

4.6.3 Oxidation States of Actinoids

Unlocking the chemistry of the 5f series—from the stable +3 baseline to the +7 extremes.



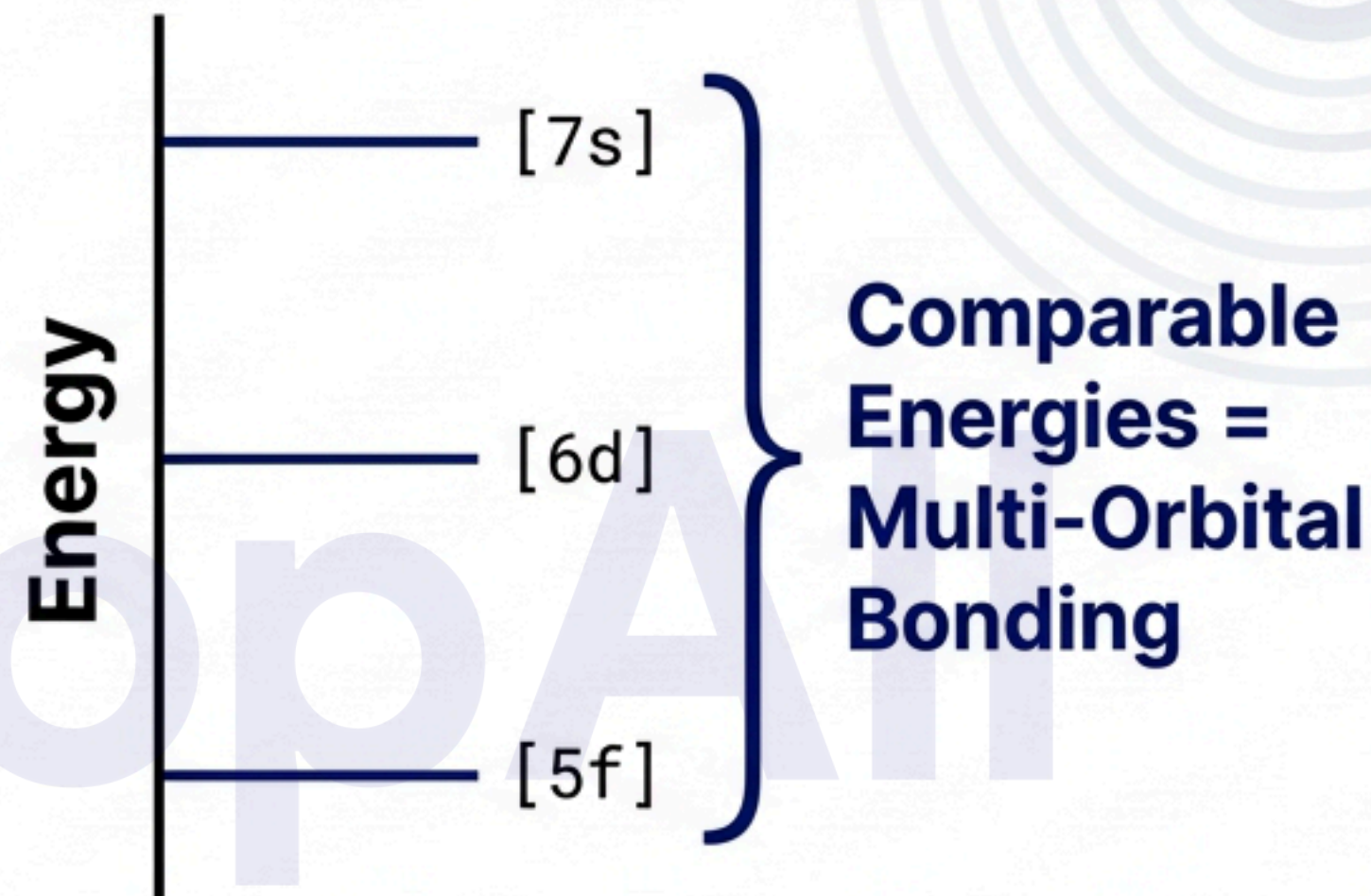
[+7]

The Hallmark of Actinoids: Variability

Unlike lanthanoids, actinoids show a much greater, more uneven range of oxidation states.

[Baseline State = +3]

Most common and general state across the entire series.

