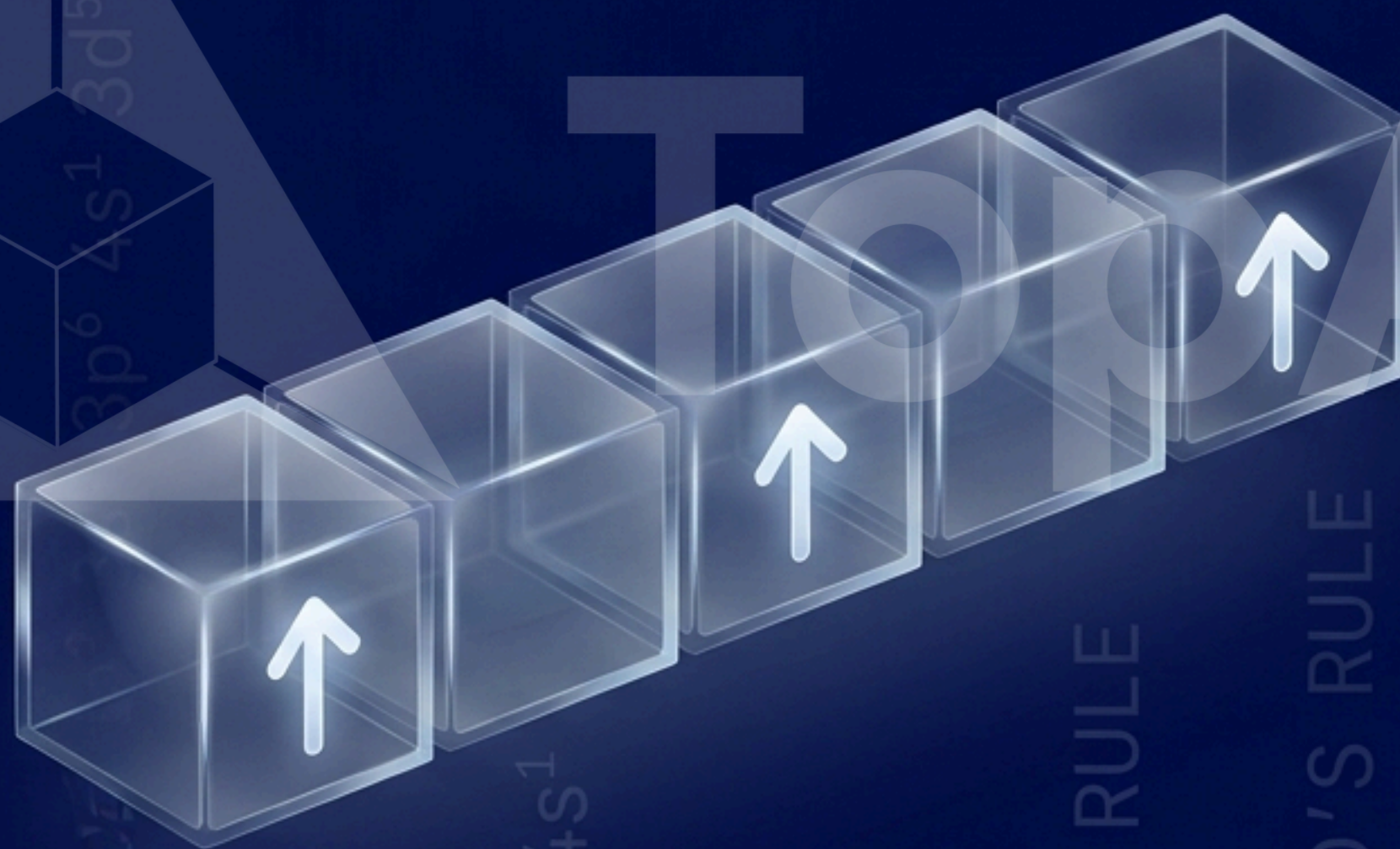


Half-Filled & Fully Filled Stability

The Architecture of Atomic Orbital Energy



The Patterns of Supreme Stability

Certain electronic configurations naturally lower the total energy of an atom, granting it extra stability. These occur when degenerate orbitals are either perfectly half-filled or completely filled.

