Fractional quantum Hall effect in bilayer graphene devices and their possible applications in quantum computation

Chi-Te Liang
Department of Physics, National Taiwan University, Taipei 106, Taiwan

The fractional quantum Hall (FQH) effect is a canonical example of electron-electron interactions producing new ground states in many-body systems. To date, most FQH studies have focused on the $N=0$ Landau level (LL). In this talk, I shall report transport measurements of FQH states in the $N=2$ LL (filling factors $4<|\nu|<8$) in bilayer graphene, a system with spin and valley degrees of freedom in all LLs, and an additional orbital degeneracy in the 8-fold degenerate $N=0$/$N=1$ LLs. The FQH states we observe in the $N=2$ LL form a complete sequence of particle-hole symmetric states whose relative strength is dependent on their denominators. The FQH states in the $N=2$ LL display energy gaps of a few Kelvin, comparable to and in some cases larger than those of fractional states in the $N=0$/$N=1$ LLs. The FQH states that we observe form, to the best of our knowledge, the highest set of particle-hole symmetric pairs seen in any material system [Ref. 1]. At the end of my talk, I hope to describe even-denominator FQH states observed in bilayer graphene and their possible applications in quantum computation [Refs. 2-4].

[1] G. Diankov, C.-T. Liang, F. Amet, P. Gallagher, M. Lee, A. J. Bestwick, K. Tharratt, W. Coniglio, J. Jaroszynski, K. Watanabe, T. Taniguchi, and D. Goldhaber-Gordon, Nat. Commun. 7, 13908 (2016).
[2] D. K. Ki, V. I. Fal'ko, D. A. Abanin, and A. F. Morpurgo, Nano Lett. 14, 2135 (2014).
[3] Y. Kim, D. S. Lee, S. Jung, V. Skákalová, T. Taniguchi, K. Watanabe, J. S. Kim, and J. H. Smet, Nano Lett. 15, 7445 (2015).
[4] J. I. A. Li, C. Tan, S. Chen, Y. Zeng, T. Taniguchi, K. Watanabe, J. Hone, and C. R. Dean, Science 358, 648 (2017).