

Misconceptions

Misconceptions

...and confusion
in astrophysics
and astronomy
...and elsewhere

Dr Steve Barrett Southport AS 17 Oct 2024

Misconceptions

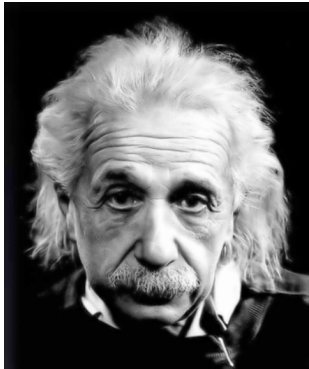
Using slides taken from ...

- Expanding Universe**
 - Where was the Big Bang?
 - Faster than the speed of light
- Matter**
 - Black holes suck
 - Dark matter is not dark
- Rocket Science**
 - Overcoming gravity
 - Parking at Lagrange 2
- Quantum Mechanics**
 - Words / Pictures / Maths
 - Common sense

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Incomprehensible



" The most
incomprehensible
thing about the
world ...
... is that it is
comprehensible "

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Misconceptions

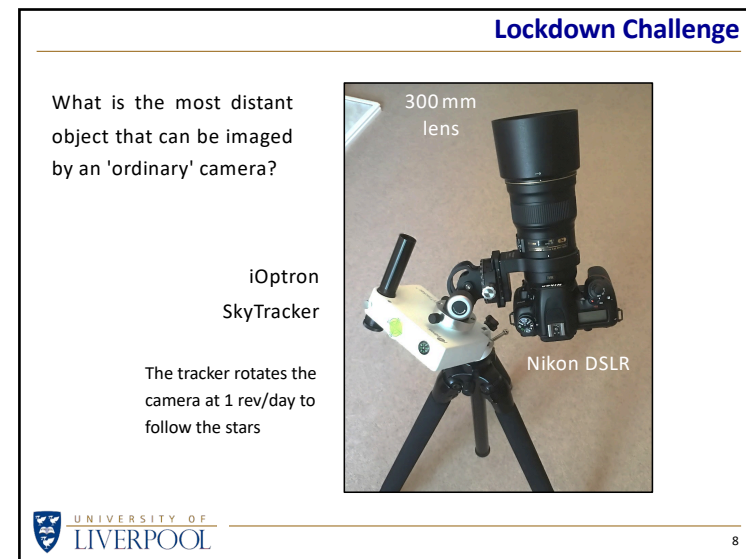
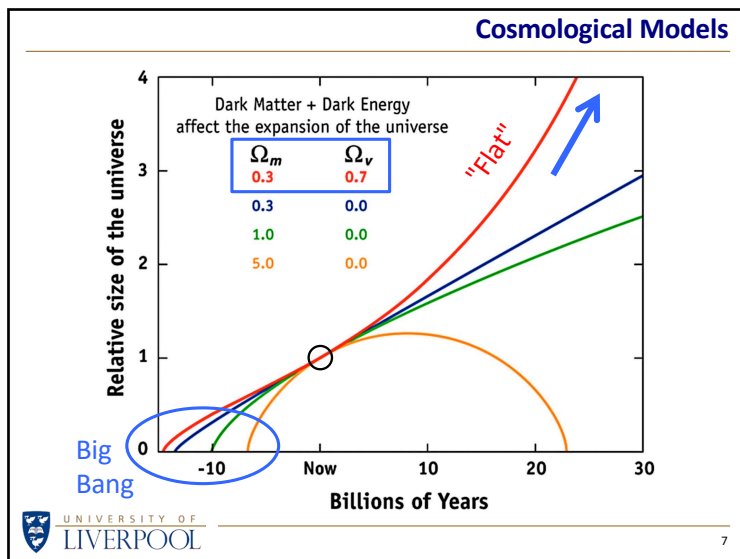
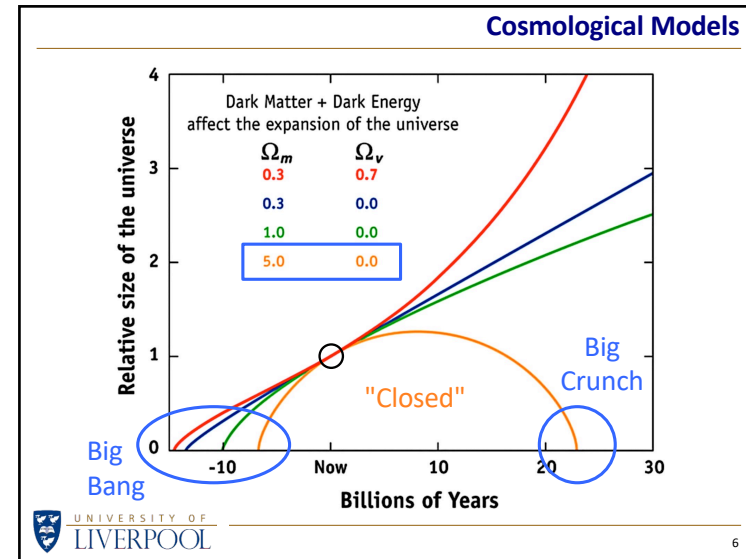
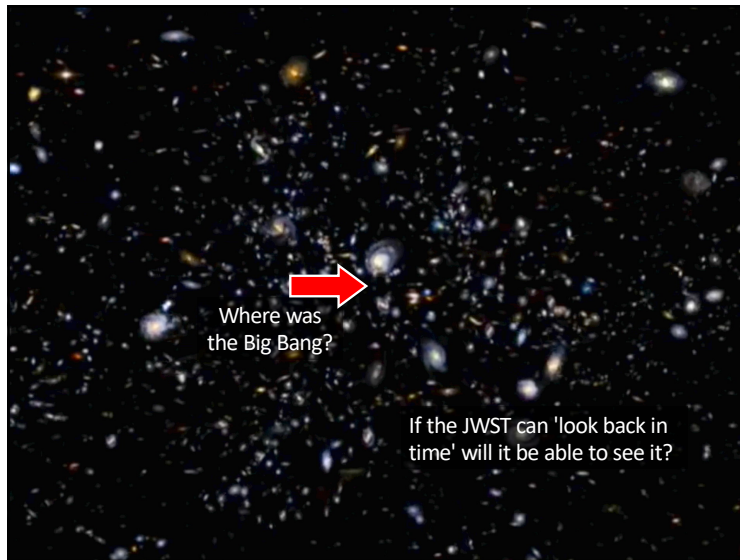
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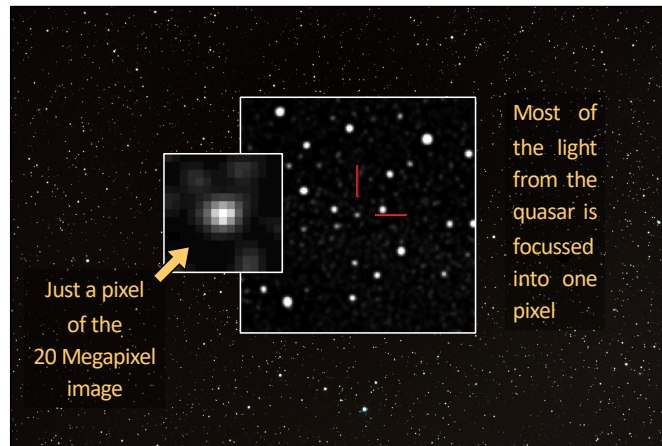
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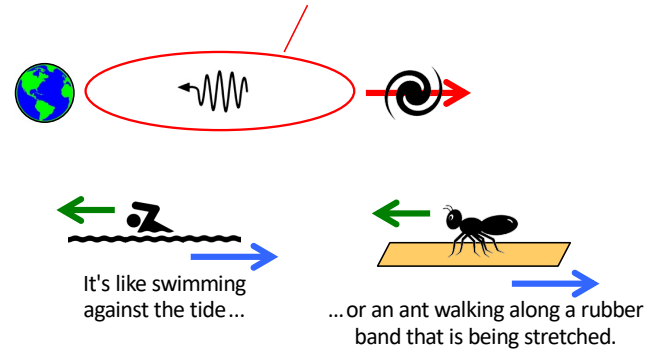
Misconceptions