Half-Filled (Maximum Symmetry)

p^3



d^5



f^7



Fully Filled (Maximum Symmetry)

p^6



d^{10}

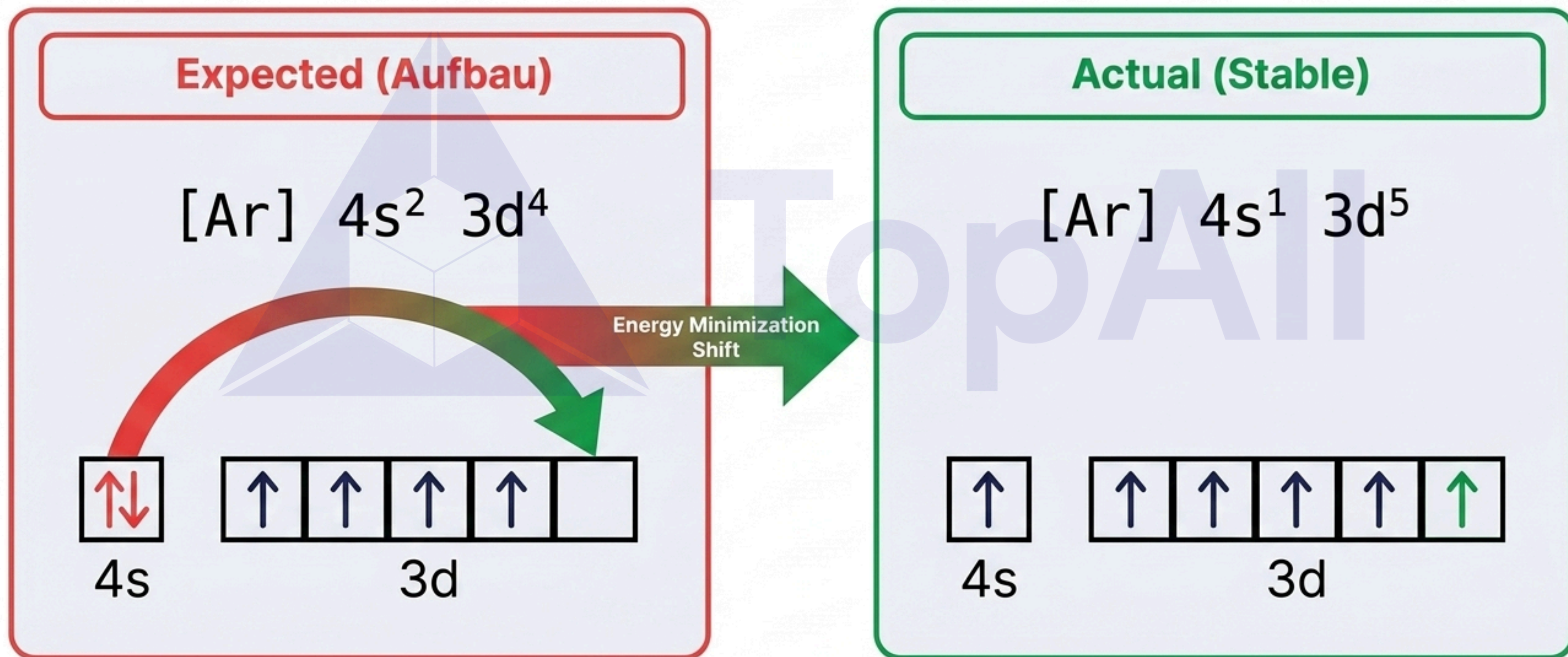


f^{14}



Exception 1: Chromium (Cr, Z=24)

Thermodynamic stability overrides the standard Aufbau progression. One electron shifts to achieve a half-filled d-subshell.





