

Before-class Questions #7:

Question 1: What is the stretched state of an atom?

The stretched state is the state where all angular momenta are parallel ($J = \sum(J_i)$) with a magnetic quantum number $M = \pm J$, i.e. the state which maximizes J and $|M|$.

Question 2: In hyperfine structure, what separates the high-field limit from the low-field limit?

The crossover occurs at the magnetic field where the Zeeman energy equals the hyperfine energy.

Question 3: Can the Lande g-factor become negative?

Not for an atom with a single electron or a single electron outside full shells. Yes for multi-electron atoms, in the case when S and L are anti-parallel, and the resultant J points in the direction of L , but the magnetic moment in the direction of S .

Question 4: When does the Lande g-factor directly give the Zeeman shifts for the atomic states?

Low field limit and no nuclear spin.

Question 5: For the positronium ground states at low magnetic fields, what are the magnetic moments of the hyperfine states in units of the Bohr magneton?

All 4 states have 0 magnetic moment. Three states in $F=1$ have spin aligned, but zero magnetic moment because of opposite electron/positron g_e factor. In the $F=0$ state, electron/positron anti-align and dipole moments are aligned, but the angular wavefunction is isotropic for $F=0$.

Question 6: Can the g_F factor become negative? Under what conditions?

Yes. Large nuclear angular momentum $I > J$ when I anti-aligns with J . Or small nuclear momentum with negative g_J (in multi-electron atoms, see previous question).