $|1\rangle$

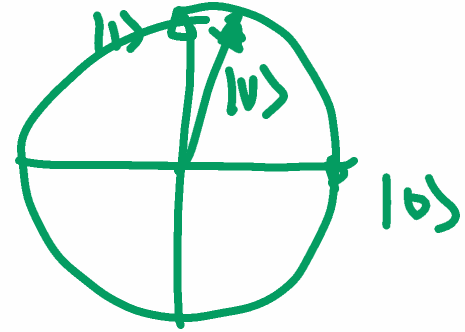
5) When we measure a Quantum System $|v\rangle$
we only see 2 possible values, $|0\rangle$ or $|1\rangle$!!

$$|v\rangle = a|0\rangle + b|1\rangle$$

a^2 is the probability of measuring $|0\rangle$

b^2 " " " " " " $|1\rangle$

Example: $|v\rangle = 0.2\,|0\rangle + x\,|1\rangle$



1) Find x^2

2) What is the probability of finding the system in $|0\rangle$

3) Idem $|1\rangle$

Sol) We know that length of $|v\rangle$ must be 1

$(0.2)^2 + x^2 = 1$ $\quad x^2 = 1 - 0.04 = 0.96$

$\therefore$ is $x \overset{?}{=} +\sqrt{0.96}$ or $x = -\sqrt{0.96}$

Need Grad Course

6) We can "pik up" Quantum systems in 2 ways

a) Independantly

b) ENTANGLED

Examples below

⑦ Qubit : Atom (or Q syst) that has 2 (or more) fundamental states accessible

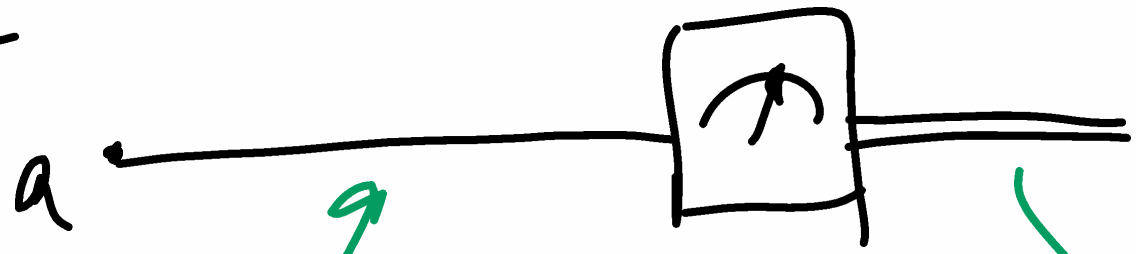
QUANTUM CIRCUITS

Each line is a Qubit

→ horizontal axis ~ "time"

Example

1-single qubit



1-Single Qbit