L-S Coupling /(Russel-Saunders Coupling)

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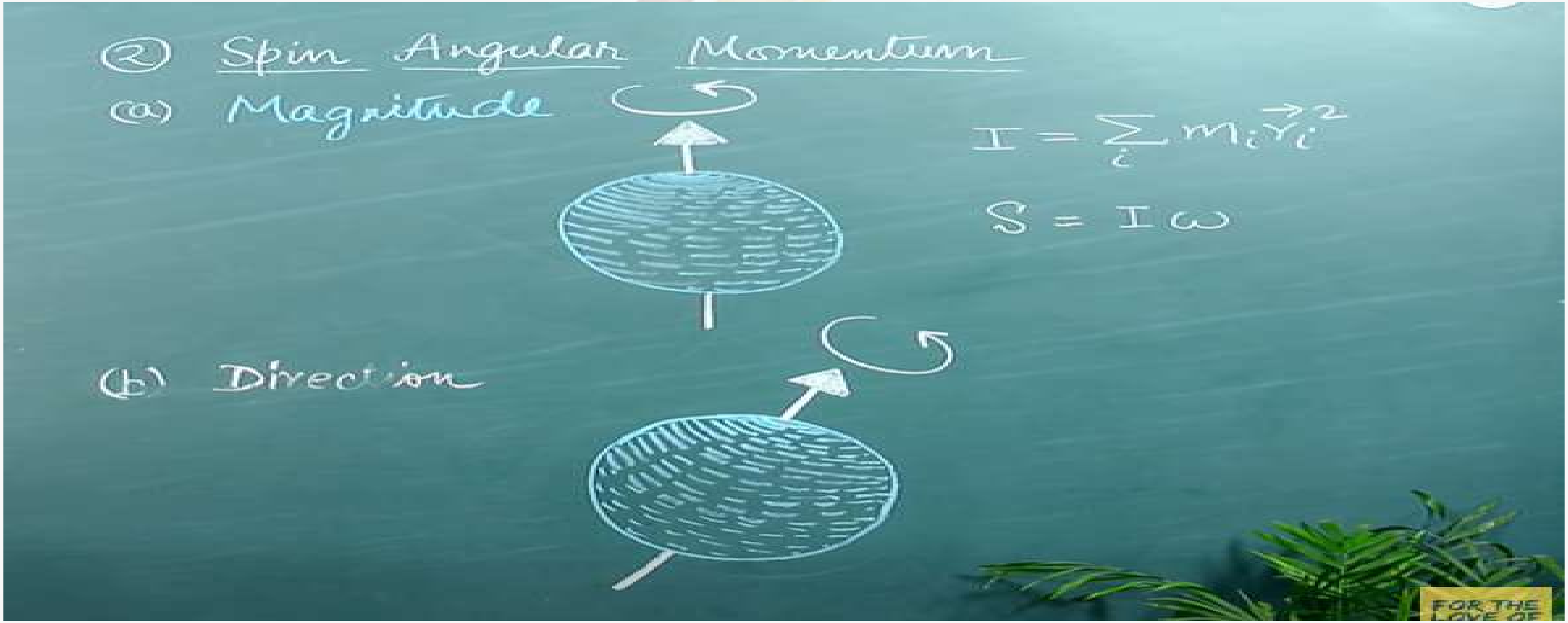
Orbital Angular Momentum

Spin Angular Momentum



Angular momentum is described by a vector(L) it has magnitude and direction.

In -3D systems / Classical physics

There is no any restriction in magnitude, so it can have continuous values i.e it is not quantised

In similar way there is no any restriction in direction of angular momentum due to all possible orientation of orbit i.e. it is not quantised

Thus, in classical mechanics both magnitude and direction of angular momentum are continuous. They are not quantised.

Examples: planetary motion around sun.

Quantum View of : Atom/ Electron

We will see , when electros revolve round the nucleus the electrons not necessarily to have every momentum and any direction. Electrons faces a large numbers of restrictions which is known as quantization.

