Irradiated Schrödinger Cat States in ultra-high mobility 2D Electron Systems.

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In this work we study the quantum superposition of coherent states of the quantum harmonic oscillator that show up in ultra-high mobility 2D electron systems under low intensity magnetic fields. In a previous work[1] we shown that the well-known microwave-induced resistance oscillations (MIRO) that rise in irradiated 2D electron systems are sustained by coherent states of the quantum harmonic oscillator. In that work we described irradiated magnetoresistance based on these states pointing out that the principle of minimum uncertainty of coherent states is crucial to understand MIRO and zero resistance states.

Remarkably enough, for the case of ultra-high mobility samples, experimental evidence on MIRO[2] presents striking results such as magnetoresistance resonance peak shift to twice the cyclotron frequency ($2w_c = w$) and a dramatic magnetoresistance drop. The former result is similar to the one described in quantum optics as a second harmonic generation process. The latter is obtained either under illumination or in the dark. We have introduced the quantum superposition of coherent states giving rise to even and odd coherent states that turn into Schrodinger cat states in these kind of samples. Now the system is made up of two Gaussian wave packets oscillating in tandem at w_c with a phase difference of π. As a result, the frequency of the system becomes $2w_c$ giving rise to the resonance peak shift when under illumination (see Fig.1). The magnetoresistance drop is explained by states misalignment in the quasi-elastic charged impurity-electron scattering.

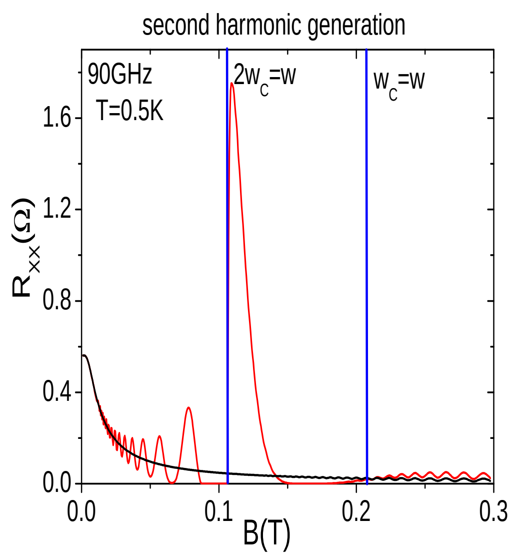

Fig. 1. Dark (black curve) and irradiated (red curve) magnetoresistance vs magnetic field for two component Schrodinger cat states

We have generalized the model introducing three-component Schrodinger cat states. We obtain that the joint effect of three Gaussian wave packets oscillating at w_c with a phase difference of $2\pi/3$ and $4\pi/3$ among them, gives rise to a resonance peak shift to $3w_c = w$ or third harmonic generation. In the same way, magnetotransport keeps plummeting showing an even more abrupt drop. These are predictions, because the corresponding experiments have not been carried out yet. We would expect that increasing the number of components of the cat state, for instance *n-component*, the resonance peak would shift to $n \times \hbar w_c = w$.

References

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