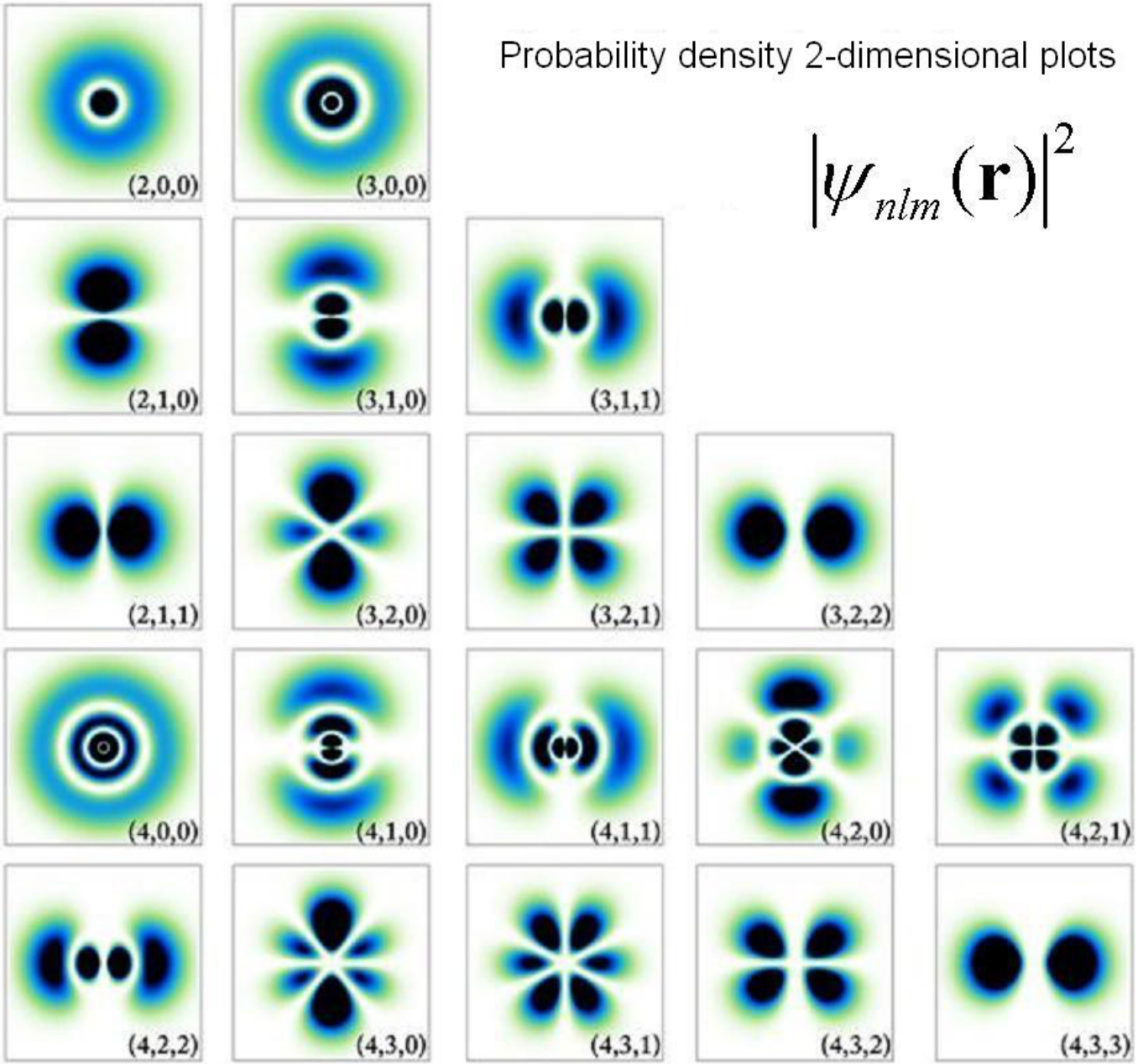
The Quantum Mechanical Model



Probability density 2-dimensional plots

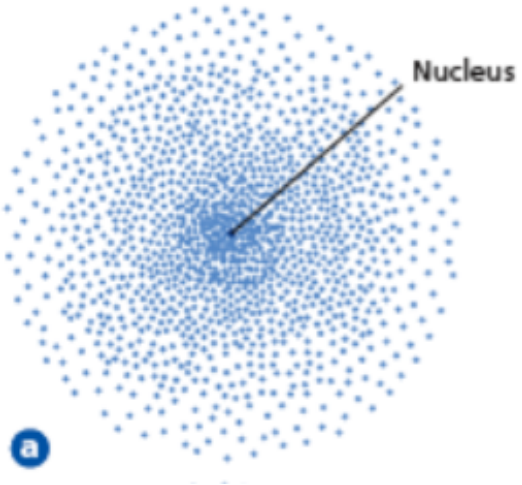
$$\left|\psi_{nlm}(\mathbf{r})\right|^2$$

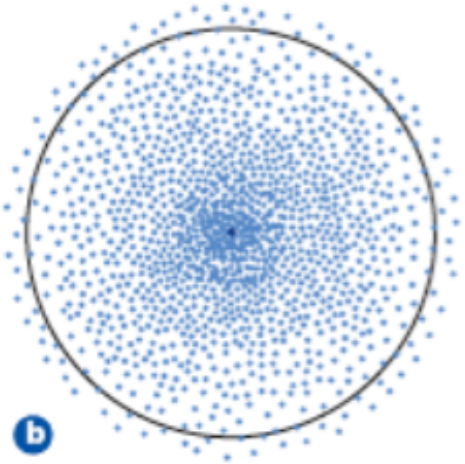
Heisenberg Uncertainty Principle

- 1920s: The exact position of an electron can never be known.
- Determining both the position and path of an electron is impossible.
- Can only determine an electron's most probable location using a mathematical model.

