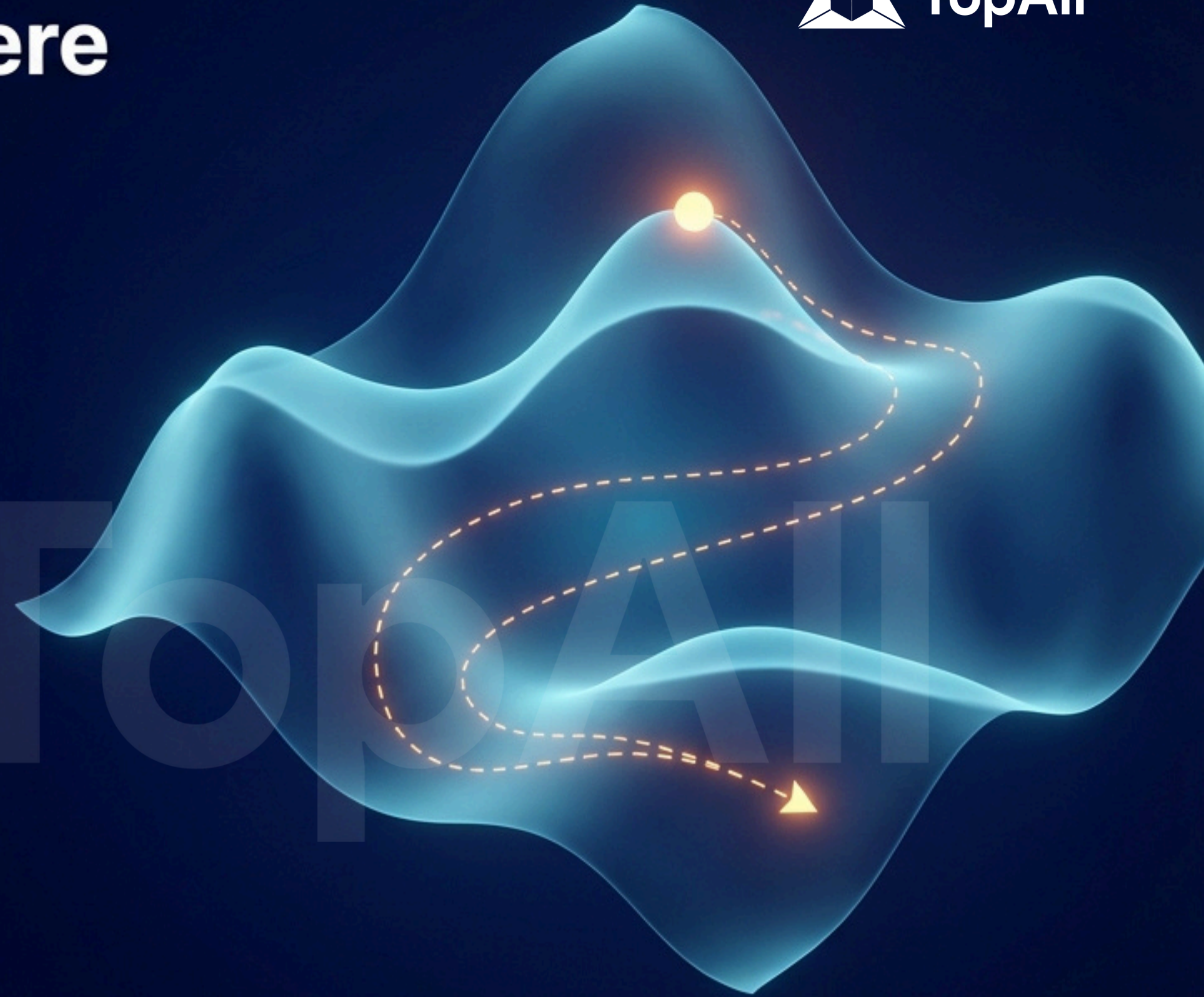


Invisible Surfaces Where No Work is Done

Imagine navigating a powerful electric field without expending a single joule of energy.

In the invisible landscape of electrostatics, there are specific “safe zones”—surfaces where a charge can slide freely, completely unaffected by the push and pull of the field.