Imaging a Quasar

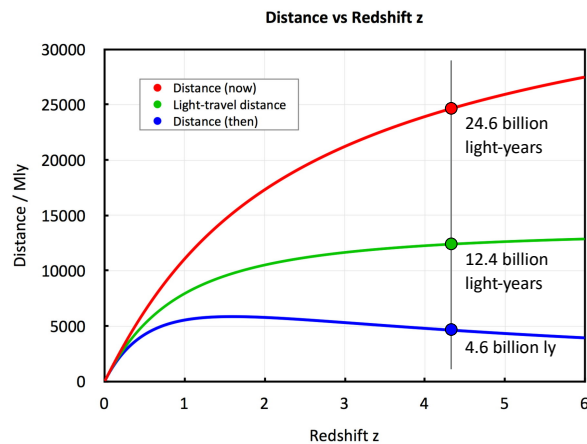


Distance to the Quasar

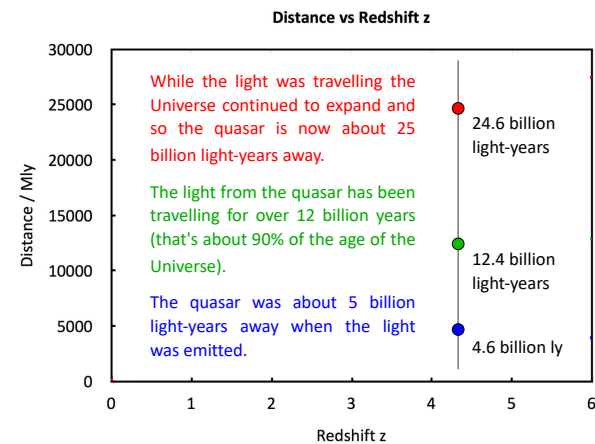
What distance has the light travelled to reach us?
That's tricky: Space continues to expand as the light travels.



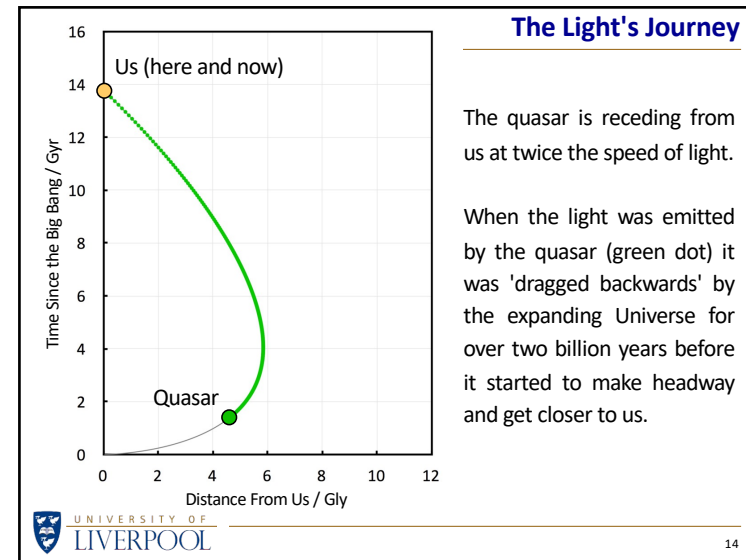
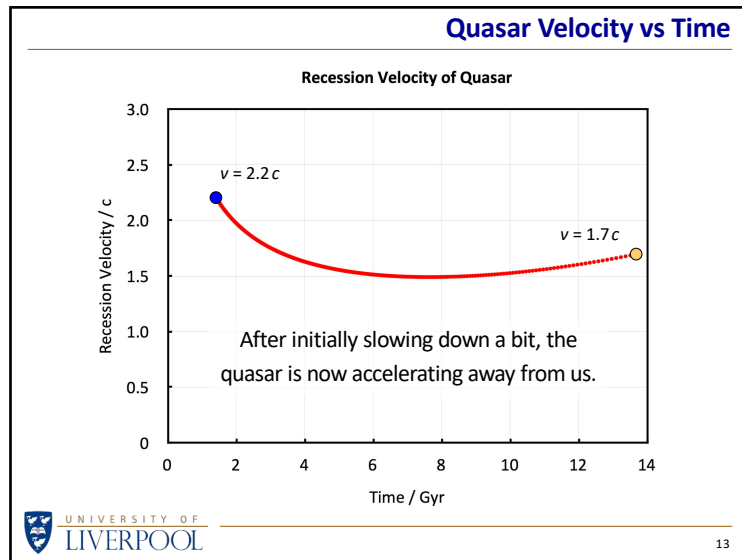
Distance vs Redshift