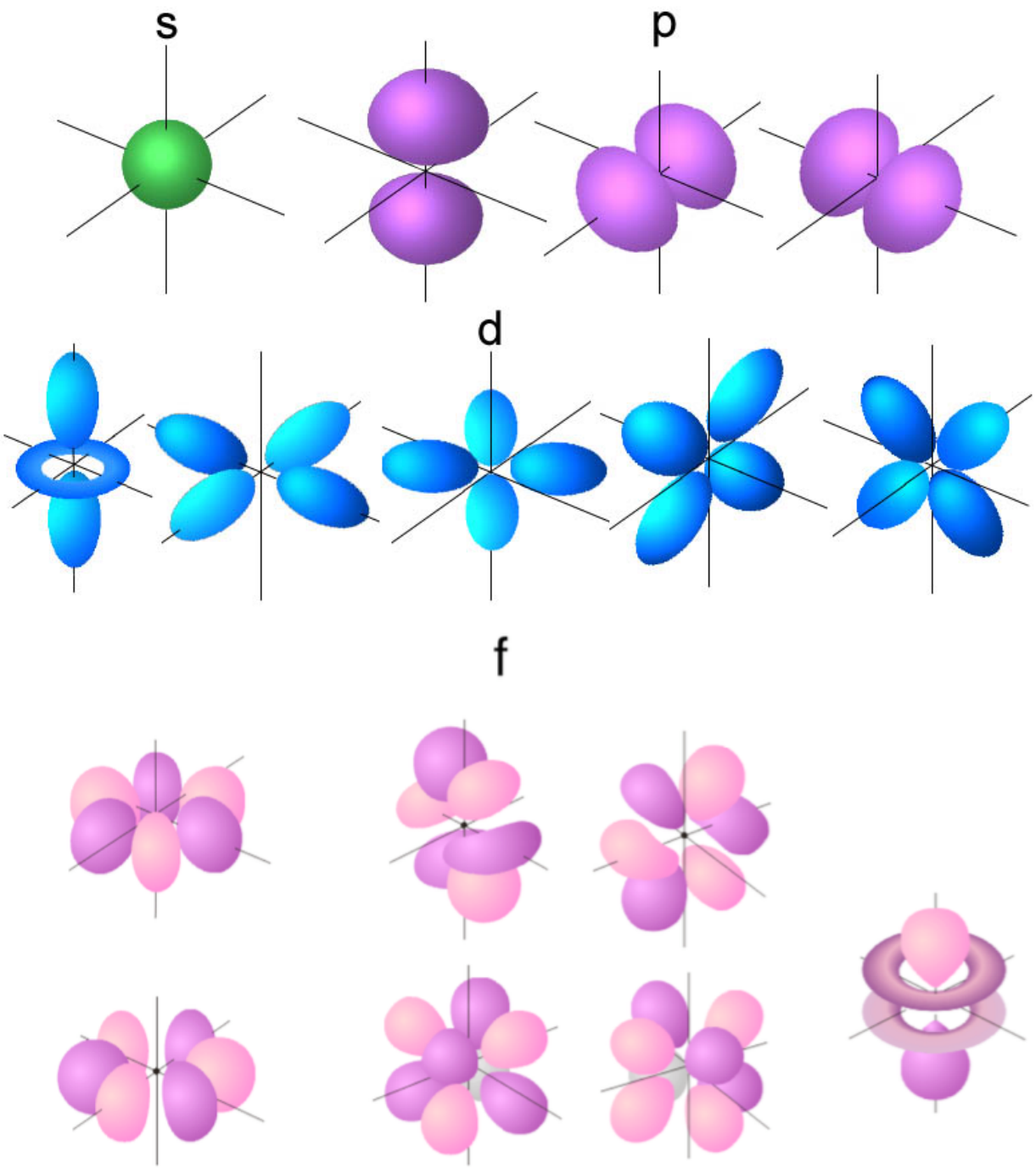
Quantum Mechanics

- Each energy level has sublevels where an electron can exist.
- Sublevels contain “orbitals” that describe the most probable location of an electron.
- The shape of orbitals is determined by a 90% probability of finding an electron.



