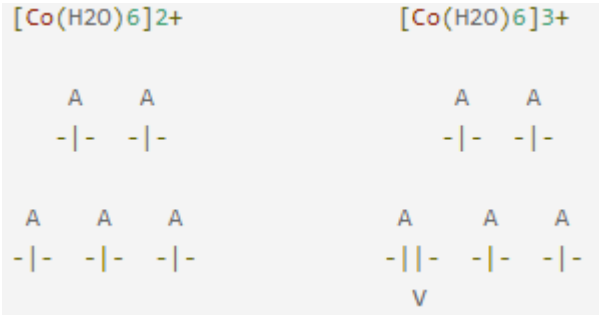
Answer on Question #85704 – Chemistry – Inorganic Chemistry

$[Co(H_2O)_6]^{2+}$ ion is more stable than $[Co(H_2O)_6]^{3+}$ ion justify it?

Solution:

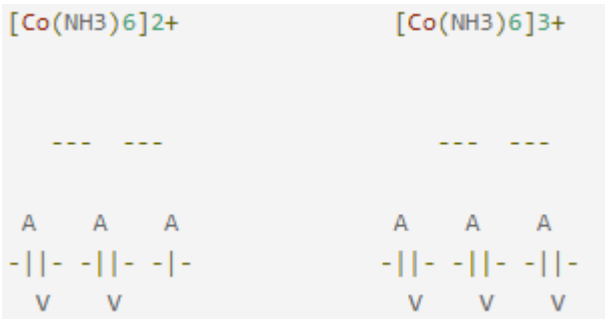
$[Co(H_2O)_6]^{2+}$ is more stable than $[Co(H_2O)_6]^{3+}$ because Co^{2+} is more stabilised by weak field ligand, H_2O than is Co^{3+}.



With weak-field ligands, the half-filled shell with all spins parallel has extra stability. It's the same reason that Cr has electron configuration [Ar] $4s^1 3d^5$ rather than [Ar] $4s^2 3d^4$.

$Co^{2+}(3d^7)$= (t2g)5(eg)2 has higher value of crystal field stabilization energy than $Co^{3+}(3d^6)$ = (t2g)4(eg)2 in the weak octahedral field leading to greater stability of $Co^{2+}(aq)$ than $Co^{3+}(aq)$.

On the other hand, $[Co(H_2O)_6]^{3+}$ is more stable than $[Co(H_2O)_6]^{2+}$ because Co^{3+} is more stabilised by strong field ligand NH_3 than is Co^{2+}. This is due to higher value of crystal field stabilization energy for $Co^{3+}(3d^6)$ = (t2g)6(eg)0 than $Co^{2+}(3d^7)$ = (t2g)6(eg)1 in the strong octahedral field ligand NH_3 leading to greater stability in former. The crystal field diagram is then:



Note that the full orbital level also has extra stability.