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$$E=mc^2$$



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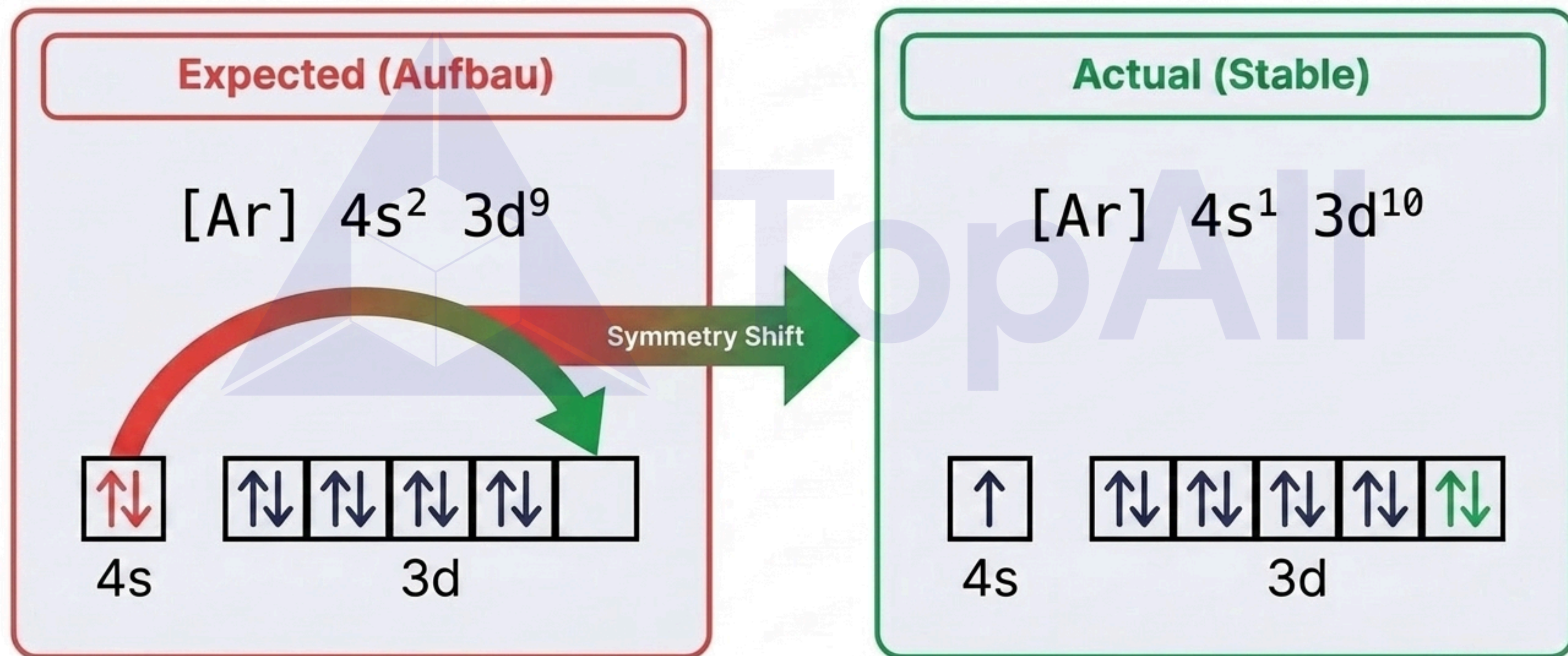
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Exception 2: Copper (Cu, Z=29)

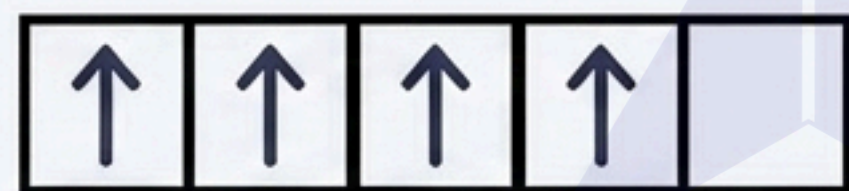
The same rule applies to fully filled states. Copper shifts one electron to complete its d-subshell, achieving a symmetrical d^{10} state.



