Two-dimensional superlattices: from atomic planes to practical devices

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The superlattice is a regular structure with the period significantly larger than the typical distance between atoms, but smaller than the electron mean free path. A possibility to control the period and the symmetry of an artificial superlattice makes it an ideal playground for band structure engineering and designing materials with on-demand electronic properties. Recently, high quality two-dimensional superlattices have been obtained by stacking atomically thin materials, such as graphene. A range of ground-breaking experiments has followed this technological breakthrough, which includes reports on the emergence of superconductivity [1], the observation of the Hofstadter butterfly in the magnetic miniband structure [2] and the fractal quantum Hall effect [3].

Behaviour of a superlattice in strong perpendicular magnetic field is of particular interest as it allows experimental verification of important predictions of quantum mechanics, which can only be tested in real crystals at prohibitively high magnetic fields of the order of 10 kT. In this presentation I will review the electronic properties of two-dimensional materials and practical approaches for making superlattices with focus on my own recent experimental results.

1. Y. Cao *et al.*, Nature **556**, 44 (2019)
2. L. A. Ponomarenko *et al.*, Nature **497**, 594 (2013)
3. L. Wang *et al.*, Science **350**, 1231 (2015)