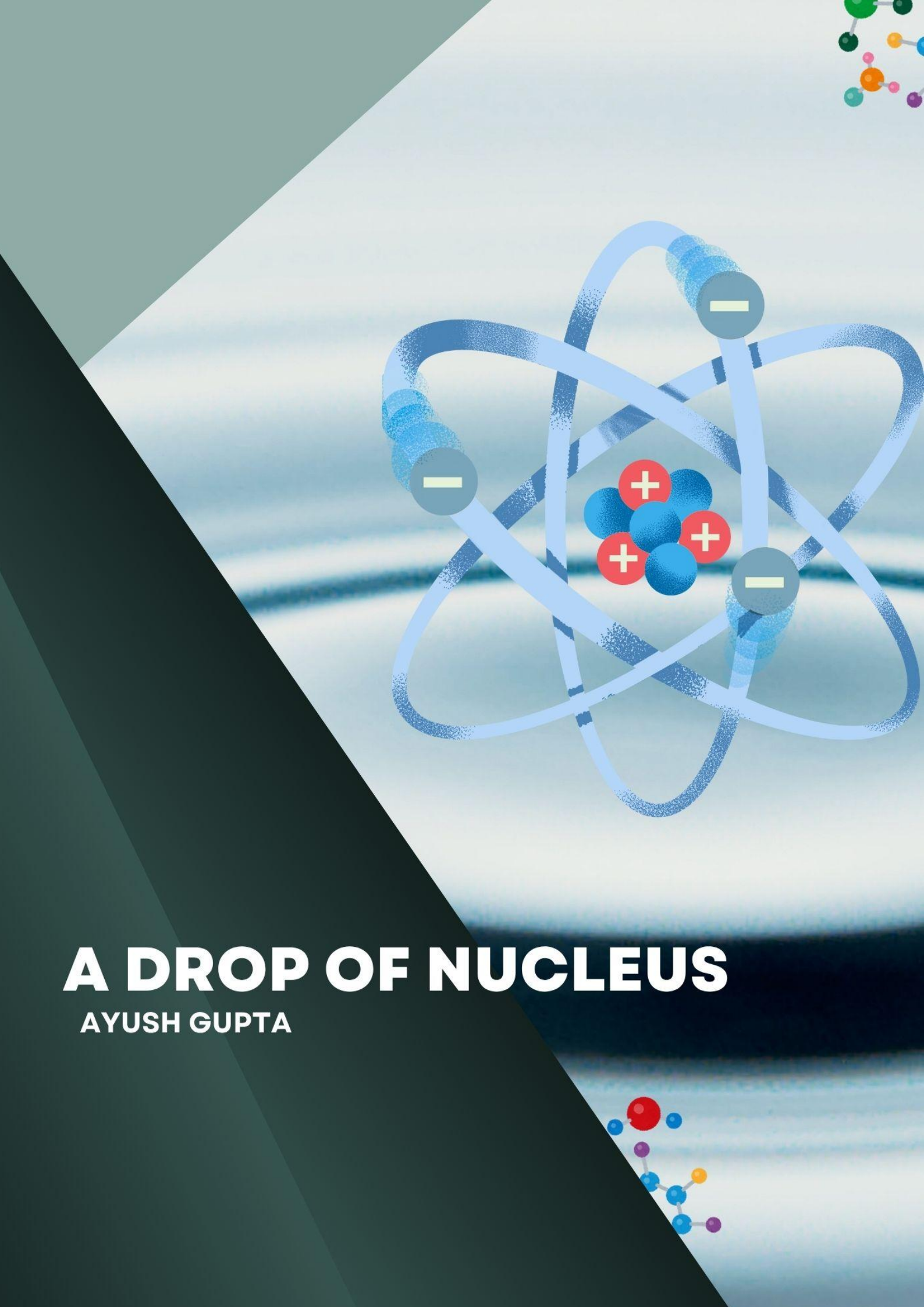


A DROP OF NUCLEUS

AYUSH GUPTA

A Drop of Nucleus

--Ayush Gupta (09-6-2025)

One day on a random evening while solving some questions I realised that the sphere's volume is same as a volume of a cone in which its height is 4 times the radius. Consider a sphere and a cone of radius "r" and height of the cone being "h", with volume:

$$V_{sphere} = \frac{4}{3}\pi r^3$$

$$V_{cone} = \frac{1}{3}\pi r^2 h$$

So, if the height of the cone is 4 times the radius (h = 4r), then:

$$V_{cone} = \frac{1}{3}\pi r^2(4r) = \frac{4}{3}\pi r^3 = V_{sphere}$$

We model nucleus of an atom as a sphere with neutron and protons bound together, and we represent its volume as a volume of sphere which we here say the **Nuclear Volume** which is

$$V_{sphere} = \frac{4}{3}\pi r^3$$

So, from this is it possible to say that a nucleus also might also take a conical shape in which its height is four times its radius? And not only this volume is a special case, also there's an interesting relation between the curved surface area or lateral surface area between them --