From the quantum Mechanics : The Angular momentum is Quantised

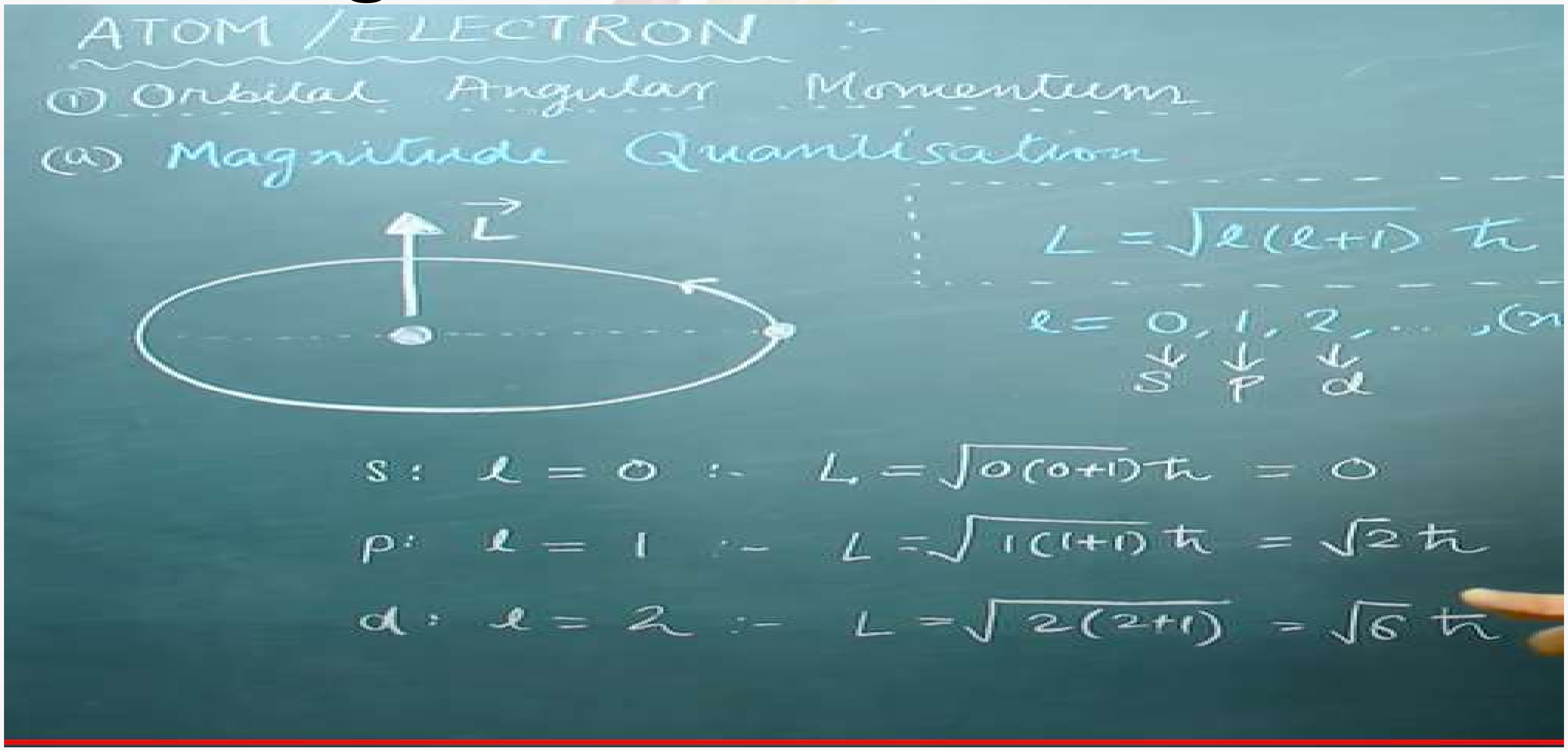
$L=\sqrt{l(l+1)}\, h/2\pi$

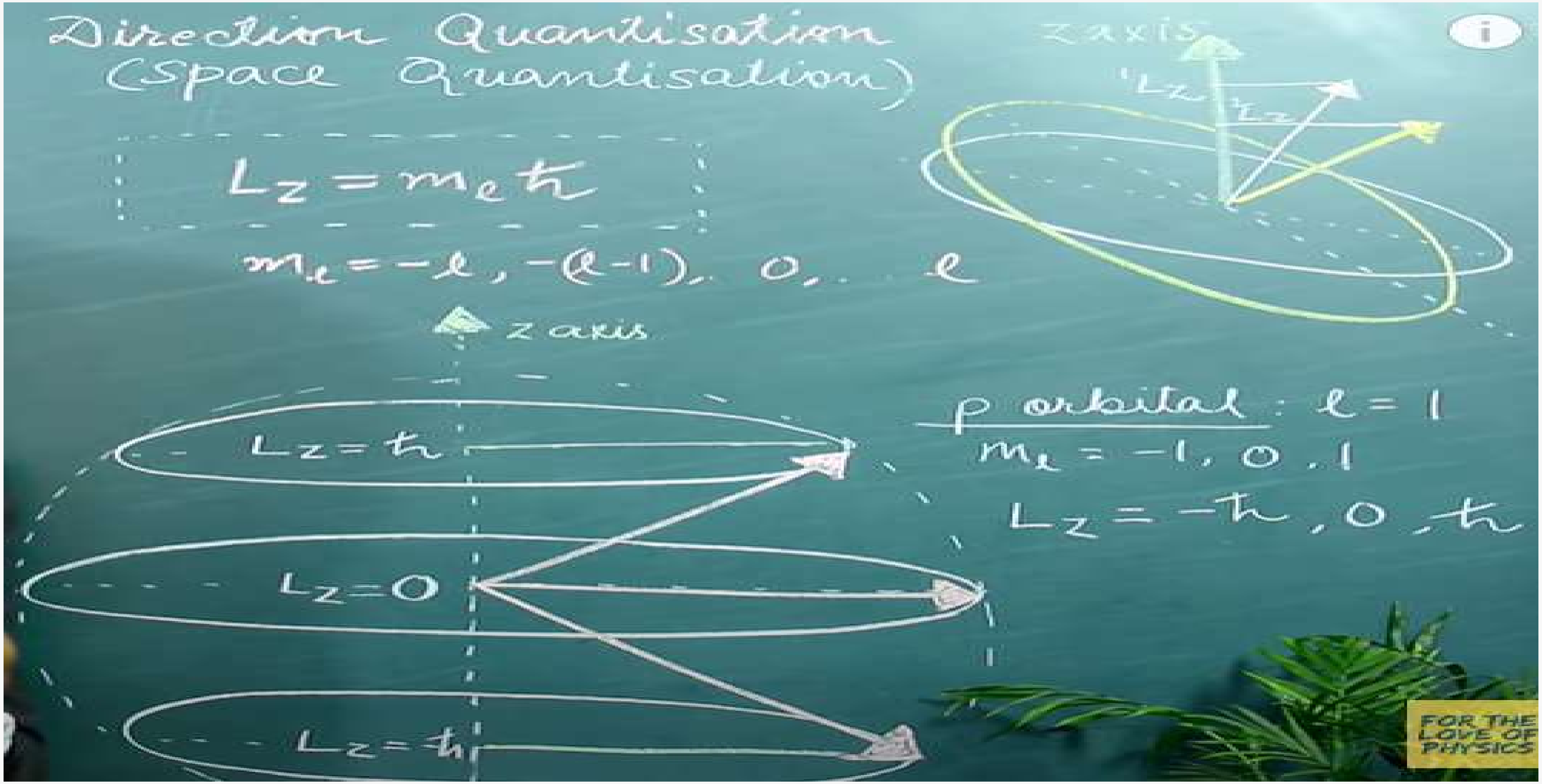
where $l=0,1,2,3,\dots\dots\dots(n-1)$

From Schrodinger Equations

$l=0$ for s orbital, $l=1$ for p- orbital, $l=2$ for d orbital, $l=3$ for f orbital and so on

