Hole Localization in the Magneto-luminescence of a 2DEG

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The influence of hole localization on the magneto-luminescence emission of a two-dimensional electron gas present in semiconductor quantum wells and heterostructures is studied. Collective phenomena as the Fermi-edge singularity or shake-up processes are investigated in Be-doped samples and compared to Be-free ones to asses the role of hole localization. For holes localized at large distances from an heterojunction a narrow emission line is observed due to a Fermi-edge singularity involving electrons in the second confined state. The evolution of this line in a perpendicular magnetic field shows common characteristics with previous results in high mobility samples not containing Be, which are indicative of a general behavior of the electron system in heterojunctions involving localized holes. At filling factor 2 the emission intensity is abruptly transferred to the recombination of electrons in the lowest Landau-level with free valence holes, irrespective of the presence of Be. The abruptness of this transition, which is also observed in some samples at filling factor 1, reveals a coherent change in the electron system over a macroscopic sample area. The new optical emission shows marked deviations with respect to the single-particle behavior, which are tentatively interpreted as the formation of a complex state involving a free photo-created hole and the electron system. This complex unbinds when the Fermi level crosses the mobility edge.