Distance vs Redshift



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Ancient Light

The Beginning of Everything

Dark Matter

Why is it Dark? Does it Matter?

The End of Everything

Fiat Lux

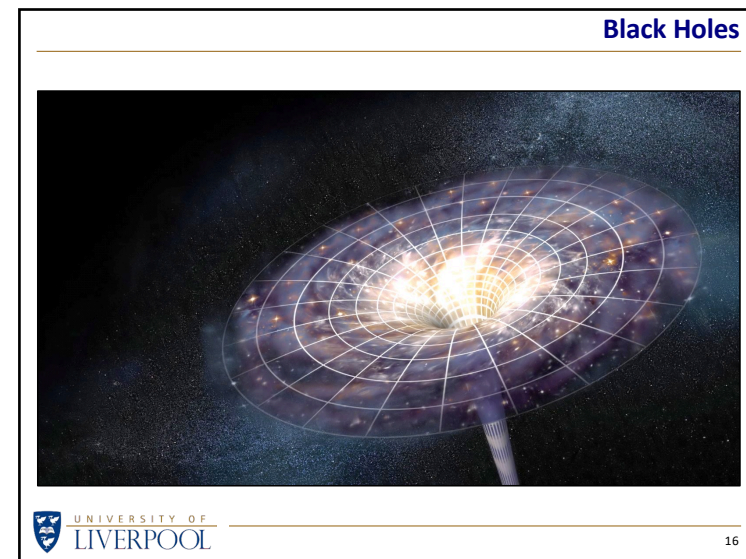
It's Not Rocket Science!

Warping Space and Time

The Weird World of the Very Very Small

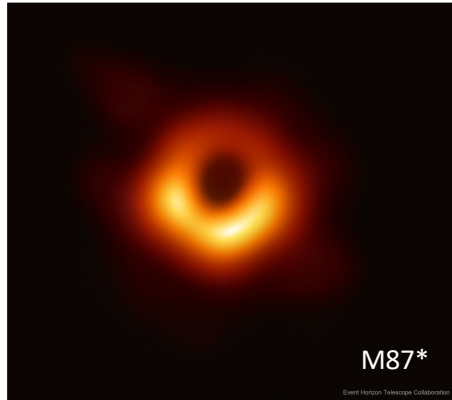
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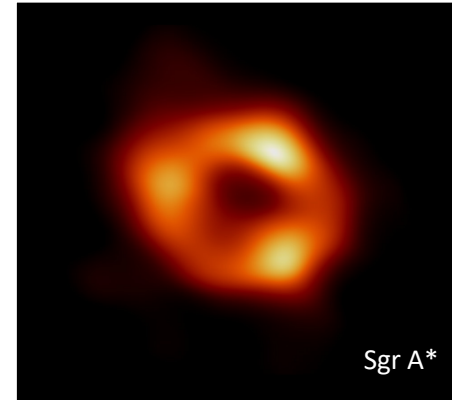