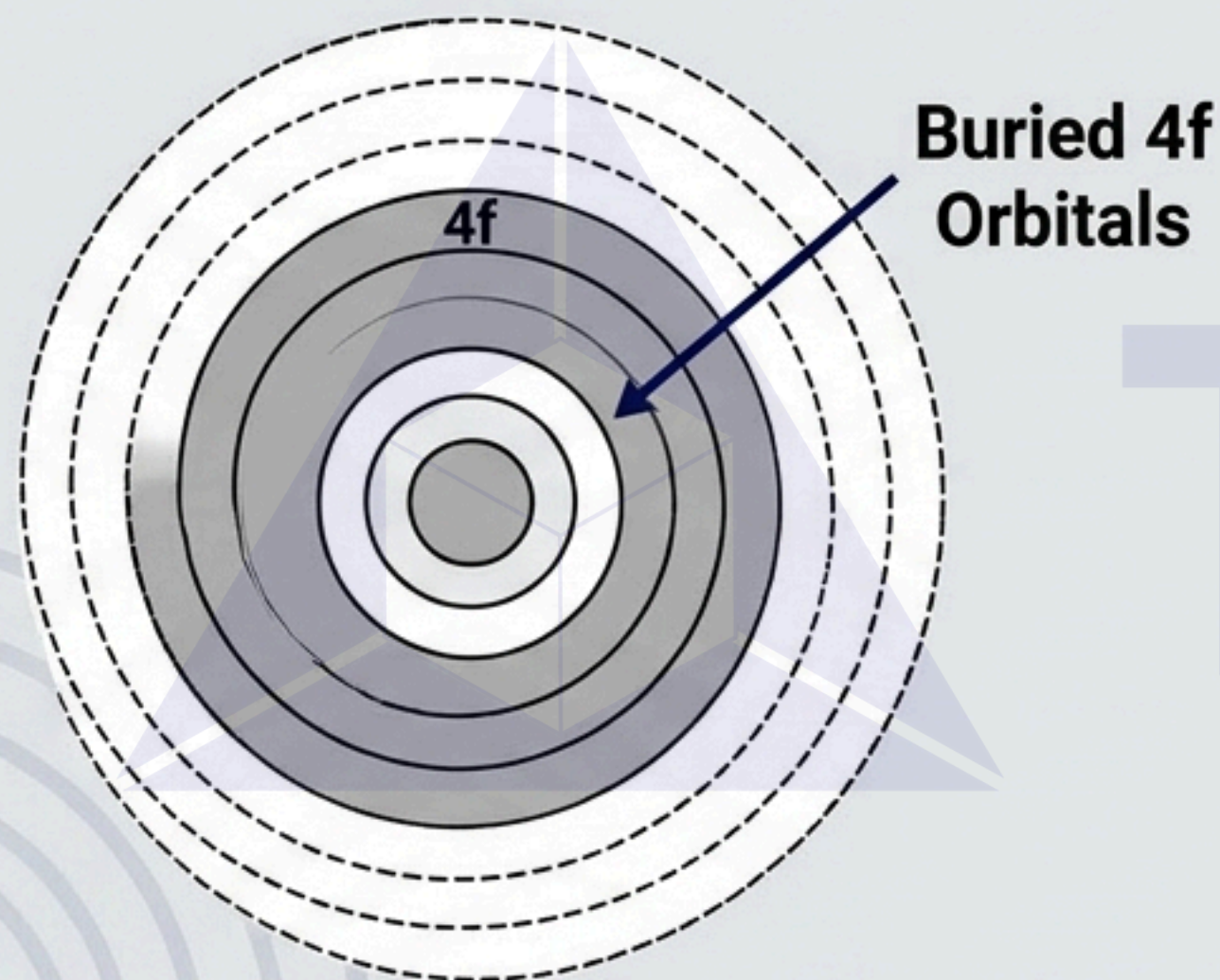


Electrons from all three subshells can easily participate in bond formation due to negligible energy gaps.

