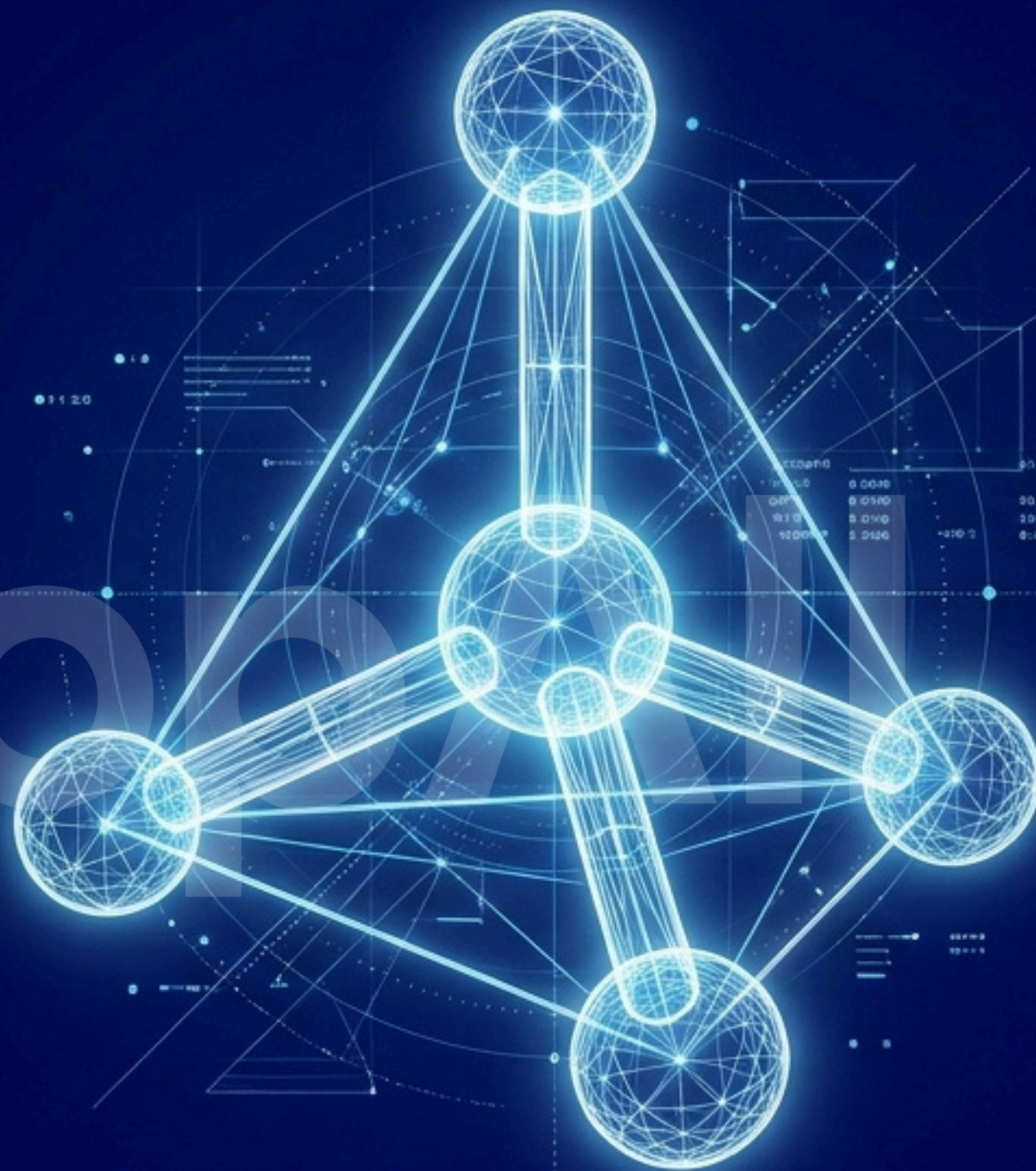


CHAPTER 5 • COORDINATION COMPOUNDS • 5.5.4(B)