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Black Holes



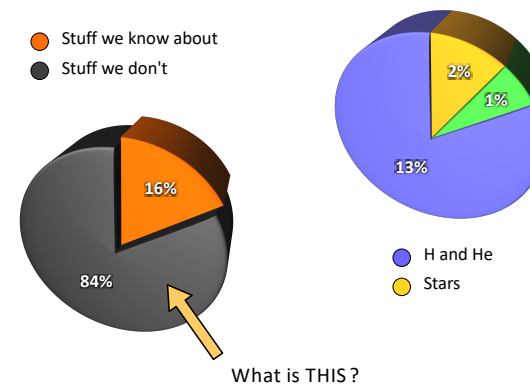
Black Holes



Nothing Is Safe From a Black Hole



Composition of Matter

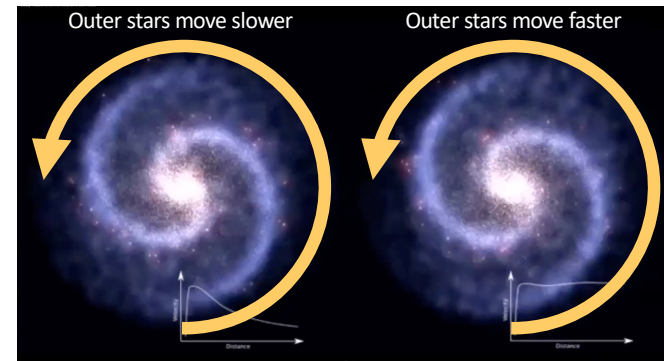


Misconceptions

Horsehead Nebula – Not Dark Matter



What Is the Evidence?



Without dark matter

With dark matter

Cosmic Web

When the very early Universe was the size of a golf ball it had very small variations in density ('dimples') ...

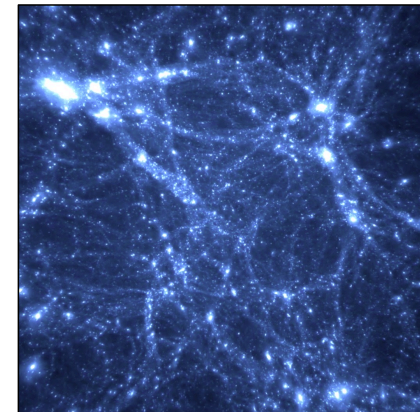
... and over billions of years these collapsed into a cosmic web of filaments and voids.



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Rocket Science

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Newton's Cannonballs

Isaac Newton
Principia 1686

The need for **horizontal** velocity was realised more than 300 years ago

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Orbit Size and Orbit Period

Green planet is closer to Sun

Gravitational pull from Sun is stronger

Planet moves faster to stay in orbit

Shorter period ('year')

Red planet is further from Sun

Gravitational pull from Sun is weaker

Planet moves more slowly to stay in orbit

Longer period ('year')

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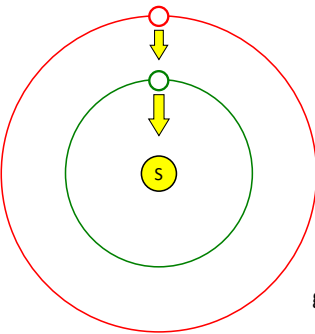
Misconceptions

Orbit Size and Orbit Period

The arrows show the gravitational force of the Sun on each planet.

At a greater distance, the force is less.

Is that always the case?



We can't change the gravitational pull of the Sun...

...but we can arrange it so that an object in the red orbit feels an additional gravitational force.

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Lagrange Points

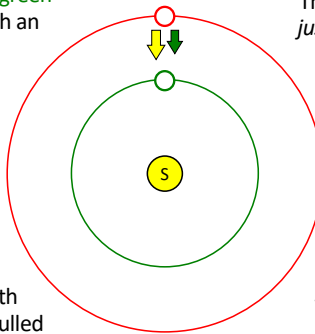
Let's assume that green is planet Earth with an orbital period of exactly 1 year.

