Cyclotron resonance in bilayer graphene

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The hyperbolic dispersion of bilayer graphene leads to a Landau level (LL) spectrum that is linear in the magnetic field, $B$, at low energies but shifts to a $\sqrt{B}$ dependence with increasing energy. Here we present the first infrared transmission measurements of the unique $B$-field dependence of LL transitions in bilayer graphene, in a gated $400\mu m^2$ sample in fields up to $B = 18$ T. Eight intraband transitions are observed among LL indices $|n| \leq 4$, including the unusual zero-energy $n = 0$ level, and are found to follow a selection rule of $\Delta n = +1$. We find the change in field dependence is plainly visible between the behavior of the transition energies for $n = -1 \rightarrow 0$ and $n = 0 \rightarrow +1$, which are close to linear in $B$, as compared with all other transitions which display a clear $\sqrt{B}$ behavior. However, the shift in field dependence occurs at energies well below where it is expected based on nearest-neighbor tight-binding calculations, and a single set of fitting parameters within this theory fails to describe our results.