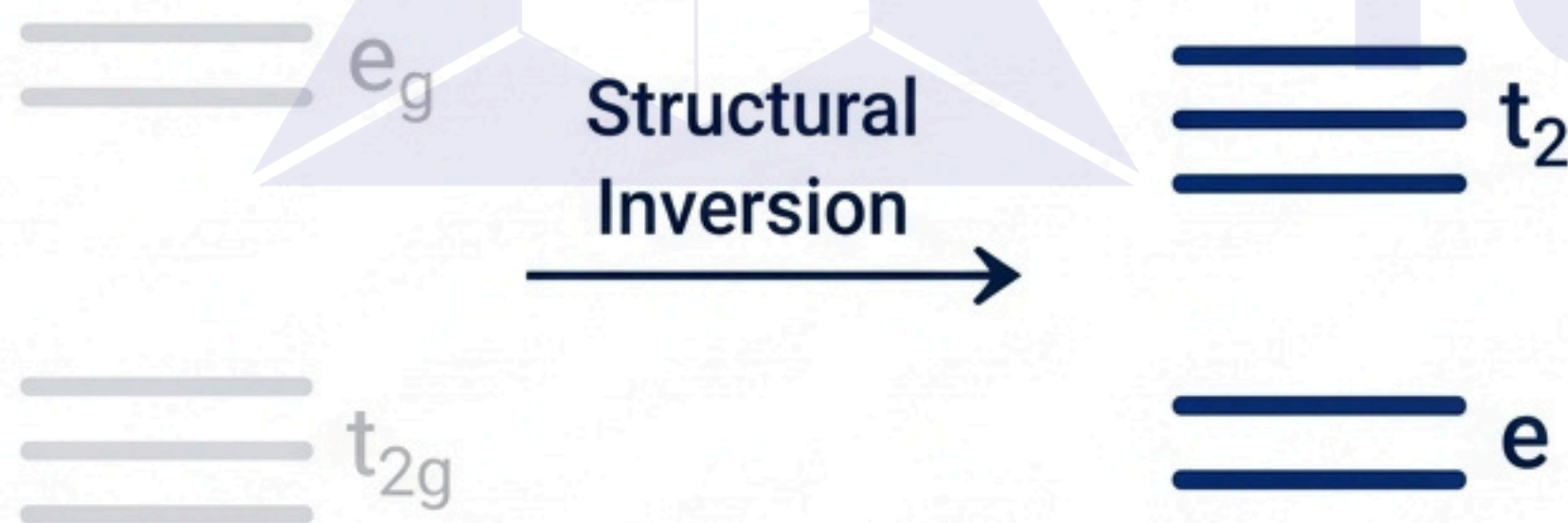
Crystal Field Splitting in Tetrahedral Coordination Entities

Understanding Orbital Inversion,
Splitting Magnitude, and Spin States.



The Inverted Architecture

In tetrahedral coordination entities, the splitting of the d-orbitals is completely inverted compared to octahedral fields. The e orbitals are lowered in energy, while the t_2 orbitals are raised.



