The effect of quantum confinement on the electron g-factor in semiconductor nanocrystals

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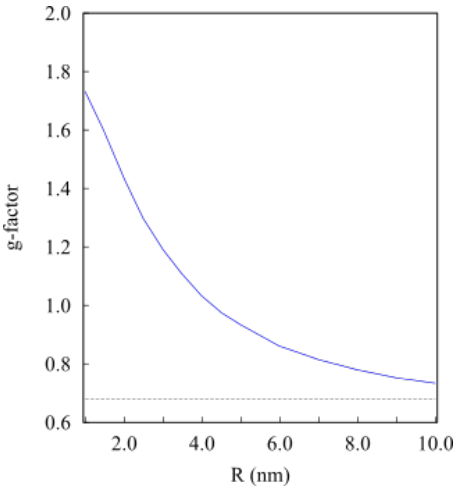
The Landé g-factor of free electrons is one of the most precise physical quantity (accuracy of one part in a trillion). However, when it comes to semiconductor physics, the electron effective g-factor is difficult to determine both theoretically and experimentally. There is a lack of g-factor values in the literature, especially for quantum dots.



Evolution of the electron g-factor in a spherical zinc-blende CdSe nanocrystal versus its radius (solid line).The dashed line is the bulk value.

Using an atomistic tight-binding approach, we calculate the electron g-factor of several colloidal nanocrystal compounds with various sizes. In this presentation, we shall focus on the effect of quantum confinement on the g-factor in semiconductor nanocrystals. The spin-orbit coupling induces an orbital angular momentum which deviates the bulk effective g-factor from the free electron value g_0. On the one hand, when the size of the system is reduced, the orbital angular momentum is quenched and the g-factor tends to g_0. On the other hand, when the diameter of the nanocrystal is increased, the g-factor tends to the bulk value, in good agreement with literature when bulk values are available. We show that the g-factor has a strong dependence on the nanocrystals size, even for diameters above 10 nm. A very sharp evolution versus the radius can be obtained, for example in InSb nanocrystals, for which the bulk value is around -56. For compounds in which the bulk value is negative, it is possible to find a nanocrystal size where the Zeeman splitting vanishes.