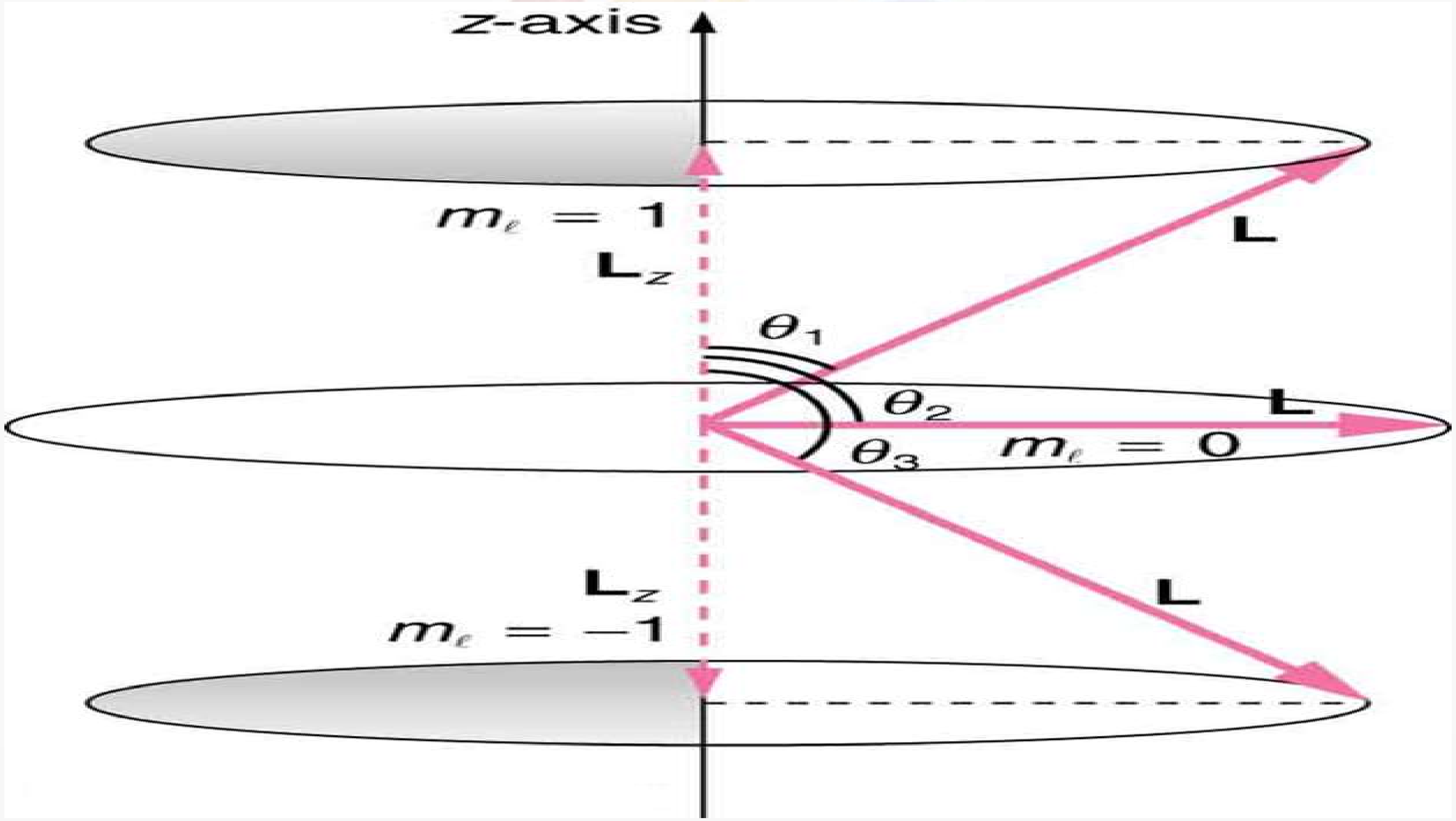
Magnitude Quantization



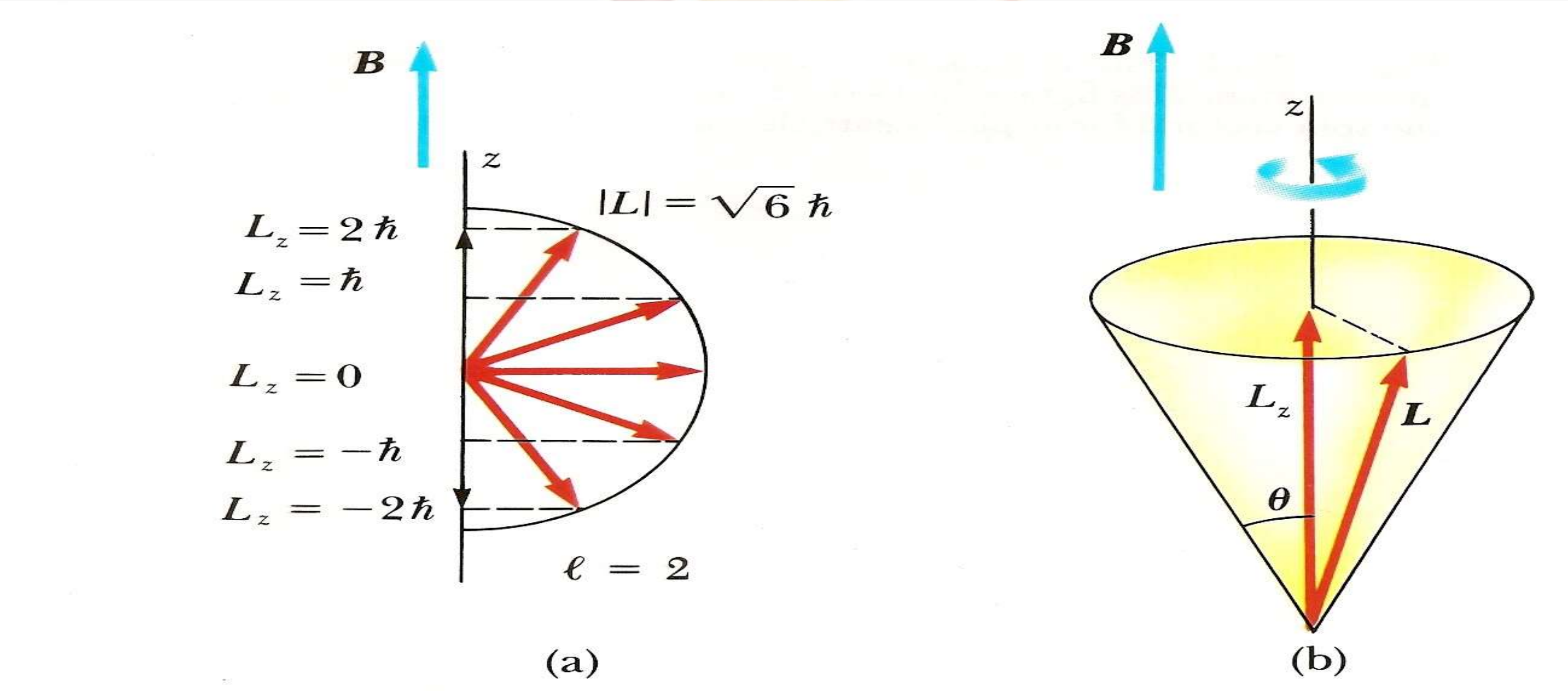


Direction Quantisation
(Space Quantisation)
Lz = mℓ ħ
mℓ = −ℓ, −(ℓ−1), 0, ... ℓ
z axis
p orbital : ℓ = 1
mℓ = −1, 0, 1
Lz = −ħ, 0, ħ
Lz = ħ
Lz = 0
Lz = ħ
FOR THE LOVE OF PHYSICS

Space Quantization



Angular momentum Quantization