Section 2.6 Introduction



The Definition

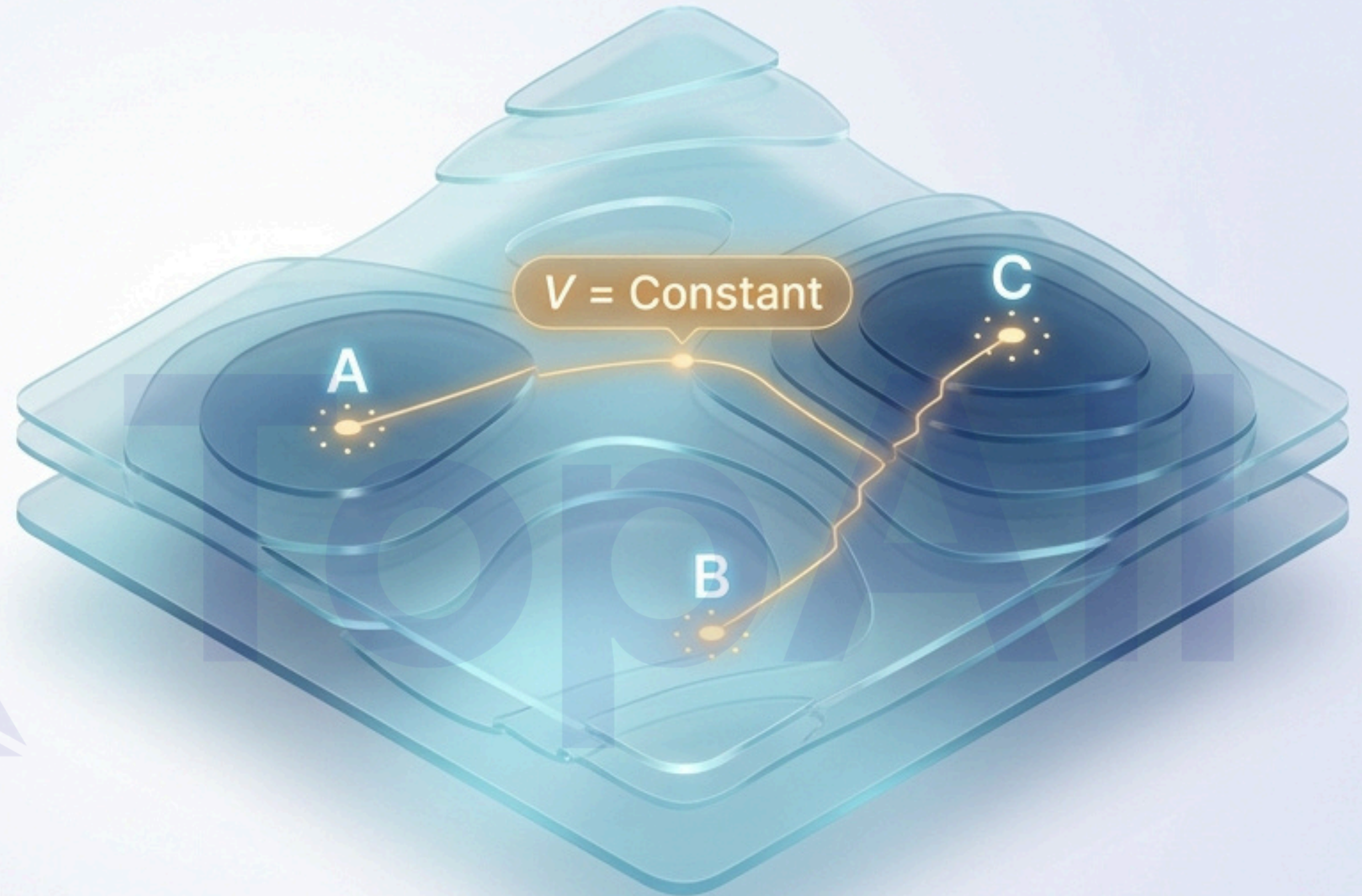
An equipotential surface is a surface with a constant value of potential at all points on the surface.

The Math

For any two points A and B on this surface:

$$V_A = V_B$$

Therefore, $\Delta V = 0$.

