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Interaction of Dirac Fermion excitons and biexciton-exciton cascade in graphene quantum dots ISIL OZFIDAN, University of Ottawa, MAREK KORKUSINSKI, National Research Council Canada, PAWEL HAWRYLAK, University of Ottawa — We present a microscopic theory of interacting Dirac quasi-electrons and quasi-holes confined in graphene quantum dots. The single particle states of quantum dots are described using a tight binding model and screened direct, exchange, and scattering Coulomb matrix elements are computed using Slater p_z orbitals. The many-body ground and excited states are expanded in a finite number of electron-hole pair excitations from the Hartree-Fock ground state and computed using exact diagonalization techniques. The resulting exciton and bi-exciton spectrum reflects the degeneracy of the top of the valence and bottom of the conduction band characteristic of graphene quantum dots with C3 symmetry. We study the interaction of multi-electron and hole complexes as a function of quantum dot size, shape and strength of Coulomb interactions. We identify two degenerate bright exciton (X) states and a corresponding biexciton (XX) state as XX-X cascade candidates, a source of entangled photon pairs. We next calculate the exciton to bi-exciton transitions detected in transient absorption experiments to extract the strength of exciton-exciton interactions and biexciton binding energies. We further explore the possibility of excitonic instability.

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