Atom/ Electron

S:=0, L= √0(0+1) h/2π=0.h/2π =0

l=1, L= √1(1+1) h/2π= √2.h/2π

l=2, L= √2(2+1) h/2π= √6.h/2π

l=3, L=1, L= √3(3+1) h/2π= √12.h/2π

…

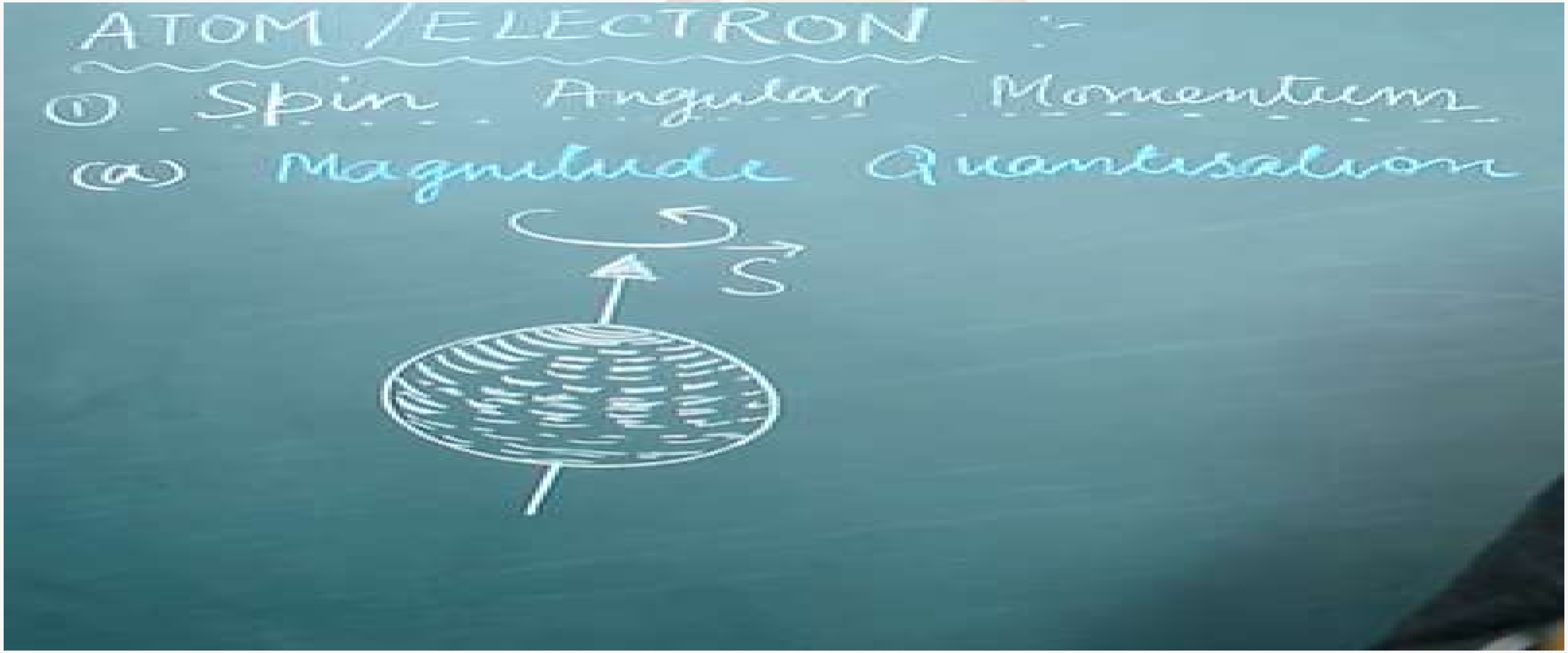
…

Angular momentum magnitude is quantized of electrons

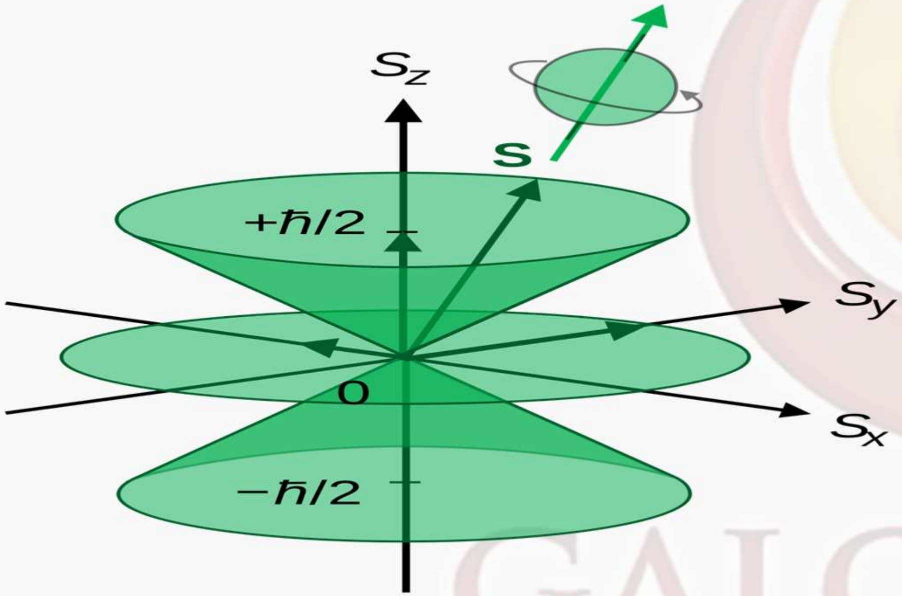
Magnitude has some definite values , it can not have all values