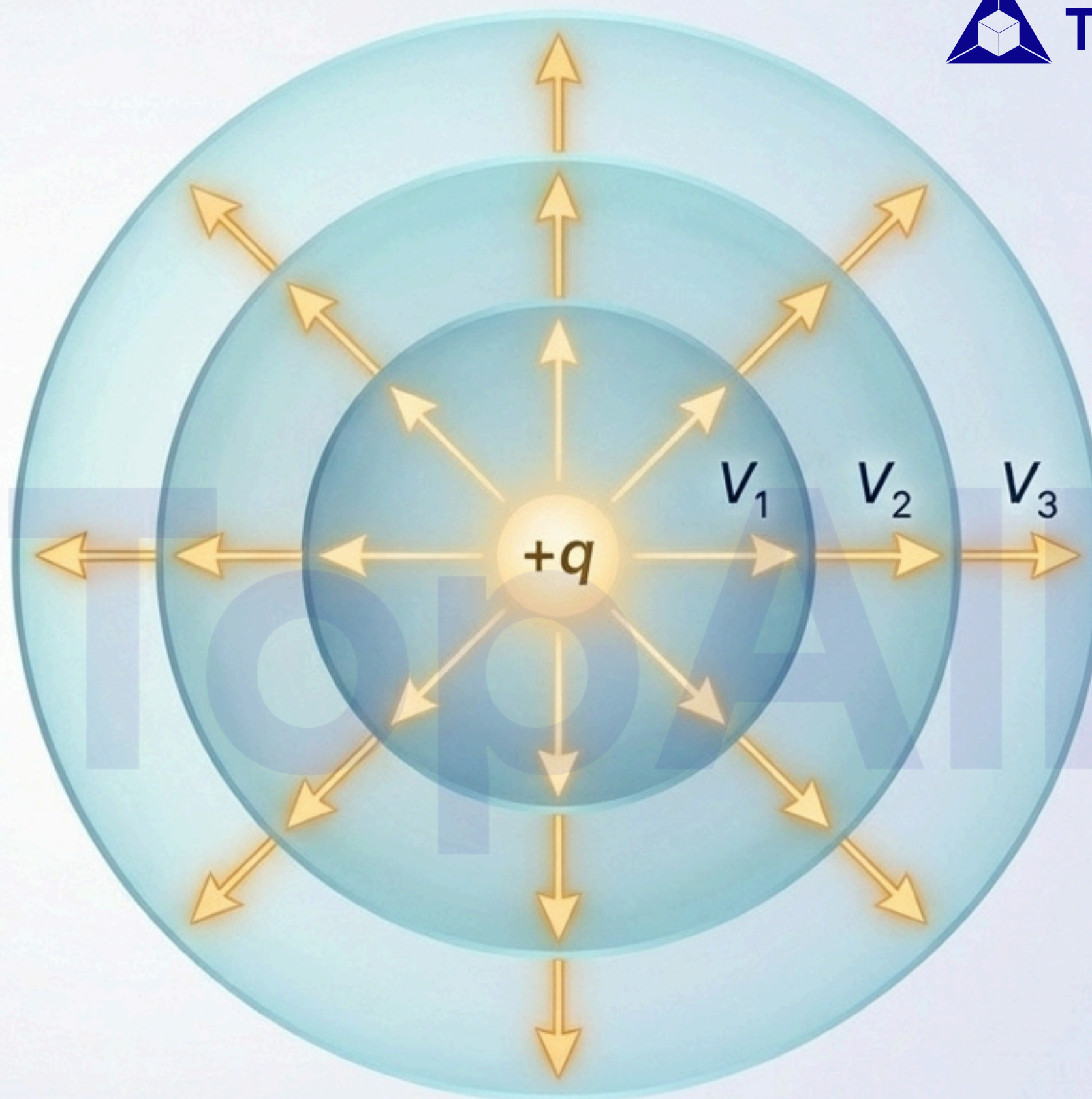


The Point Charge: Concentric Spheres

For a single charge q ,
potential is determined
strictly by distance r :

$$V = \frac{1}{4\pi\epsilon_0} \frac{q}{r}$$

Since V is constant if r is
constant, the surfaces form
perfectly symmetrical
spherical shells.





