DYSPROSIUM ELECTRON CONFIGURATION

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References: Griffiths, David J. (2005), Introduction to Quantum Mechanics, 2nd Edition; Pearson Education - Problem 5.14.

The rare-earth element dysprosium has atomic number 66, and its ground state is listed as $^5I_8$. This means that $S=2$, $L=6$ (since after $F=3$, the labels go in alphabetical order, so $G=4$, $H=5$ and $I=6$), and $J=8$. This isn't enough information on its own to determine the electron configuration, since the outer shells don't fill in strict order of n and L due to shielding effects. For these shells, the s shell of level $n+1$ is filled before the p shell of level n, and the d shell of $n+1$ before the p of n and so on. Given the maximum populations of the various shells (s has a maximum of 2, p of 6, d of 10 and f of 14), a possible configuration for dysprosium is

$$(1s)^2\,(2s)^2\,(2p)^6\,(3s)^2\,(3p)^6\,(4s)^2\,(3d)^{10}\,(4p)^6\,(5s)^2\,(4d)^{10}\,(5p)^6\,(6s)^2\,(4f)^{10}$$

We can check this against the given values. The last shell $(4f)$ contains 10 out of a possible 14 electrons. According to Hund's first rule, these should be arranged to give the maximum possible spin, which would mean 3 pairs and 4 unpaired electrons with parallel spin. This gives $S=4\times\frac{1}{2}=2$ which matches the listing above. The value of L is difficult to check, since it depends on symmetry requirements which would be difficult (though possible, if you're persistent) to calculate for the 4 unpaired electrons. However, the 4 unpaired electrons in the $4f$ shell have a maximum possible L of $L=12$, so $L=6$ is certainly possible. Having L and S, we can apply Hund's third rule which in this case says that $J=L+S$ since the last shell is more than half full.