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Hall Plateaus at magic angles in ultraquantum Bismuth

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The behaviour of a three-dimensional electron gas in the presence of a magnetic field strong enough to put all carriers in the first Landau level (i.e. beyond the quantum limit) is a longstanding question of theoretical condensed matter physics [1]. This issue has been recently explored by two high-field experiments on elemental semi-metal Bismuth. In a first study of transport coefficients (which are dominated by hole-like carriers), the Nernst coefficient presented three unexpected maxima that are concomitant with quasi-plateaux in the Hall coefficient [2]. In a second series of experiments, torque magnetometry (which mainly probes the three Dirac valley electron pockets) detected a field-induced phase transition [3]. The full understanding of the electron and hole behaviours above the quantum limit of pure Bi is therefore still under debate. In this talk, we will present our measurement of the Hall resistivity and torque magnetometry with magnetic field up to 31 T and rotating in the trigonal-bisectrix plane [4]. The Hall response is dominated by the hole pockets according to its sign as well as the period and the angular dependence of its quantum oscillations. In the vicinity of the quantum limit, it presents additional anomalies which are the fingerprints of the electron pockets. We found that for particular orientations of the magnetic field (namely "magic angles"), the Hall response becomes field-independent within the experimental resolution around 20T. This drastic dependence of the plateaux on the field orientation provides strong constraints for theoretical scenarios.

[1] Bertrand I. Halperin, *Japanese Journal of Applied Physics*, **26**, Supplement 26-3 (1987).
[2] Kamran Behnia, Luis Balicas, Yakov Kopelevich, *Science*, **317**, 1729 (2008).
[3] Lu Li, J. G. Checkelsky, Y. S. Hor, C. Uher, A. F. Hebard, R. J. Cava, and N. P. Ong , *Science*, **321**, 5888 (2008).
[4] Benoît Fauqué, Luis Balicas, Ilya Sheikin, Jean Paul Issi and Kamran Behnia, to be published