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Let's Test Them Now.**

$$E=mc^2$$



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Key Highlights

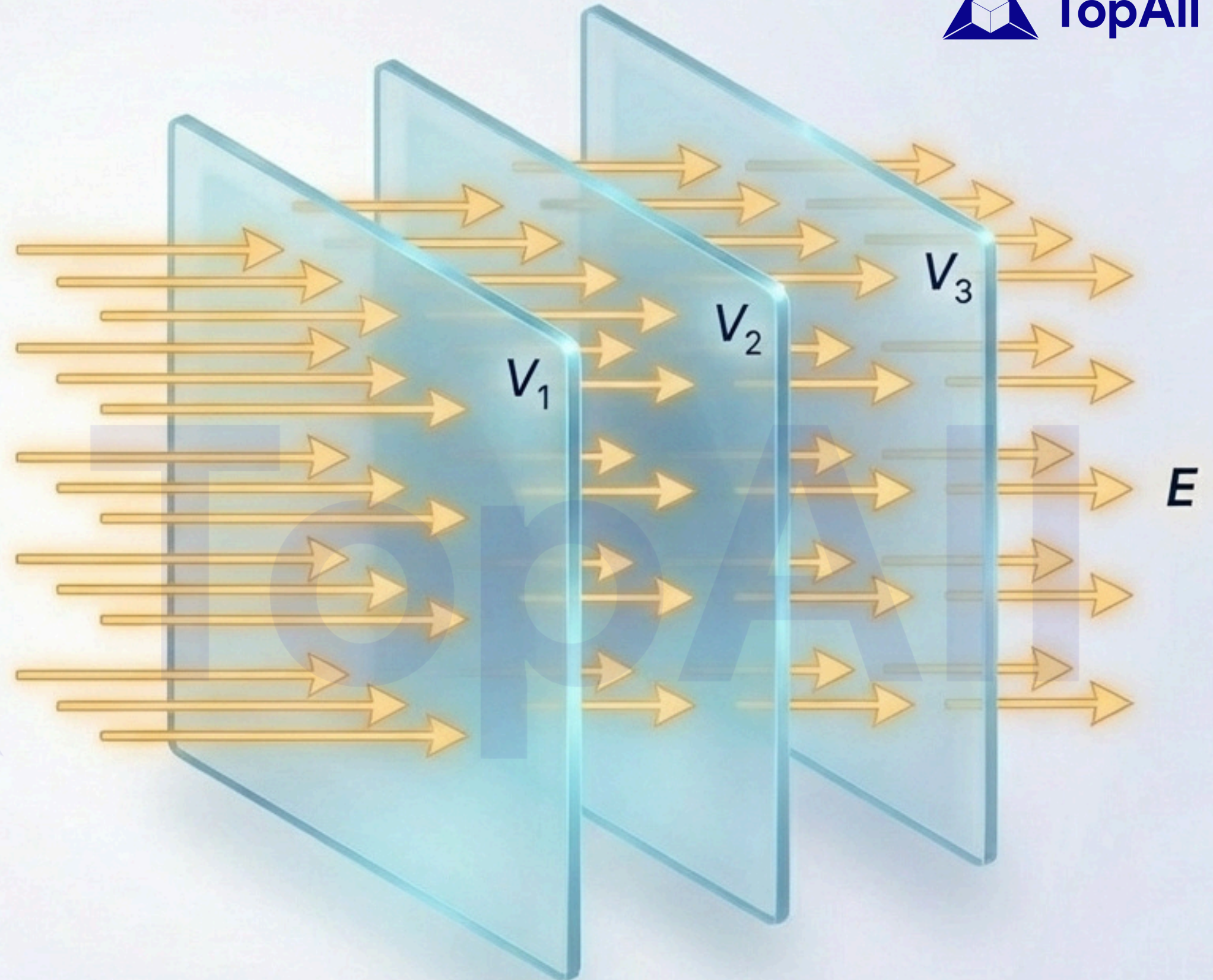
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The Uniform Field: Parallel Planes

For a uniform electric field E pointing along the x -axis, the equipotential surfaces stretch into flat planes normal to the x -axis.

These planes are parallel to the y - z plane. Equal spacing between planes represents equal drops in potential.



