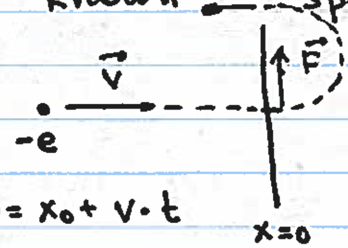
Classical vs Quantum way of thinking

Classical physics is determenistic : one can obtain complete information about any system, and use physical laws to predict its future behaviour.

Example : an electron moving with a known speed

$\odot B$



$x(t) = x_0 + v \cdot t$

$\vec{F} = (-e) \cdot \vec{v} \times \vec{B} = (0, F_y, 0)$

$F_y = -e v \cdot B$ directio-up!

$R = \dfrac{m_e V}{e \cdot B}$

Of course, in reality all measured values ~~One can~~ will have some uncertainties, so the prediction is not perfect. But in principle we can improve the measurement accuracy infinitely well without disturbing the electron.

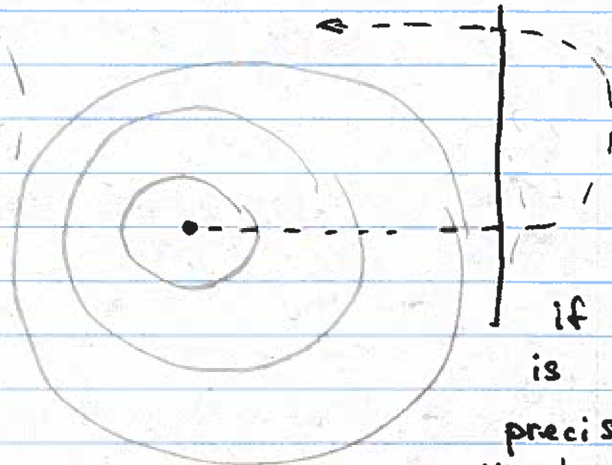
Quantum physics requires us to separate the measurement process, it will now have two parts :

1. A state of a quantum system (encompasses all details of its being)

2. The measurement of a specific parameter that in QM can change the original state of the system. Thus, almost never one can completely characterise the state through measurements

We will quantify this phenomena in the Uncertainty Principle that postulate that some parameters cannot be measured with absolute accuracy at the same time

Electron trajectory → with quantum uncertainty



electron wave packet
(similar amount of uncertainty in x and p)
→ on average, similar to classical trajectory, but with growing uncertanty

If an electron is localized precisely, we won't know its trajectory at all!
Will result in really messy interference!

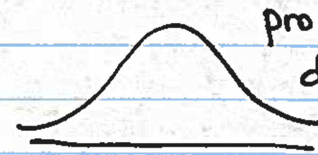
Different measurement outcomes:

descrete varables	continuous variables
finite or infinite	any values in a range
specific outcomes	can be measured
Energies of an electron in a potential well	Momentum, position of a particle

E_3 $|3\rangle$ $|E_3\rangle$

E_2 $|2\rangle$ $|E_2\rangle$

E_1 $|1\rangle$ or $|E_1\rangle$



probability distribution

Notation for quantum states

Bra — ket

$|\text{state identifier}\rangle$ $\langle\text{state identifier}|$