Why Actinoids Break the Rules

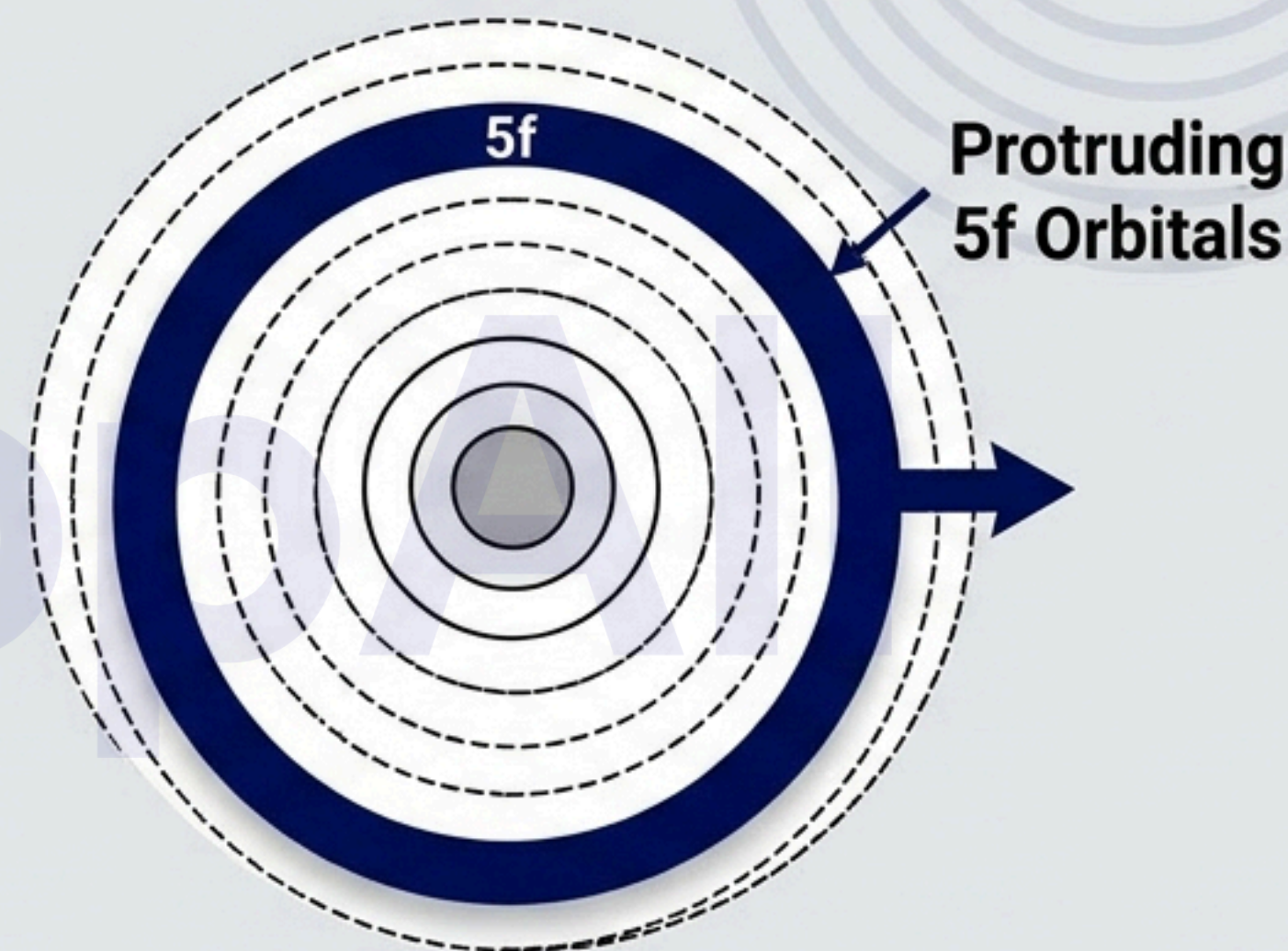


Lanthanoids



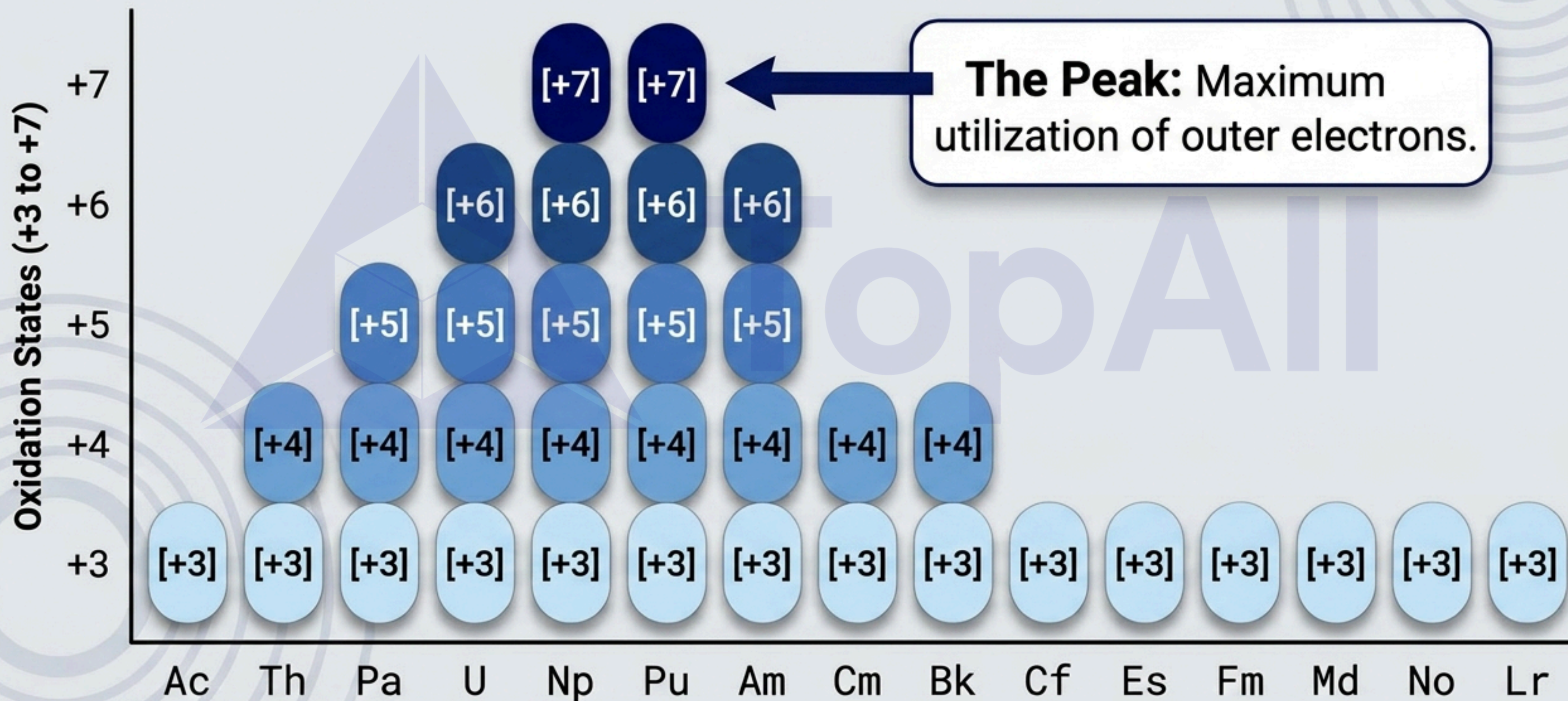
Strong shielding → Limited bonding (mostly +3)

Actinoids



Less effective shielding → Outer electrons held less firmly → Highly available for complex bonding