The red orbit has a period of *more* than 1 year.

What if the red orbit is close enough to the Earth that an object is pulled by both the Sun **AND** the Earth?

There is a red orbit at just the right distance such that the extra pull from the Earth makes the red object orbit faster with a period of 1 year.

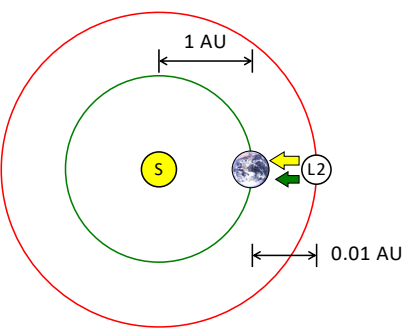
That would mean that the red object would orbit the Sun 'with' the Earth.



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Lagrange Point L2



1 AU

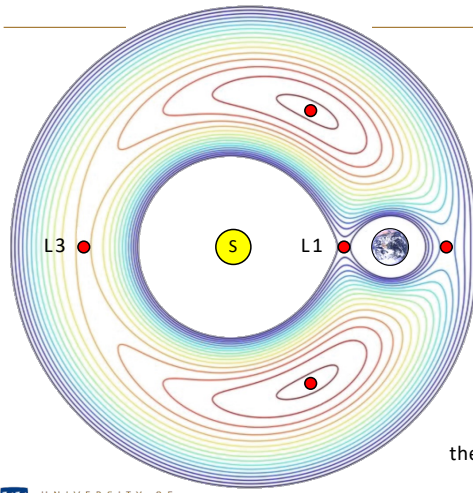
0.01 AU

Not to scale!

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Parking at L2



L3

L1

L2

The ability of a spacecraft to 'park' at a Lagrange point is sometimes visualised using this doughnut.

Imagine that the contours represent height and think about a ball wanting to roll 'downhill'.

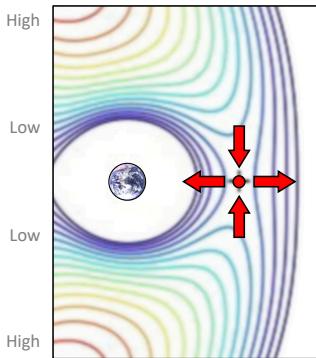
Look more closely at the contours around L2...

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Parking at L2



The arrows show the directions of 'downhill' in the vicinity of L2.

L2 is *not* on a 'hilltop'.

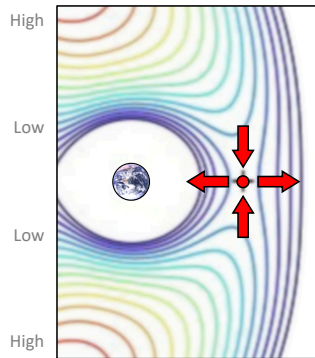
L2 is *not* in a 'well'.

L2 is at a saddle point.

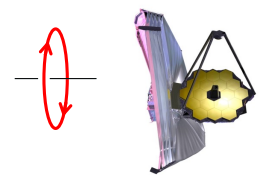
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Parking at L2



Hence the JWST can park in a 'halo' orbit around L2, but it will slowly drift towards Earth...



...and so will need a station-keeping nudge every few months.

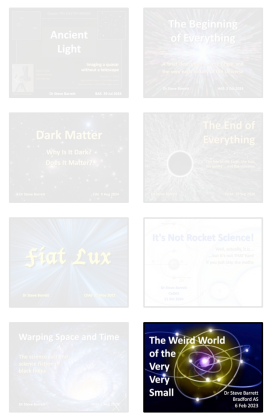
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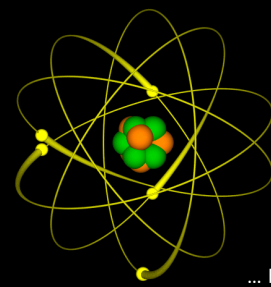
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Bohr Model



This might be how we imagine atoms with electrons buzzing around a nucleus like bees ...

