Interband Magneto-Optical Spectroscopy of $Pb_{1-x}Sn_xSe$

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Since the last century, considerable research has been conducted on valley-degenerate narrow gap semiconductors, including $Pb_{1-x}Sn_xSe$ and $Pb_{1-x}Sn_xTe$ alloys [1-3]. Both $Pb_{1-x}Sn_xSe$ and $Pb_{1-x}Sn_xTe$ possess band minima at the L-point of their Brillouin zone, yielding a valley degeneracy of four. In (111)-oriented films, it is still not fully understood how differences between the longitudinal valley, oriented along the growth axis, and the oblique valleys, oriented at an angle with respect to that axis, appear in magneto-optical infrared spectroscopy [4,5]. In this work, we observe an anomaly in the interband transition intensity ratio of longitudinal and oblique valleys under the magnetic field. Based on the Mitchell-Wallis model [1] and the Kubo formula, we provide a theoretical fit for the interband magneto-optical response of $Pb_{1-x}Sn_xSe$, which agrees very well with experimental observations and explains the spectral shape of the data at magnetic fields as high as 35T. Our model provides a quantitative determination of the relative strength of the optical absorption from the longitudinal and oblique valleys and allows us to obtain the real and imaginary part of the dielectric constant by comparing the model to the experimental data.

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