The Oxidation State Landscape





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$$E=mc^2$$



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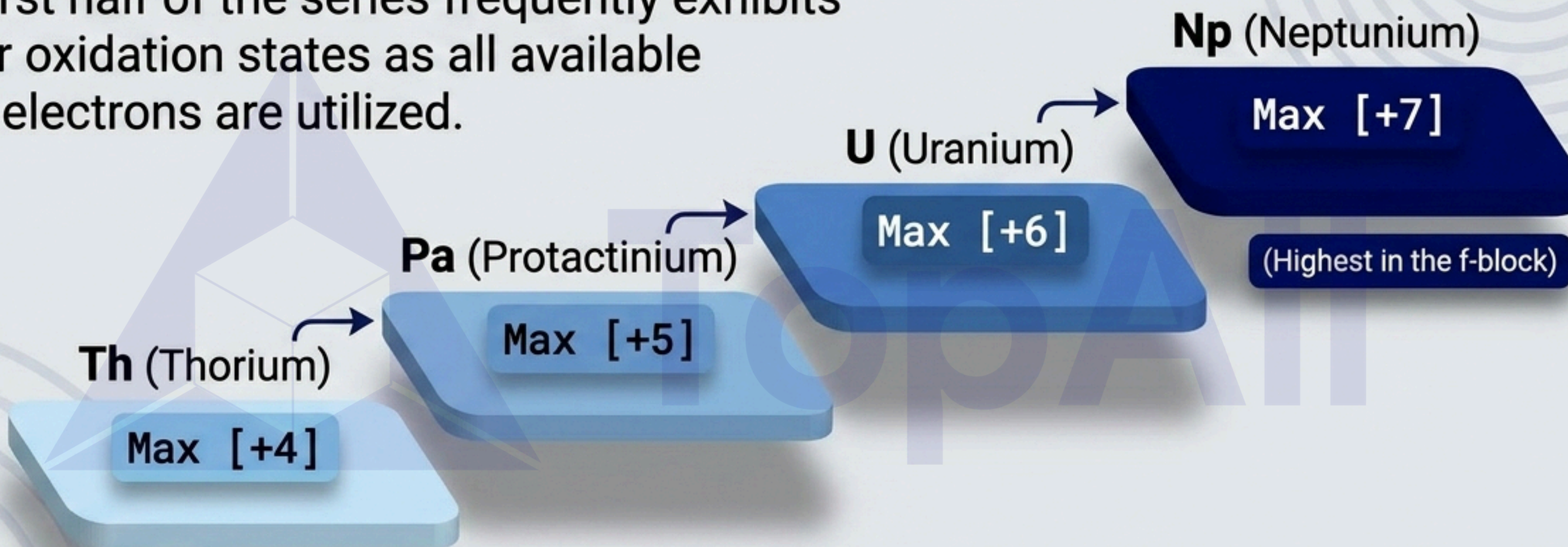
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Early Actinoids: The Climb to +7

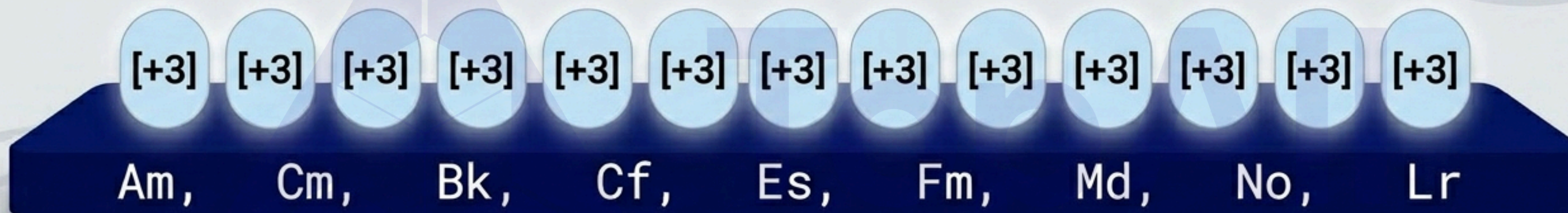
The first half of the series frequently exhibits higher oxidation states as all available outer electrons are utilized.



Note: Actinoid ions in +3 and +4 states tend to hydrolyze easily.

Late Actinoids: Return to Stability

As the series progresses from Am to Lr, the elements begin to heavily resemble the lanthanoids. Higher oxidation states become rare or nonexistent.



The Role of Actinoid Contraction

As nuclear charge increases across the series, the **poorly-shielding** 5f electrons are pulled tighter to the nucleus. They become harder to remove, making higher oxidation states energetically unfavorable.

Distinctive Behaviors: f-Block Showdown

	Lanthanoids (4f)	Actinoids (5f)
Principal State	[+3]	[+3]
State Variability	[Limited (+2, +4 rare)]	[High (up to +7)]
Orbital Energy	[4f and 5d differ greatly]	[5f, 6d, 7s are comparable]
Shielding & Position	[Deeply buried 4f, highly shielded]	[Protruding 5f, poorly shielded]



NEET/JEE High-Yield Focus



Thorium's Secret: Thorium (Th, $Z=90$) formally adds its outer electrons to $[6d]$ rather than $[5f]$ initially, yet still exhibits a maximum $[+4]$ oxidation state.

