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Transient Hall Effect Measurement in Black Phosphorus[1] JIAJUN LUO, LINTAO PENG, SPENCER A. WELLS, CHRISTOPHER R. RYDER, MARK C. HERSAM, MATTHEW GRAYSON, Northwestern Univ — Black phosphorus exfoliated flakes exhibit a slow conductivity transient after a sudden change of the gate voltage. To separate transients in carrier density from those in mobility in the overall conductivity transient, a traditional Hall effect method requires either a Hall bar geometry that is difficult to fabricate out of a single flake, or van der Pauw geometry with a sequence of measurements first at +B and again at -B to eliminate the B-symmetric offset signal. Unfortunately, the latter requires that the exact same transient response can be perfectly repeated. In this work, we introduce a heterodyne circuit for measuring Hall effect in a single transient signal. The heterodyne circuit performs an electrical analog of the alternating B-field, using an ac modulation of the Onsager-Casimir relations to eliminate the offset signal in the transverse Hall resistance. Thus the carrier density transient can be accurately measured with sub-second time resolution. The mobility transient response can be extracted by additionally measuring the sheet conductivity transient. Transient Hall effect measurements in black phosphorus flakes showed a stretched exponential relaxation of carrier density and an approximately constant mobility.

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