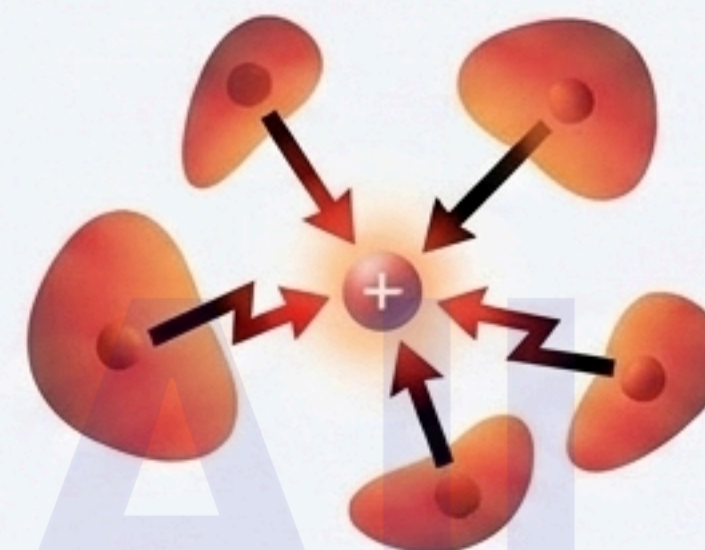
Reason 1: Symmetrical Distribution

Symmetry inherently leads to lower energy and higher stability. Electrons in the same subshell have equal energy but different spatial distributions.