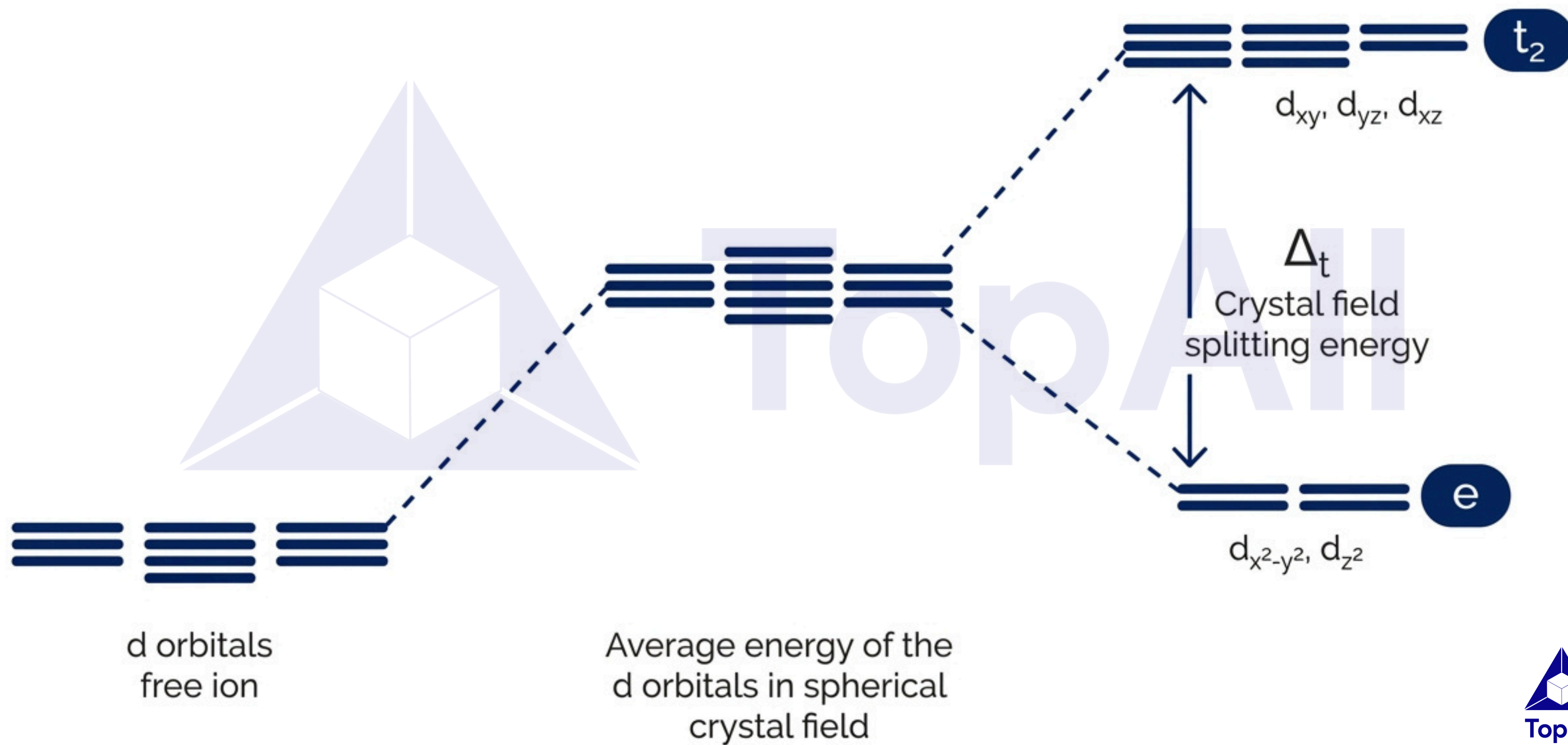
NOMENCLATURE NOTE

The Absence of "g"

The "g" subscript (gerade) indicates a center of symmetry. Because **tetrahedral complexes inherently lack** a center of symmetry, the "g" is strictly removed.

We use **e** and **t_2** instead of **e_g** and **t_{2g}** .

