Comment on "Conduction-Valence Landau-Level Mixing Effect"

In a recent Letter, Chiang *et al.* [1] presented results of a theoretical calculation of the effects of finite-k coupling across the interface [2] on the Landau level spectrum in a model "semimetallic" InAs/AlGaSb heterostructure. These authors assert that the resulting complex Landau-level structure explains our published results [3,4]. We interpreted the observed two-line spectrum as electron cyclotron resonance (CR) and a ($1s$-$2p_+$-like) internal transition of stable excitons (the X line). Subsequently, we reported the observation of additional weak lines that extrapolated to zero frequency at finite B [5,6], and attributed these lines to this same finite-k coupling effect [2]. A compilation of these data is presented in Fig. 1.

The purpose of this Comment is to point out the following: (1) There are several problems in the interpretation of Chiang *et al.,* and (2) their assertion that "the strongest argument against this (excitonic) interpretation is ... that the energy separation between the two lines should increase with increasing magnetic field" is based on a lack of understanding of the behavior of $1s$-$2p_+$ hydrogenic transitions in the high field limit (see, e.g., Ref. [7]).

First we note that Chiang *et al.* have chosen a set of parameters that gives roughly the observed splitting at high field (>4 T; they do not plot data for $B < 4$ T) but *does not* yield the observed, approximately constant splitting over the entire field range of the experiments (0.7–7.5 T). Their results basically reflect an enhanced spin splitting of CR, which appears sequentially over different (limited) field regions and *increases* with increasing B. Thus their calculated splitting becomes much smaller than e.g., the observed value of about 3 meV at 1 T. The experimental data for X clearly extrapolate to a finite energy intercept at $B = 0$, while both their transitions extrapolate to zero frequency at $B = 0$, since they are both CR transitions.

Second, the position of the chemical potential and its influence on the intensities of the various transitions vs B are not taken into account in Ref. [1]. However, for the net electron density of our sample and the overlap considered in the calculation, the chemical potential should lie *above* the highest hole state and remain there over the field range of interest; thus the calculated effects should not be experimentally observable.

Third, their upper line shows discontinuities like our CR, but there are essentially no discontinuities in their lower line (only kinks exist). This is opposite to the experiments: clear discontinuities in CR; only kinks in X. More importantly, in our data, kinks in X and discontinuities in CR occur *simultaneously*, so that the separation is approximately constant. In their Fig. 4(b) a discontinuity in the upper line always occurs between two kinks in the lower line, so that *the splitting oscillates* with B.

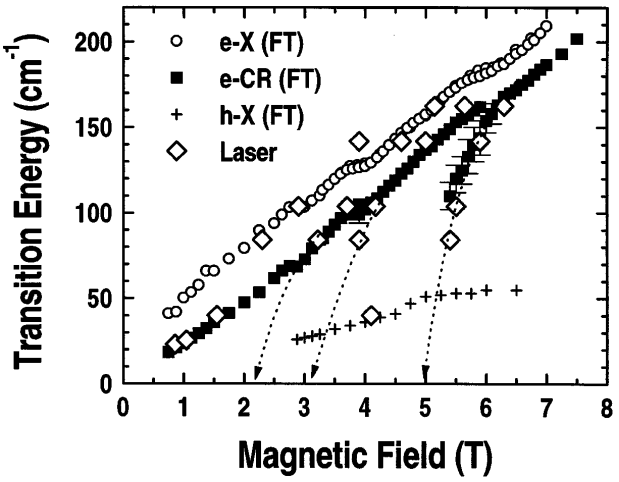

FIG. 1. Transition energy vs B for an InAs/$Al_{0.1}Ga_{0.9}Sb$ quantum well at 4.2 K, including both Fourier-transform (FT) and laser spectroscopy.

Our picture in the high field limit is completely consistent with the data, including the fact that the separation between CR and the $1s$-$2p_+$ line of the exciton should be essentially constant [7]. With increasing temperature, X becomes weaker, together with the CR oscillations. At the highest temperature in our experiment (70 K), X disappears and the observed single CR shows *no* anomalies [4,6]—consistent with the notion that the two lines have different origins and X is *not* spin-split CR.

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