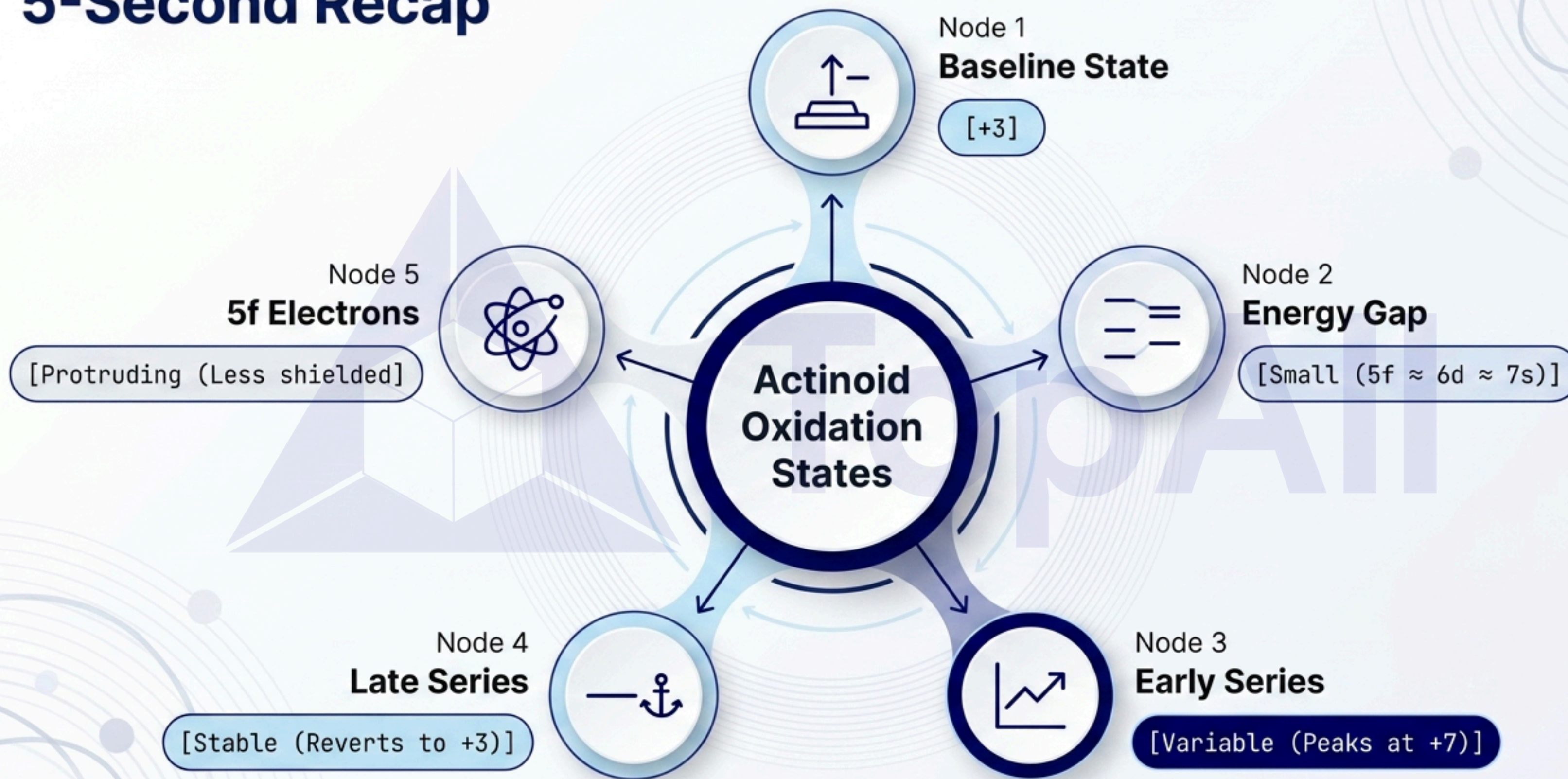


Hydrolysis Risk: Never forget that actinoid ions in the $[+3]$ and $[+4]$ states have a strong tendency to hydrolyze in aqueous solutions.



Maximum State: If asked for the highest oxidation state in the entire f-block, the answer is $[+7]$, exhibited strictly by Np and Pu.

5-Second Recap





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