... but it doesn't show us that all the electrons have different energies

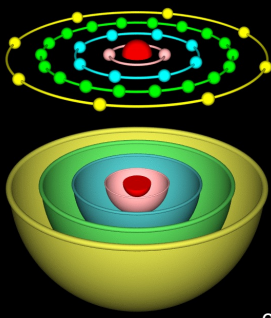
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Bohr Model

It is better to think of the electrons in different sized orbits ...

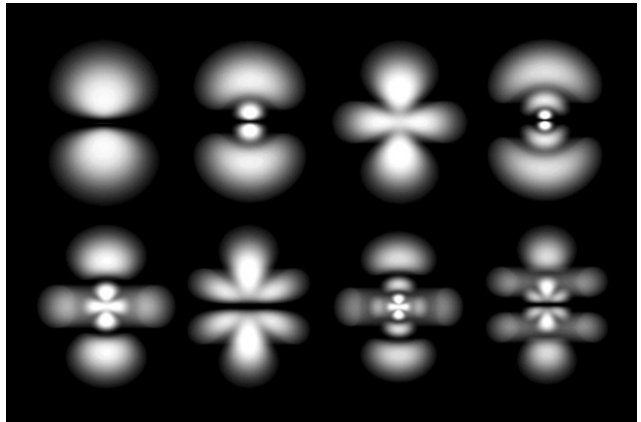


... or concentric shells surrounding the nucleus

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Electron 'Clouds' of Probability



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How Can We Describe Atoms?


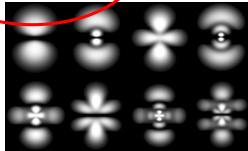
Particles
Waves
Orbits
Spin
Energy

Words

Maths

Pictures

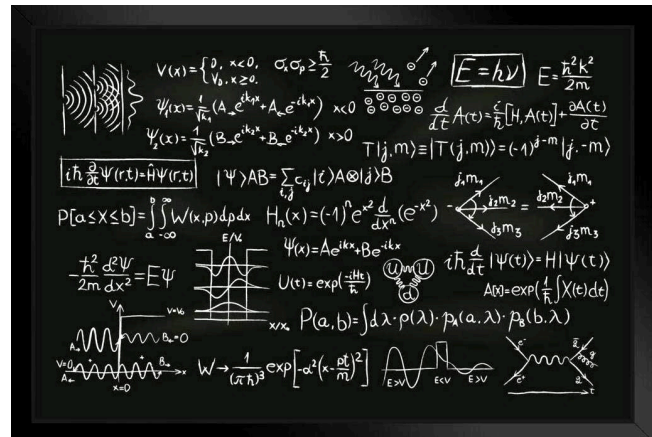
$H\psi = E\psi$

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How Can We Describe Atoms?



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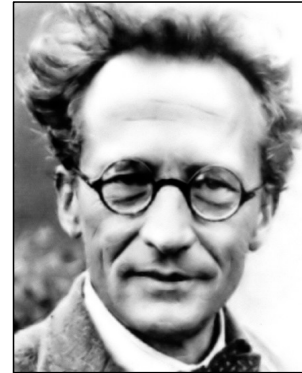
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Heisenberg



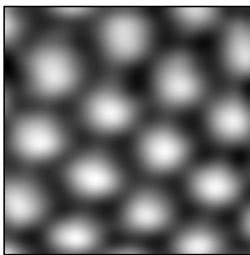
" We wish to talk about the structure of atoms. But we cannot talk about atoms in ordinary language "

Schrödinger



" Atomic physics has shown that atoms have no meaning, but can only be understood in experimental measurement "

A World of Atoms



850 pm

On this scale, a grain of sand would be about the size of the Moon.

" To see a world in a grain of sand ... "

William Blake

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...and confusion in astrophysics and astronomy

...and elsewhere

www.liverpool.ac.uk/~sdb/Talks

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