As postulated previously, due to their characteristic bright and stable photoluminescence, semiconductor nanocrystal quantum dots (NQDs) have attracted much interest as potential replacements for fluorescent organic dyes for general bio-labeling applications and, in particular, as molecular probes for single-particle tracking applications. NQDs are indeed near ideal fluorophores; however, despite these numerous enabling characteristics, NQD optical properties are frustratingly sensitive to their surface chemistry and chemical environment, exhibit fluorescence intermittency (“blinking”) at the single-NQD level, and are susceptible to an efficient nonradiative recombination process known as Auger recombination. In this talk, I will discuss our work in the development of a new class of NQD that we have called the “giant” NQD, due to its relatively thick (though not prohibitively thick!) inorganic shell. With this system, we have demonstrated unprecedented improvements in these key NQD optical properties (e.g., suppressed blinking and Auger recombination) of importance to applications ranging from single-particle tracking to biosensors to solid-state lighting. I will describe how this was achieved by combined tuning of NQD physical and electronic structures. I will also show results of recent particle tracking and bio-toxicity results.