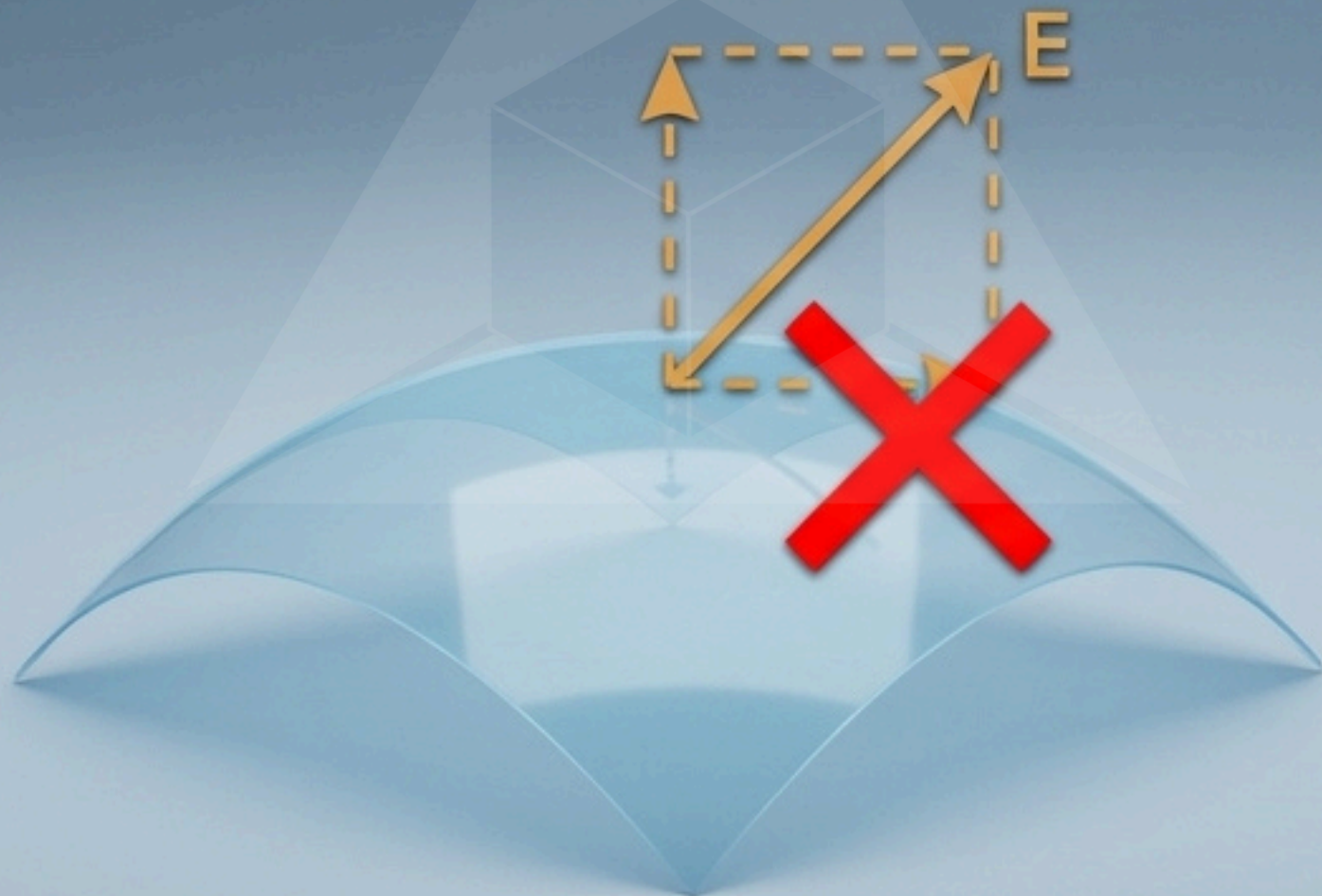
Why is the Electric Field Always Normal?

Step 1: What if it wasn't?

If E were not normal (perpendicular), it would have a non-zero component along the surface.