Asymmetrical - Higher Energy



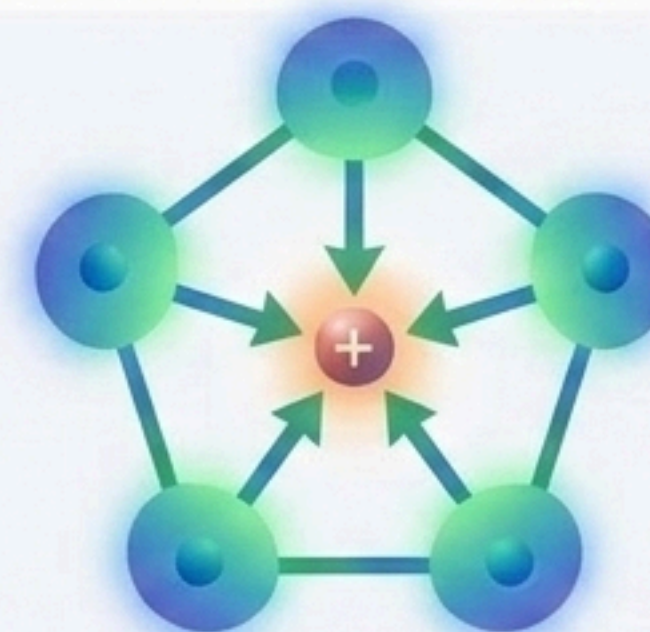
3d



Symmetrical - Lower Energy

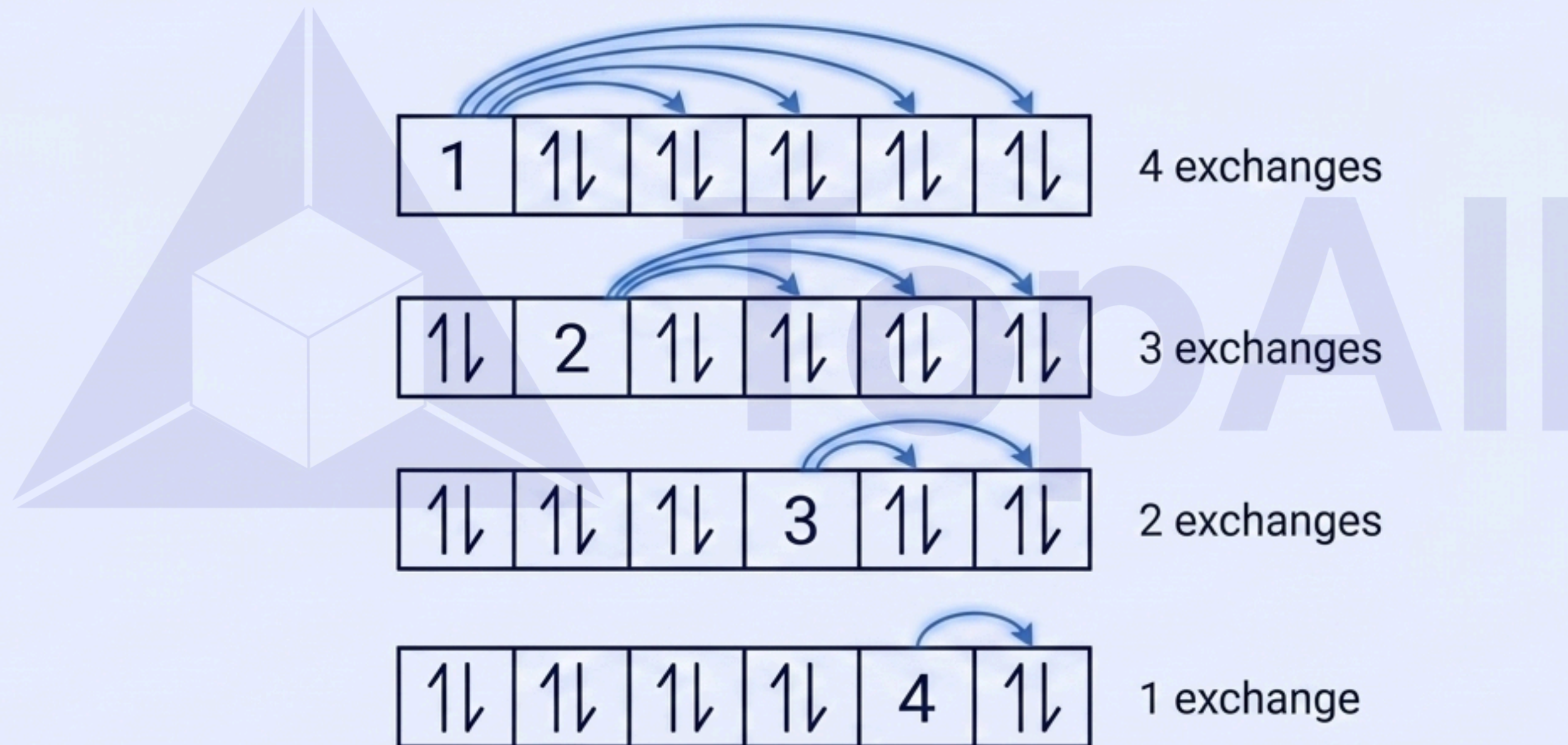


3d



Reason 2: Maximum Exchange Energy

Electrons with parallel spins in degenerate orbitals tend to **exchange positions**. Each exchange releases energy. **Half-filled** (d^5) states **maximize** these mathematical combinations.