i.e. Angular momentum is quantised.

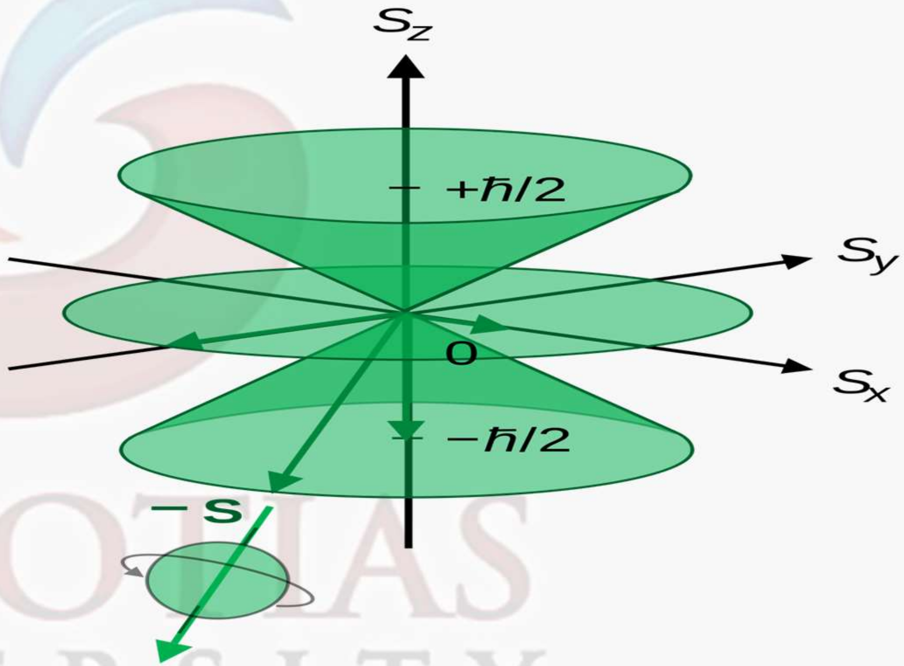
Magnitude quantization/Spin Angular Momentum



Spin Quantization



$$|\uparrow\rangle = \left|+\frac{1}{2}\right\rangle$$



$$|\downarrow\rangle = \left|-\frac{1}{2}\right\rangle$$

Spin Moment

We use the same analogy for spin moment similar to orbital moment

According to quantum mechanics $S=\sqrt{s(s+1)}\, h/2\pi$

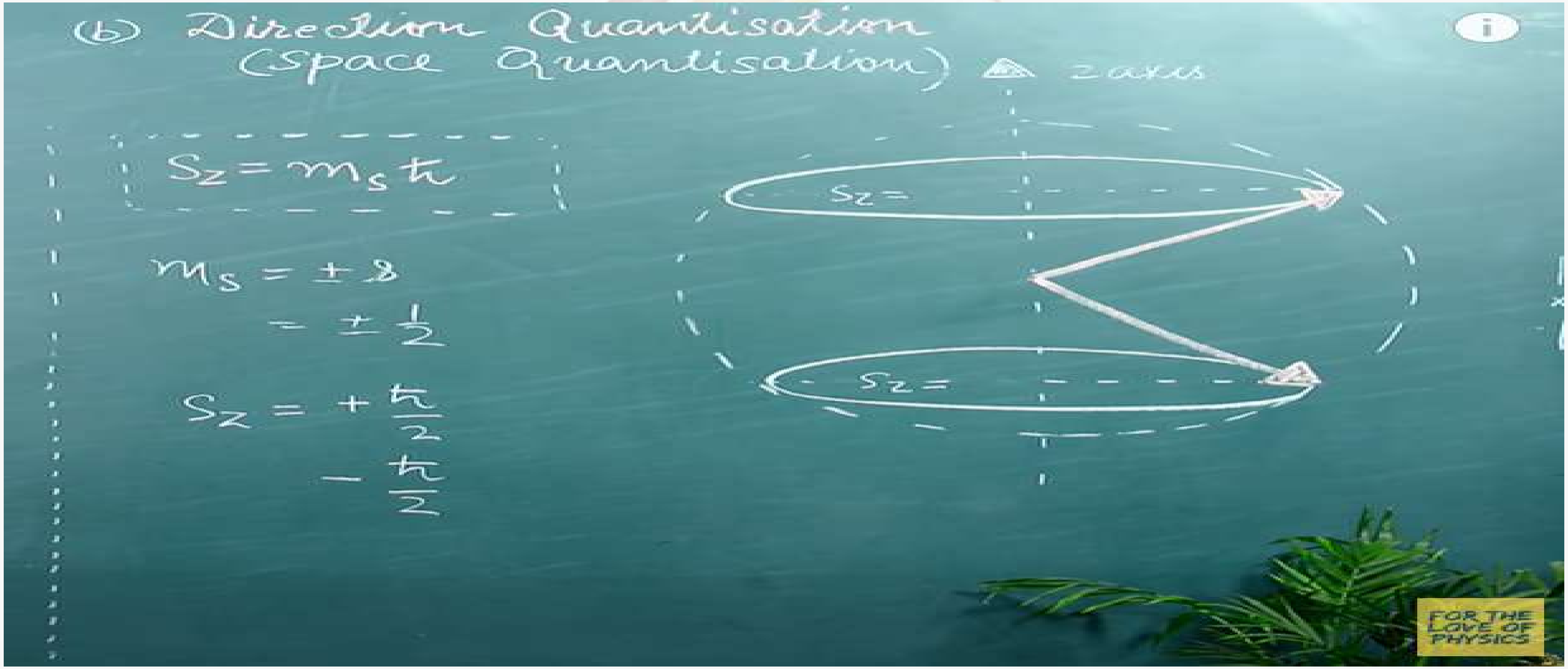
For $s=1/2$, $S=\sqrt{1/2(1/2+1)}\, h/2\pi$, $S=h/2\pi\,\sqrt{3}/2$