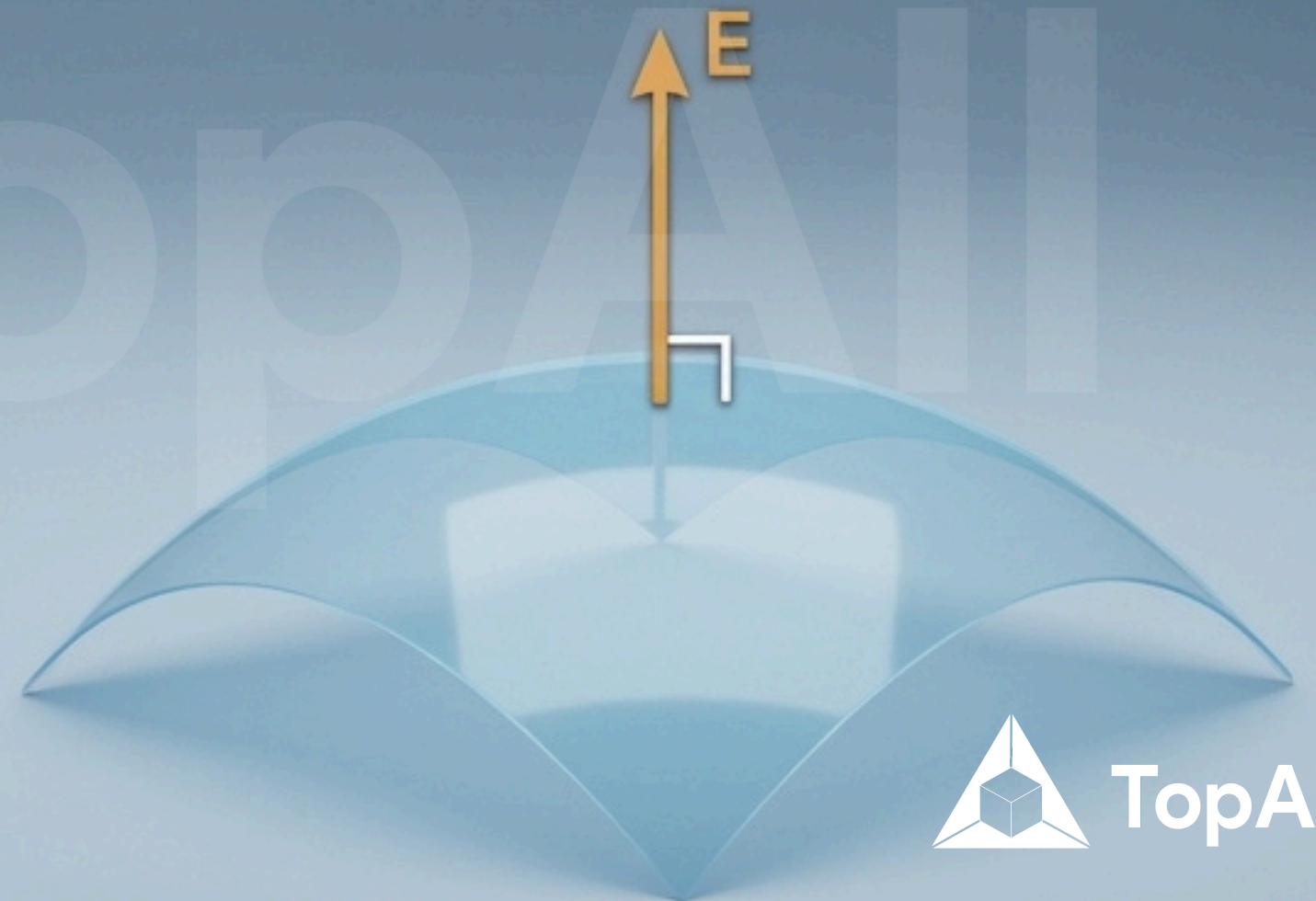
Step 2: The Contradiction

To move a test charge against this surface component, work would have to be done.



Step 3: The Conclusion

This contradicts the definition. Therefore, E must be normal (90°) to the surface at every point.



Zero Work, Same Potential

The Law

No work is required to move a test charge on an equipotential surface.