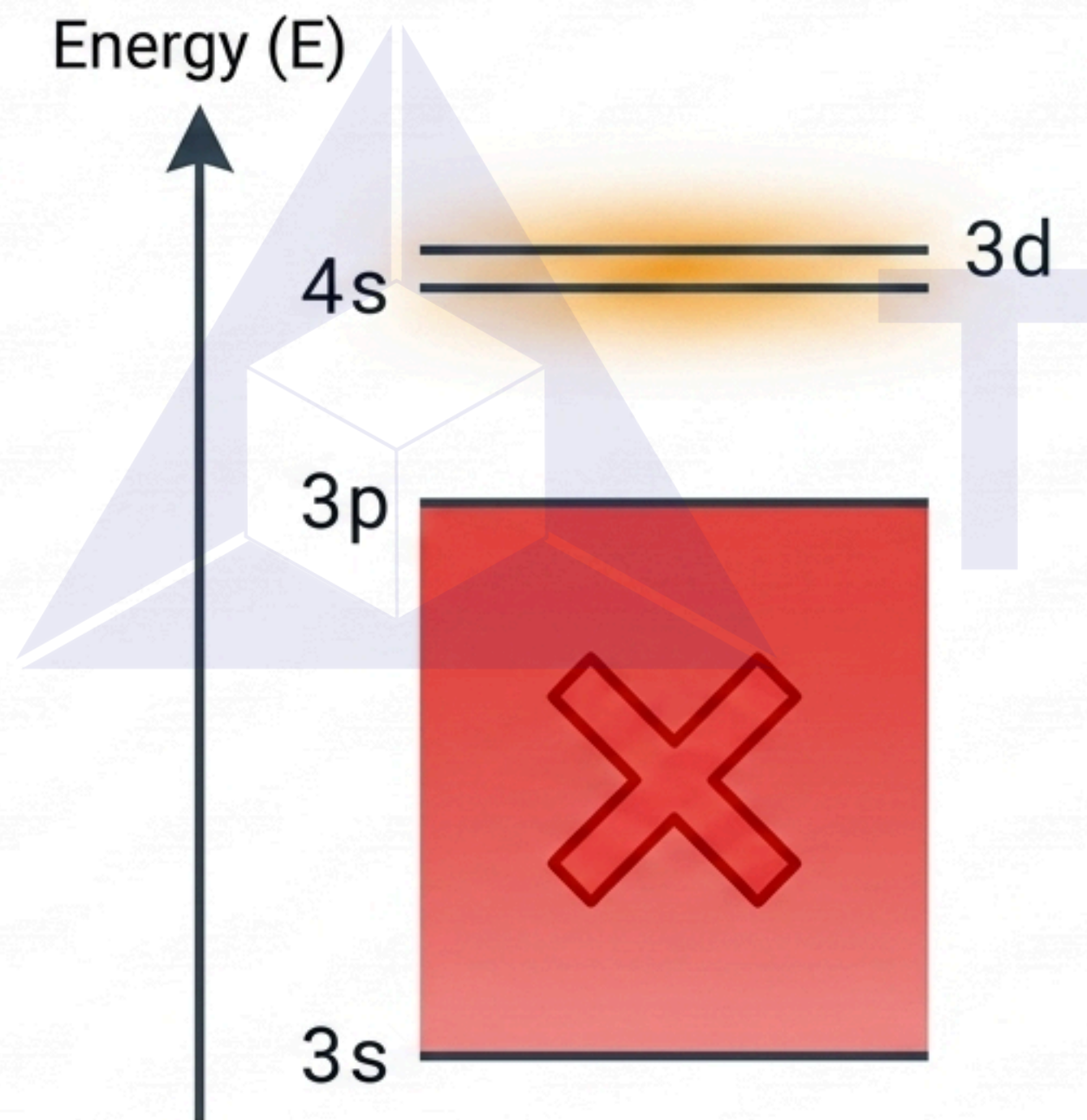


Total Exchanges = $4 + 3 + 2 + 1 = 10$ (Maximum Stability)

THE TRAP: The Energy Proximity Rule



Caution: You cannot shift electrons randomly across any orbitals just to create a stable shell. Stability shifts only occur when the energy levels are nearly identical.



The $4s \rightarrow 3d$ shift is **only permitted** because their **energy gap is infinitesimally small**. The stability gained mathematically outweighs the energy cost of the jump.

Key Takeaways



Half-filled (p^3 , d^5 , f^7) and fully filled (p^6 , d^{10} , f^{14}) subshells inherently achieve a lower, more stable total energy state.



Exceptions to Memorize: Chromium is $[\text{Ar}] 4s^1 3d^5$ (not $4s^2 3d^4$).
Copper is $[\text{Ar}] 4s^1 3d^{10}$ (not $4s^2 3d^9$).



The Physics: Extra stability is driven by symmetrical electron distribution (even nuclear pull) and maximized exchange energy (mathematical electron swaps).



The Rule: Electrons will only shift to achieve this stability if the donor and acceptor subshells (like 4s and 3d) have nearly identical energy levels.



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