$Sz=m_s\, h/2\pi$

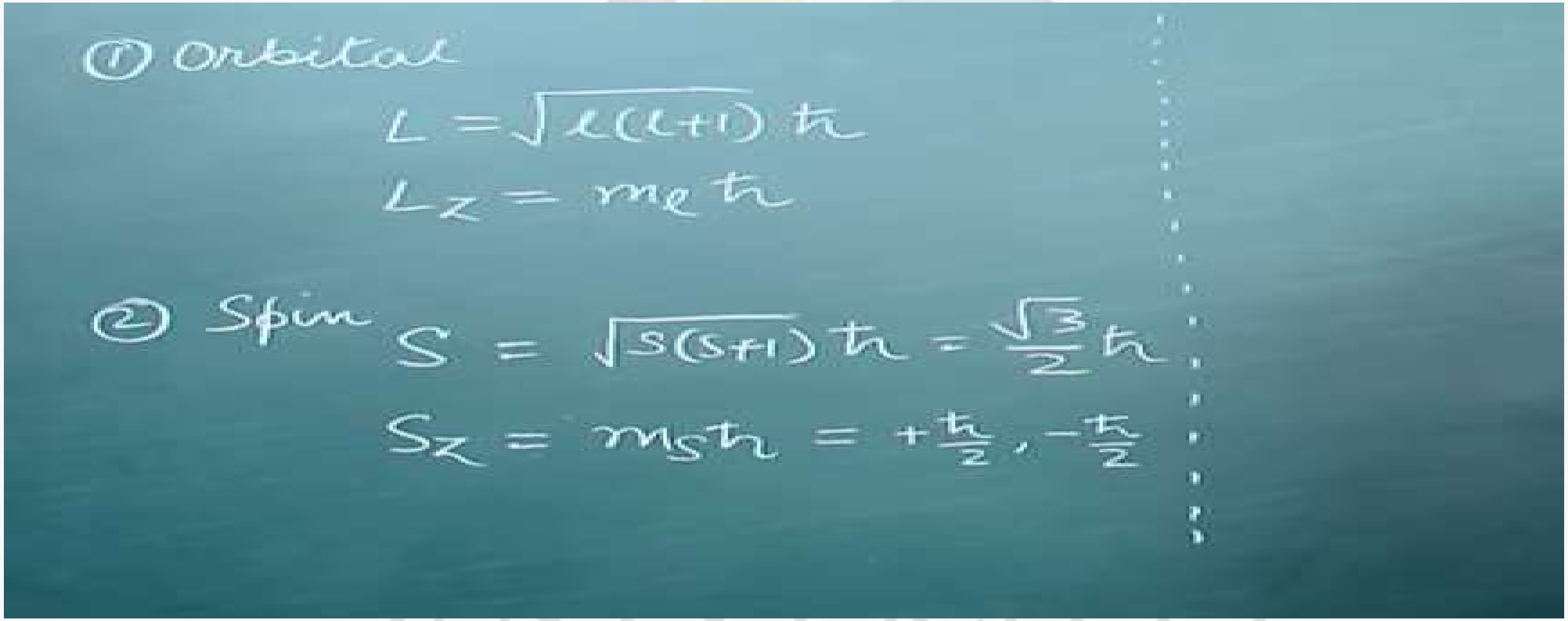
$m_s=+s$ or $m_s=-s$

Where $m_s = +1/2$ and $-1/2$

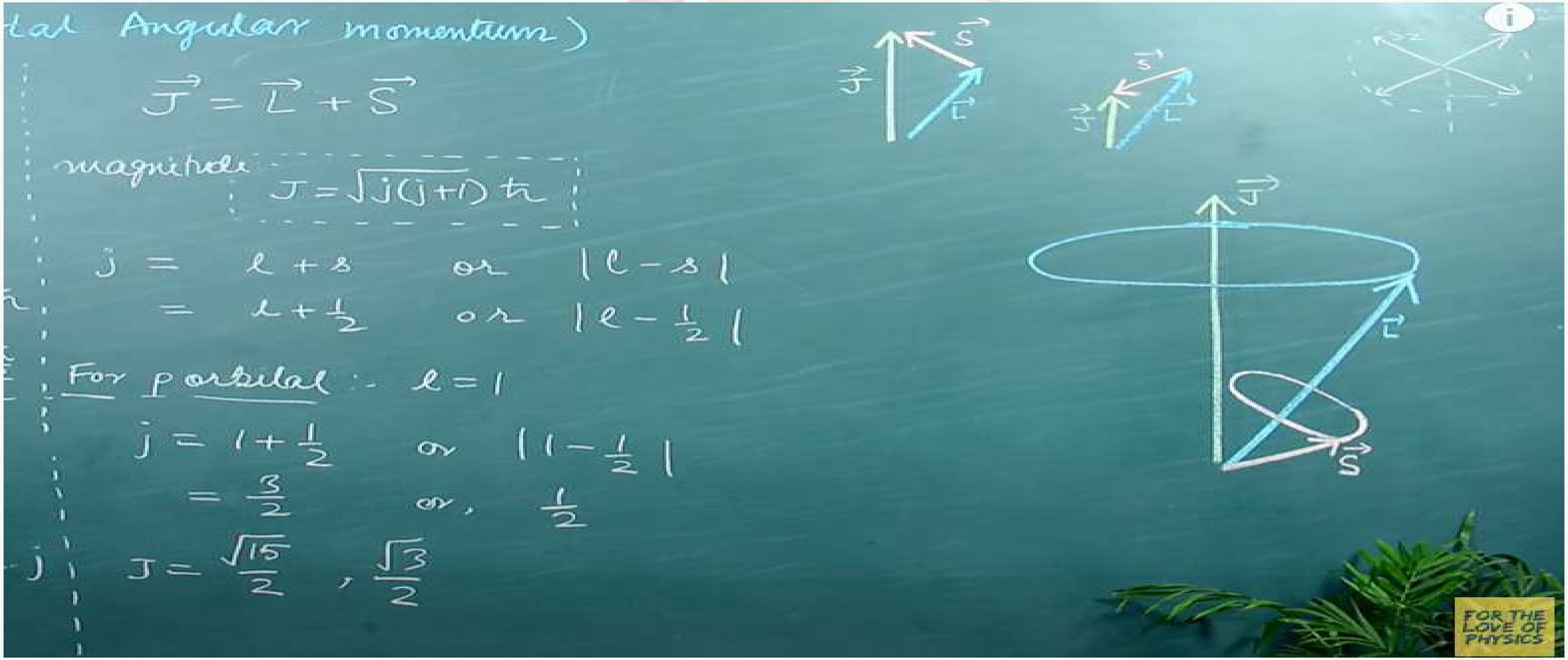
Direction Quantization (Space quantization)