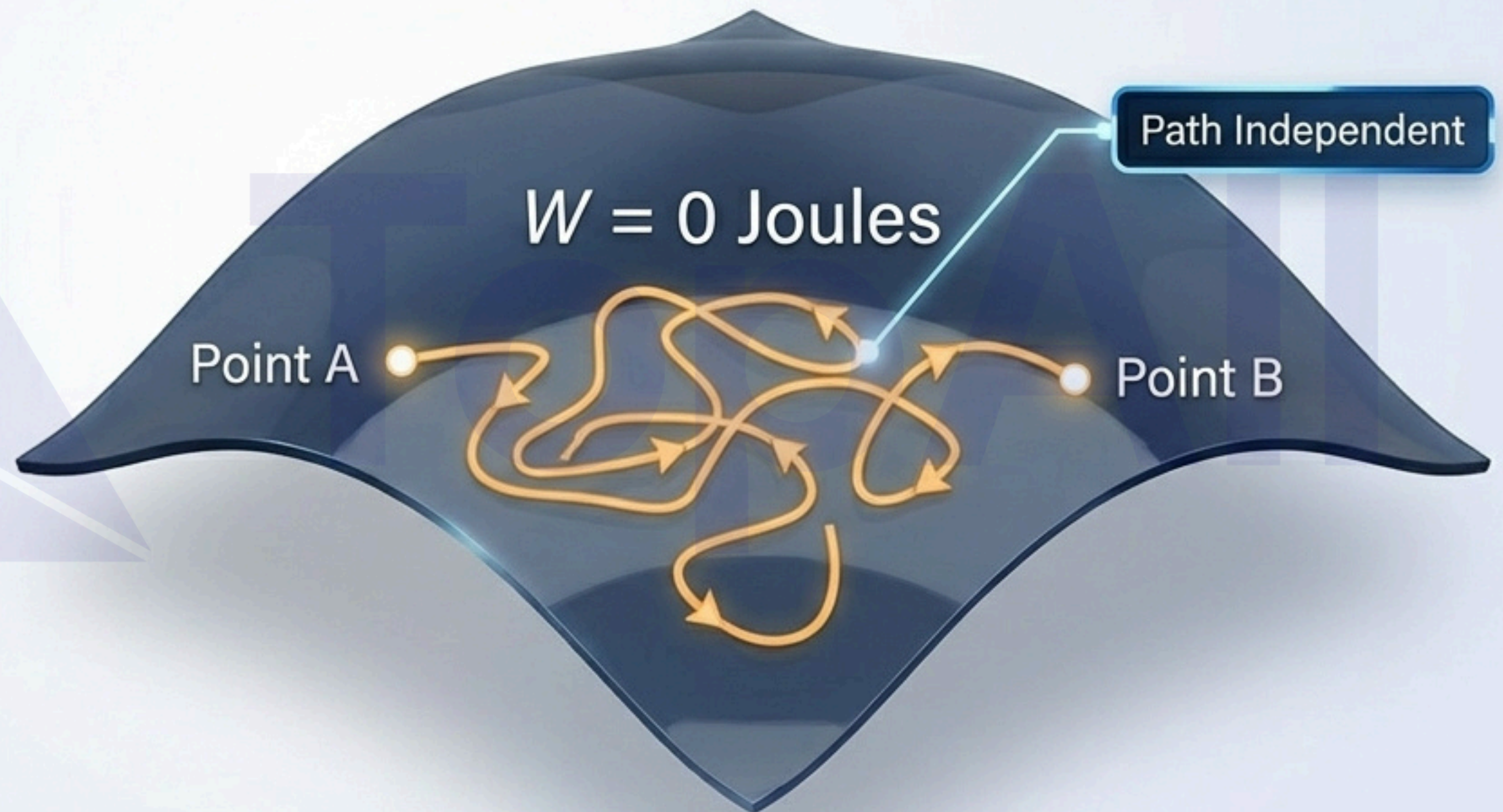
The Proof

$$W = q(V_B - V_A)$$

Since $V_A = V_B$
on this surface,

$$W = q(0) = 0$$

$$W = q(0) = 0$$



Section 2.6 Mastery

✓ Key Takeaways

- ✓ **Define:** Surface with constant potential (V).
- ✓ **Identify:** Spheres for point charges; parallel planes for uniform fields.
- ✓ **Remember:** Work done moving a charge on the surface is ALWAYS zero.
- ✓ **Visualize:** Electric field (E) is ALWAYS perpendicular (normal) to the surface.

⚠ Exam Trap

Two equipotential surfaces can never intersect!

If they did, the intersection point would have two different potential values, which is mathematically impossible.



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