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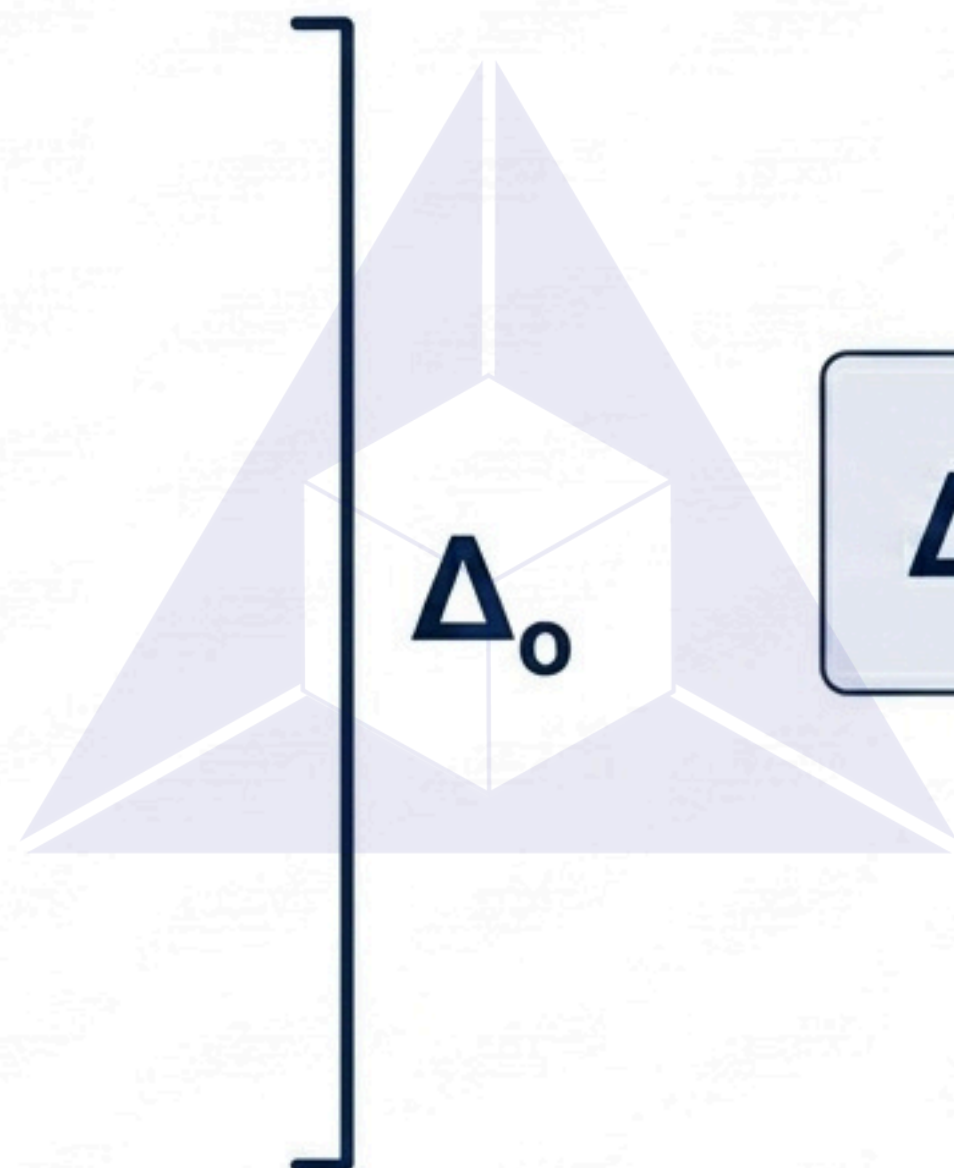
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The Magnitude of Splitting

Octahedral Splitting



Tetrahedral Splitting

$$\Delta_t = \frac{4}{9} \Delta_o$$

Δ_t

This exact mathematical relationship holds true assuming the same metal, the same ligands, and identical metal-ligand distances. Tetrahedral splitting is inherently and significantly smaller.

The Chemical Consequence: High-Spin Dominance

Small Energy Gap

Because Δ_t is only $4/9 \Delta_o$, the orbital splitting energies are fundamentally small.



Pairing Energy Prevails

The energy required to force electrons to pair up (P) in the lower e level is greater than the energy required to jump the gap to the t_2 level.



Electrons Jump

Electrons readily populate the higher t_2 orbitals before pairing occurs.

Consequently, low-spin configurations are rarely observed in tetrahedral coordination entities.

Key Takeaways

01. Inverted Architecture

The e level sits below the t_2 level. The 'g' subscript is removed entirely due to a lack of symmetry.

02. Smaller Magnitude

Tetrahedral splitting is heavily reduced compared to octahedral fields. The relationship is fixed at $\Delta_t = 4/9 \Delta_o$.

03. Spin States

Because the energy gap (Δ_t) is so small, pairing energy is rarely overcome. Thus, low-spin complexes are rarely observed.



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