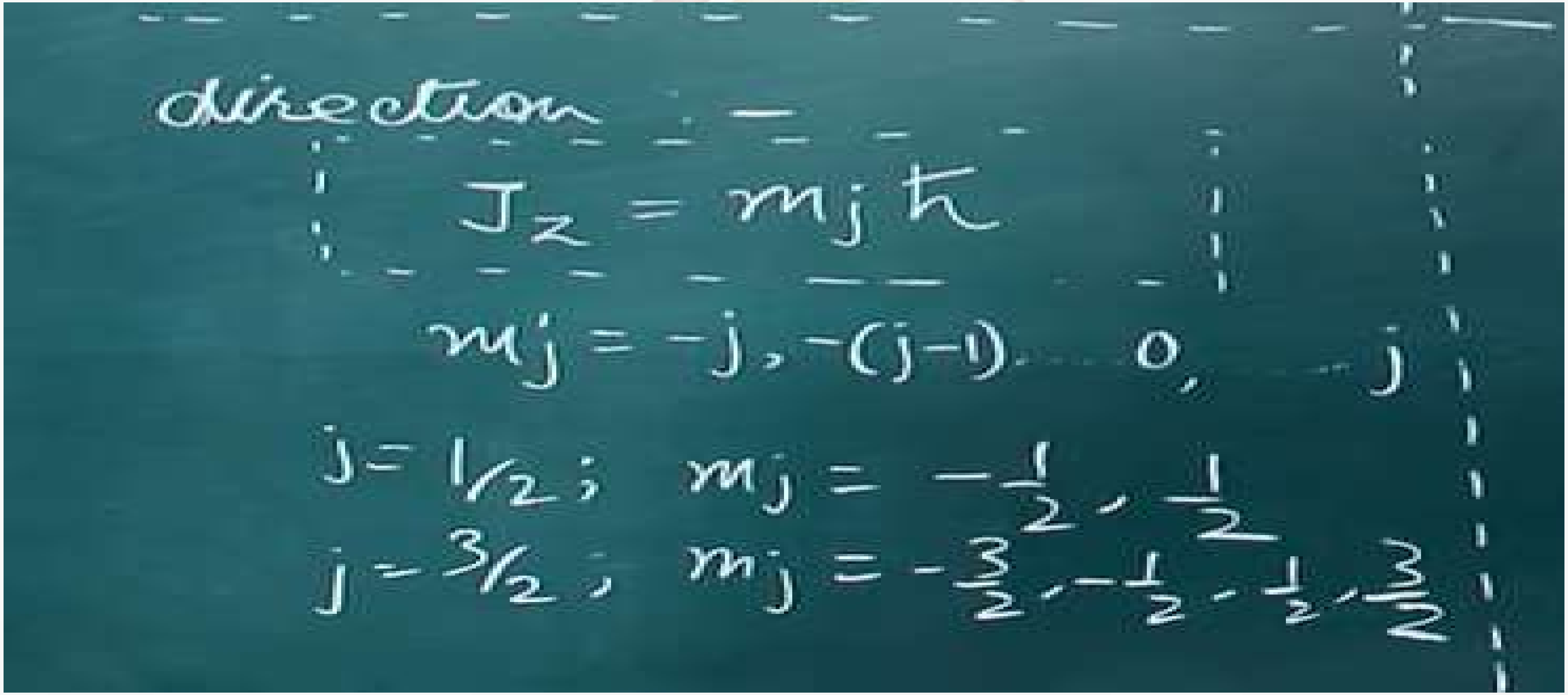
Orbital and spin Angular momentum



Total Angular Momentum (J)



Total Angular Momentum(J)