Surface area of sphere → $A_{sphere} = 4\pi r^2$

Lateral/curved Surface area of cone → $A_{cone(lateral)} = \pi r l$

So, if the slant height of cone is 4 times it's radius (l = 4r) then

$$A_{cone(lateral)} = \pi r(4r) = 4\pi r^2 = A_{sphere}$$

Both the volume and lateral surface area match between the sphere and the cone (with h = 4r and l = 4r). It's all about **stability**. Nature favors low-energy states so systems tends to like a drop of water wobbles in a changing pattern of shapes(trying to minimize the surface energy and the environmental perturbations (like friction, tap water slight oscillations) always stopping it to perfectly minimize its surface energy so it just wobbles in and out in patterns of shape like sphere to tear drop), it's the same case in the nucleus too and also in the book "in search of Schrodinger's cat" there's written "A large nucleus can be thought of as wobbling in and out changing shape from a sphere to something like a fat dumbbell and back again", this is due to quantum shape fluctuations happening in a nucleus especially in large or highly excited nuclei so maybe my mathematical observations aren't just a random coincidence.

The sphere has the smallest surface energy so that is the most stable state for a drop of water and nucleus but external energies always never make them achieve this, so what if a nucleus starts as a sphere (lowest surface energy) then under excitation (or giving it energy), it wobbles into a more cone-like or dumbbell shape? These transitions will always be constrained to **preserve volume and surface energy.** So maybe, *just maybe*, nature "chooses" transitions that preserve the cone–sphere symmetry because it's energetically optimal.

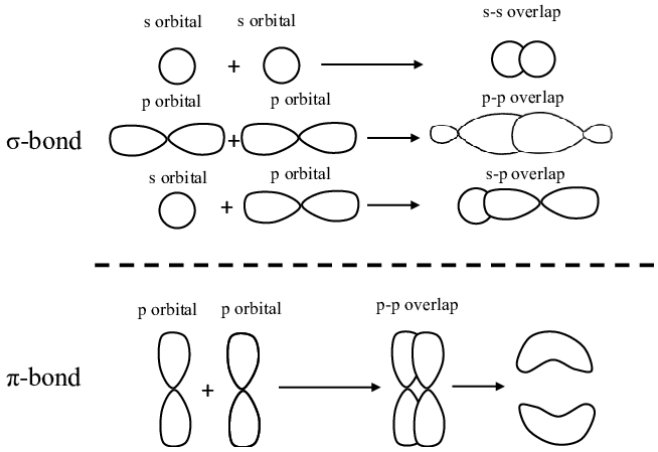
What if we reverse engineer this concept?

If we can make the nucleus a perfect sphere when its in a complete ground state with total ideal state, then imagine if can we shape the nucleus in a more "special" shape by giving it "special amount" of energy then what if it gets easier for two nuclei to fusion together due to that special shape? It could be nuclear fusion by geometric tuning, not just kinetic smashing.

If we can excite a nucleus into a different shape like an elongated or lobed "cone-like" shape, its surface area increases, and its interaction zone extends. When two such deformed nuclei approach, their probability of quantum tunneling through the Coulomb barrier may increase due to:

- Lower barrier height at specific regions
- Larger contact surface
- Better alignment of wavefunctions

Actually, Deformed nuclei already exist like the Uranium-238 is ellipsoidal and not spherical. In environments like the Sun, fusion sometimes occurs via **sub-barrier fusion**, where nuclei fuse at energies lower than expected due to quantum effects (like quantum tunnelling), so my idea might be actually useful to achieve sub-barrier fusion by changing nuclei shape. It's just like two atomic orbitals fusing/overlap/hybridization, where p–p orbital overlap (when properly aligned) generally leads to better overlapping than s–s orbital overlap.



Two Orbitals overlapping Image from - https://www.researchgate.net/figure/s-and-bond-are-formed-by-the-orbital-overlap_fig3_344271659

Still, there’s a problem in my concept, and that is that the nuclei shaped by external energy will be constantly fluctuating, so if we have to do fusion between two nuclei with proper orientation then we might need to be very quick.