Editorial: PRX Embraces the Vibrant Field of 2D Materials

We, Liuyan Zhao and Xavier Marie, both serve on PRX's Editorial Board. One of our roles is to connect our own research field, that of 2D van der Waals materials, with PRX. When we set out to discover how PRX was perceived by asking our peers "what do you think about PRX," we received a few common answers. One was "PRX is very rigorous, so papers reporting only experimental discoveries are hard to get in." Another was "PRX is only interested in fundamental physics, so a more material-oriented or device-oriented paper will have trouble getting in." Yet another was "PRX publishes a small number of papers on 2D materials, so the editors must not be very interested in this field." These answers have made us see a real need for PRX to speak to our community more directly and more clearly about its editorial attitude toward the field of 2D materials.

First and foremost, does PRX welcome papers from this field? The answer from us and from the editors is an absolute yes! In fact, PRX has recently published the discovery of fractional quantum anomalous Hall insulator (or equivalently, fractional Chern insulator) in twisted molybdenum ditelluride moiré superlattice [1], parallel with another three reports in *Nature* [2–4].

The reasons for our affirmative answer are in the history and the current status of the field itself. They are most compelling. Two decades since the successful isolation in 2004 of monolayer graphene, the field shows no sign of slowing down. The family of 2D materials has grown rapidly beyond graphene to include an exceptionally rich variety of material states ranging from band insulators, semiconductors, and metals, to correlated insulators, topological insulators, Dirac semimetals, magnets, and unconventional superconductors. We see three main reasons for this incredible, sustained growth.

The first is the ease and versality of the materials engineering. Beyond natural atomic crystals, thin layers with distinct or similar properties can be assembled in vertical stacks commonly referred to as van der Waals heterostructures and homostructures. By controlling the stacking sequence and the twist angle between the composing layers, new artificial materials can be designed to harvest distinct properties of 2D materials or even to develop absolutely new states of matter. van der Waals heterostructures also offer a unique possibility to radically transform the properties of a single atomic layer by transferring the properties of its neighbors by proximity effects.

The second lies in the promise 2D materials hold for realizing quantum states of matter that do not exist in 3D bulk materials, thanks to their low dimensionality and their exceptional structural and electrical tunability. This promise was first realized in the form of the Dirac physics in monolayer graphene that started the field. It has kept on giving ever since, as in the outstanding examples of the 2D magnetism in transition metal compounds, the correlated and topological phases in twisted graphene and twisted transition metal dichalcogenide moiré superlattices, the moiré excitons in twisted metal dichalcogenides (TMD) heterostructures, the moiré magnetism in twisted chromium triiodide superlattices, and most recently, the spontaneous (or anomalous) fractional quantum Hall effect (or equivalently, fractional Chern insulating phase) in twisted moiré superlattices.

The third reason has to do with the ability and potential of 2D material physics to influence every branch of condensed-matter physics and materials science. For example, new spintronic devices have been developed upon the exceptional transport properties of graphene, the spin-valley locking in TMDs, and the ultrathinness of 2D magnets. Quantum electrodynamics effects on a single atomic layer and novel photonic devices, including atomically thin mirrors, have been realized through the integration of TMDs into heterostructures. Many-body quantum simulators have been built with twisted graphene and twisted TMD moiré superlattices. Proximity effects can also be crucial ingredients for engineering spintronic, superconducting, and topological phenomena. This list goes on and includes optomechanics, optomagnetics, magneto-optics, and straintronics based on 2D materials and structures.

We are confident that the field will continue to bloom with a great wealth of future breakthroughs. There is every reason for PRX to be at the cutting edge of this vibrant field, given its strong reputation as a journal distinguished by its outstanding quality, its wide topical breadth, its big impact on physics research, and its remarkable reach to a broad audience.

Growing together with the field of 2D physics in the past 11 years, PRX has strived to offer a unique coverage of the field that is consistent with its editorial identity: To embrace different types of papers with a unifying sharp focus on scientific excellence and potential for genuine impact, not just citations. Many innovative papers have been published (see, e.g., a sample from the past four years in Refs. [1,5–9]). In contrast to the perception that experimental discovery papers are hard to get in, some of those (discovery type) papers reported innovative experimental results on the physics of new 2D materials, hetero- and homostructures, and moiré superlattices, with open questions introduced for future understanding and comprehension. PRX's known high standard for rigor does *not* mean that papers reporting influential experimental discoveries must have a thorough, conclusive theoretical understanding.

What does PRX think about more materials-oriented or more device-oriented studies? We speak without hesitation that papers of this type are definitely welcome, as long as they show a great potential for making a big difference scientifically or technologically down the road.

Finally, PRX is well recognized for its exceptional coverage of theoretical research of the highest impact. Needless to say, it will continue to showcase both novel theoretical concepts that open up new areas in the physics of 2D materials and in-depth theoretical investigations that solve existing important puzzles in 2D physics.

Looking forward, we and the PRX editorial team see it as our commitment and privilege to embrace the field of 2D materials: To showcase and disseminate its most influential research in as diverse a variety as possible, as speedily as possible, and with our unique format flexibility of short or long Original Research Articles as well as forward-looking Perspectives (for example, Ref. [10]).

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