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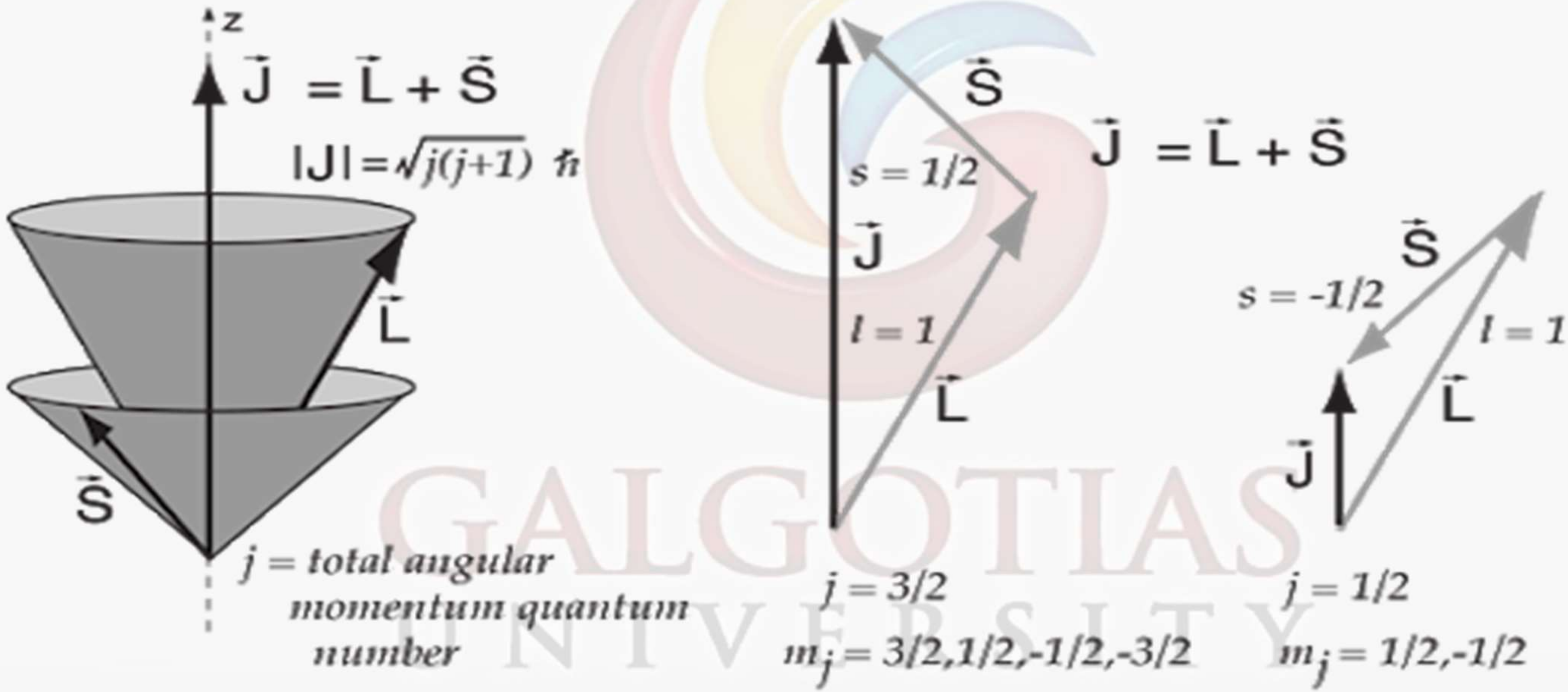
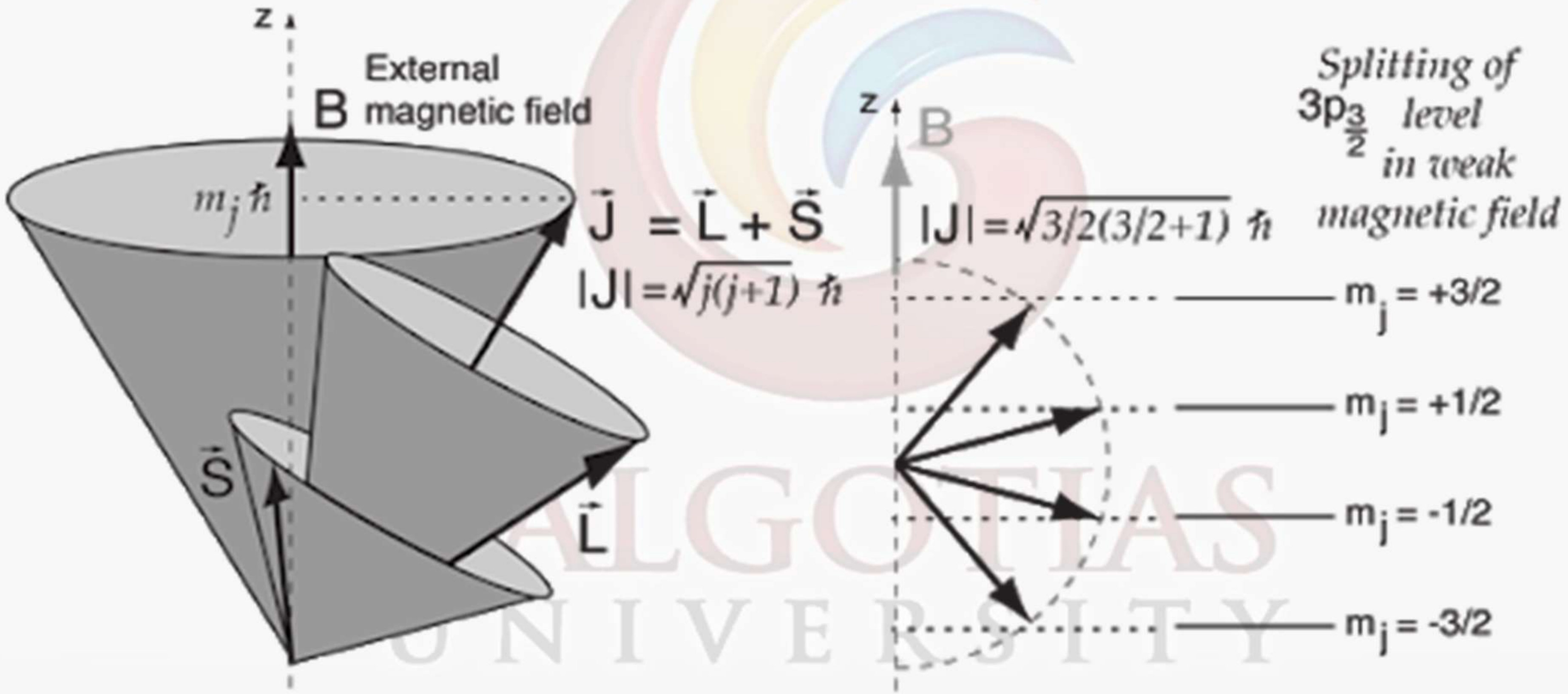


Total Angular Momentum(J)



Conclusion:

In Atomic Physics .

The angular momentum is quantized

Spin momentum quantised

Total angular momentum is vector sum of angular momentum and spin momentum

Total angular momentum is also quantized and

Total angular momentum is conserved

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