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Photoluminescence studies of colloidal PbSe nanocrystals JEFFREY HARBOLD, FRANK WISE, Applied Physics, Cornell University, CHRIS MURRAY, IBM, T. J. Watson Research Center — Nanocrystals of the IV-VI semiconductors PbS, PbSe, and PbTe provide unique opportunities to investigate the effects of strong confinements on both electrons and holes. The sparse electronic structure of IV-VI quantum dots (QDs) was expected to dramatically decrease the intraband relaxation rate of carriers; however, picosecond time-scale relaxation is observed experimentally. One possible explanation could be the presence of states between the P and S energy levels. Therefore, we undertook photoluminescence studies of PbSe QDs to elucidate their band-edge electronic structure. Our measurements reveal a splitting of the photoluminescence spectrum that increases from 20 to 120 meV when decreasing the QD diameter from 4.6 to 3.2 nm. We also observe relatively broad emission lines (approximately 40 meV) even when selectively exciting only the largest QDs within the size distribution. We present two possible explanations based on different calculations of the electronic structure of PbSe QDs and also comment on the relevance of these findings for applications of these materials.

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