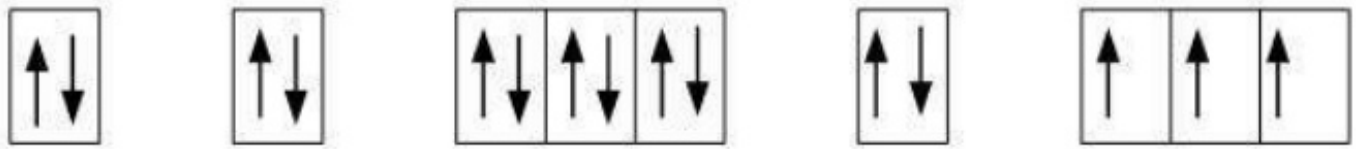


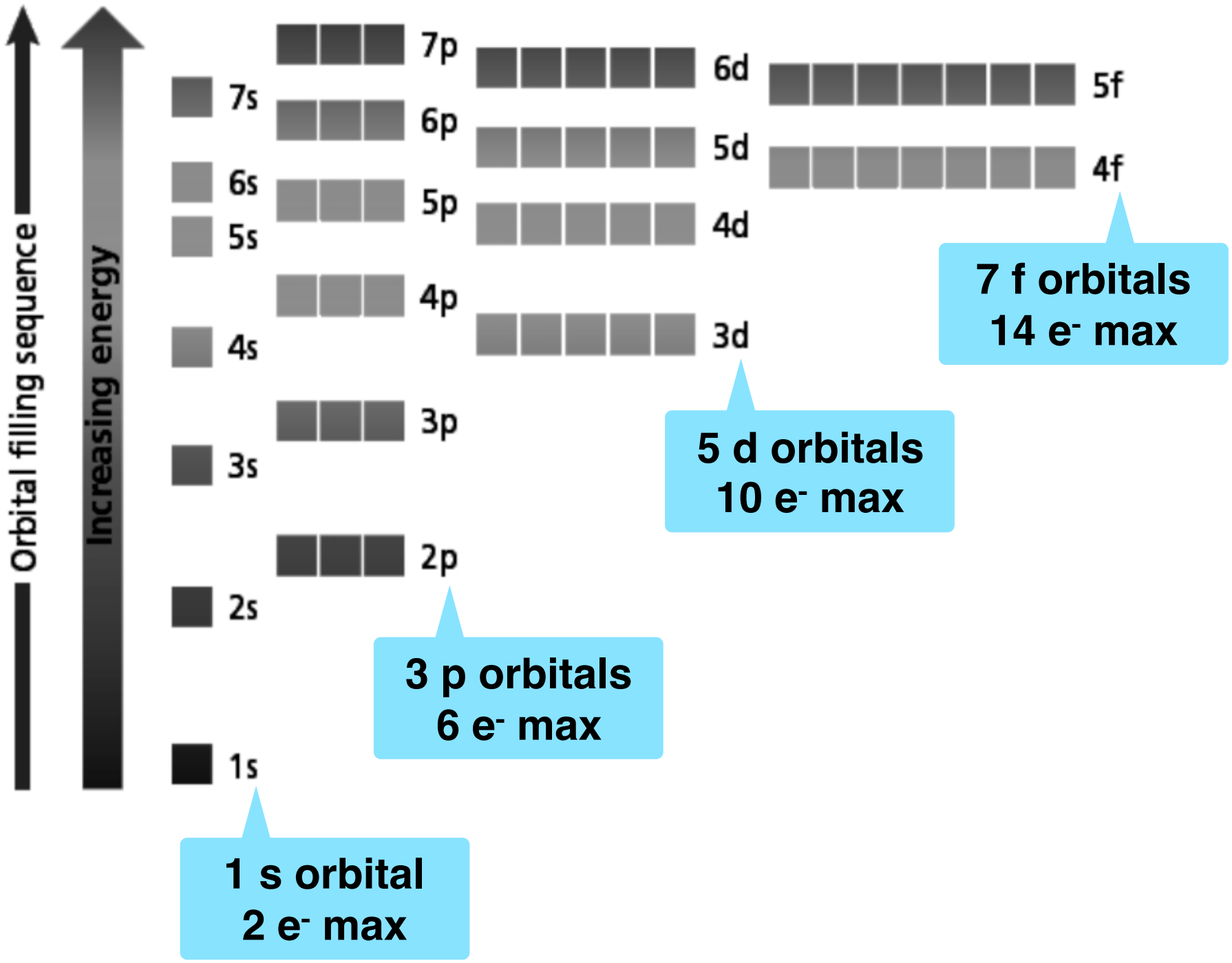
Orbitals

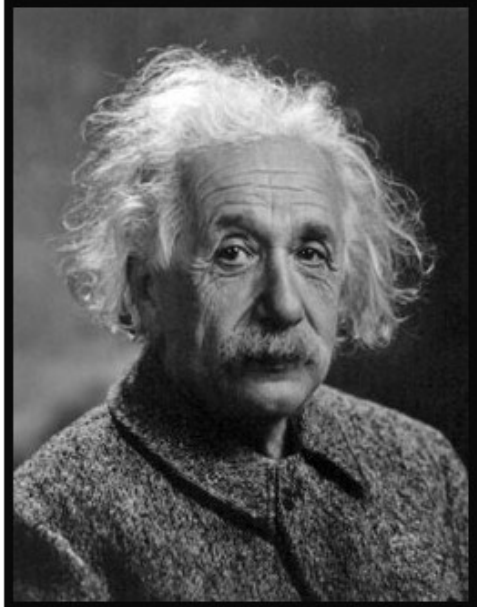


Electron Filling Rules

1. Aufbau Principle: Electrons are normally in the lowest energy orbital available.
2. Pauli Exclusion Principle: Maximum of two electrons in any one orbital (with opposite spins).
3. Hund's Rule: All orbitals in a sublevel must have one electron before the second electron is added.




Orbital filling sequence
Increasing energy
1s
2s
2p
3s
3p
4s
3d
4p
5s
4d
5p
6s
5d
6p
7s
4f
5f
6d
7p
1 s orbital
2 e- max
3 p orbitals
6 e- max
5 d orbitals
10 e- max
7 f orbitals
14 e- max



Quantum mechanics is certainly imposing. But an inner voice tells me that it is not yet the real thing. The theory says a lot, but does not really bring us any closer to the secret of the old one. I, at any rate, am convinced that He does not throw dice.

(Albert Einstein)

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If quantum mechanics hasn't profoundly shocked you, you haven't understood it yet.

(Niels Bohr)

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I think I can safely say that nobody understands quantum mechanics.

(Richard Feynman)

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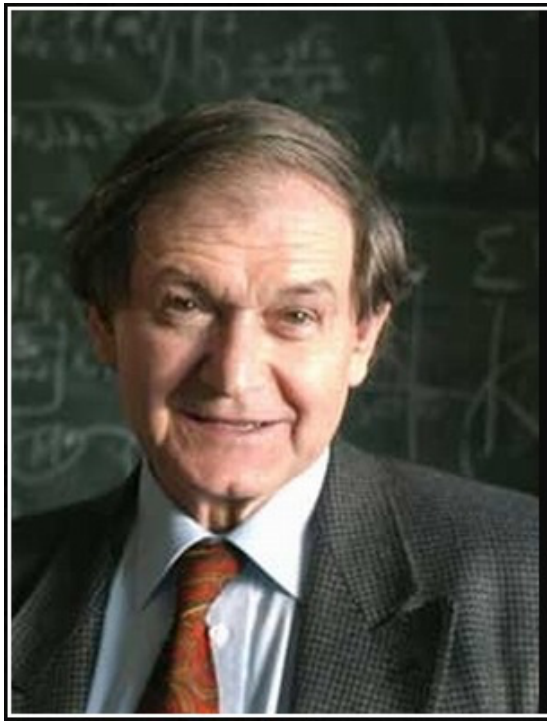


Quantum mechanics makes absolutely no sense.

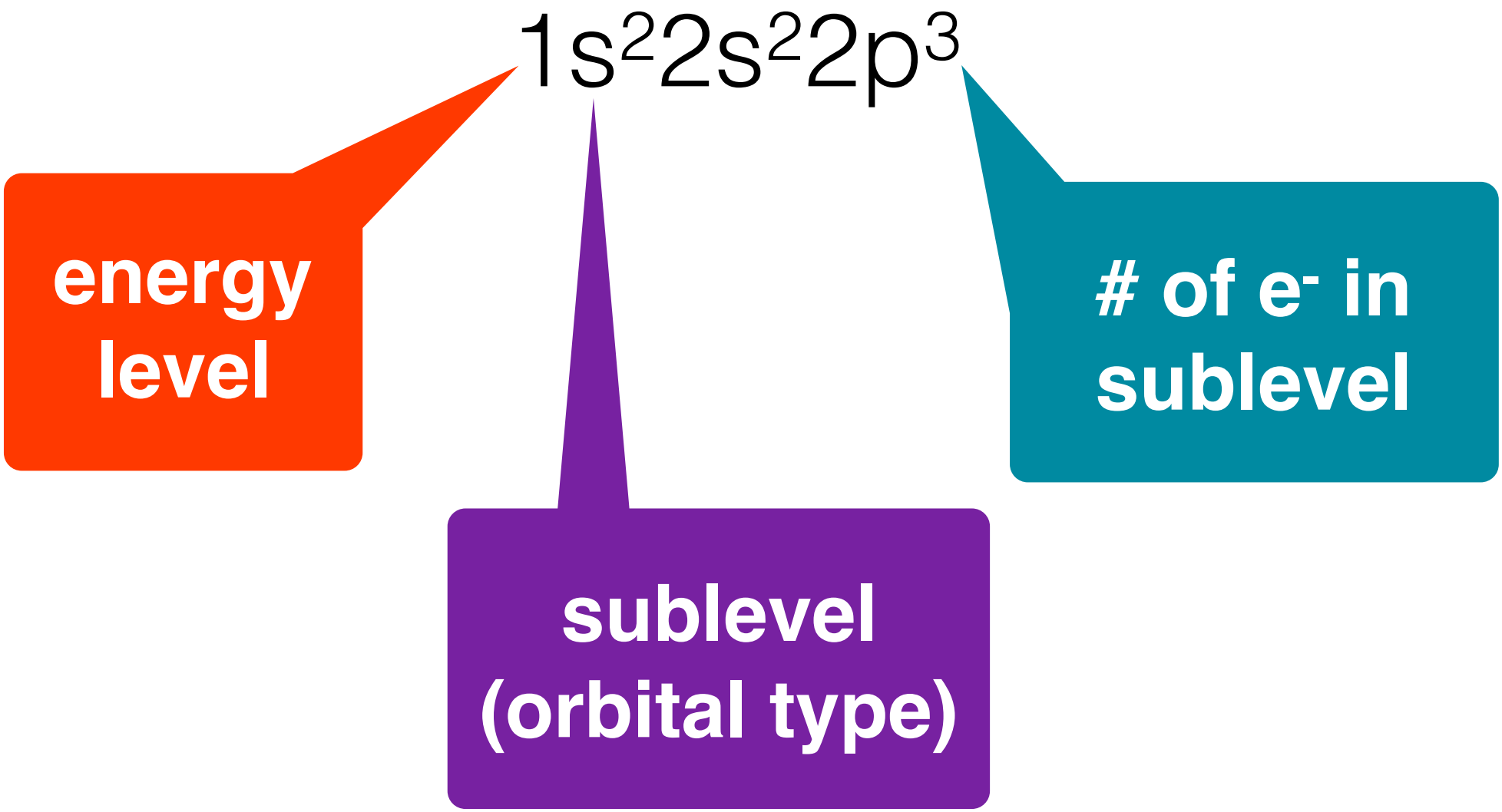
— Roger Penrose —

AZ QUOTES

Steps for determining electron configurations

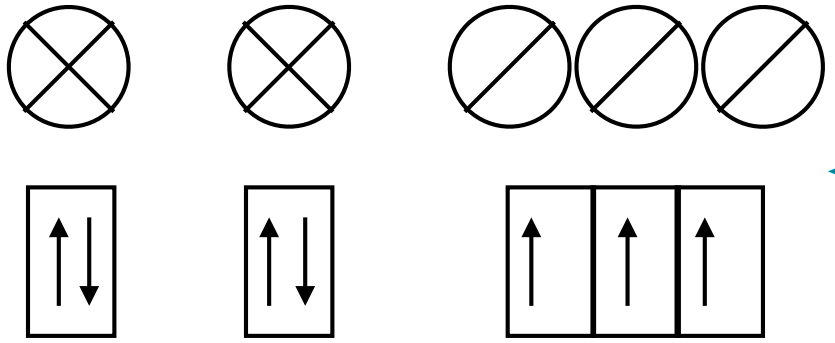
1. Determine # of e^- in element/ion
2. Fill orbitals according to e^- filling rules
3. Verify your answer by checking and counting superscripts

Electron Configuration of Nitrogen



Orbital Diagram of Nitrogen

(circles and lines OR boxes and arrows)



1s 2s 2p

# of e⁻ in sublevel

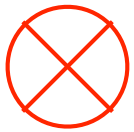
energy level

sublevel (orbital type)

Practice 1

Write the electron configuration and draw an orbital diagram for magnesium (Mg).

$1s^2 2s^2 2p^6 3s^2$



3s

0 unpaired

How many unpaired electrons?

Practice 2

Write the electron configuration and indicate the number of unpaired electrons for fluorine (F).

$1s^2 2s^2 2p^5$

2p

1 unpaired

Practice 3

Write the electron configuration and indicate the number of unpaired electrons for nickel (Ni).

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$

3d

2 unpaired

1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p 6s 4f 5d 6p 7s 5f 6d 7p