Special issue on low-dimensional order mediated by interfaces

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Preface

Special issue on low-dimensional order mediated by interfaces

Guest Editors

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The physics of 1D and 2D electron systems is in many cases substantially different from its 3D counterpart. For instance the successful realization of graphene, a 2D free-standing sheet of carbon atoms arranged in a honeycomb structure, has resulted in a myriad of exciting experiments and numerous scientific breakthroughs. Unfortunately, the realization of free-standing 1D or 2D systems is more the exception than the rule. In the vast majority of cases the low-dimensional systems are synthesized on a support, i.e. a substrate. It is clear that the presence of this substrate will have a profound effect on the physical properties of the low-dimensional structures. It is precisely this profound effect of the interface on the physical properties of the low-dimensional structures that will be addressed in this special issue.

Modern surface science techniques allow us to fabricate, with atomic precision, ultra-small quantum structures, which enables cutting edge research towards many exciting phenomena in low-dimensional correlation physics. Moreover, as will be shown by the papers of this special issue, the structures can be manipulated in an atom-by-atom fashion facilitating the systematic control of instabilities and phase transitions in low-dimensional systems. Among others, 2D superconductors, chiral solitons, spin–orbit density waves, 2D Dirac systems and even Luttinger liquids in quasi 1D systems, were recently realized by this approach. However, to date a profound understanding of the coupling to the interface, which in turn commands the low-dimensional order and stabilizes new emergent quantum phases, is still missing.

In addition, the current arsenal of experimental techniques, such as angle resolved photo-emission and scanning probe microscopy, also have the ability to study the crossover from 1D to 2D. This is very important because the physics of 1D electron systems is fundamentally different from the physics of 2D electron systems. Unlike in Fermi liquid systems, where interactions simply lead to the smooth deformation of electrons into electron-like quasiparticles, interactions in 1D induce remarkably strong correlations. These strong correlations translate into the disappearance of the electron as a fundamental unit, and its replacement by charge and spin collective modes with distinct experimental signatures. These counterintuitive properties should be universal to 1D systems.

In this special issue several studies on the structural and electronics properties of various 2D system, namely Pt-induced nanowires on Ge(0 0 1) [1], Pb chains on Si(5 5 3)-Au [2], phthalocyanine molecular chains on Au(1 1 0) [3] and Au-induced nanowires on Ge(0 0 1) [4], are presented. Reference [5] deals with tuning of the directional dependent metal-insulator transition in quasi 1D quantum wires with a spin–orbit density wave instability, whereas the lateral electronic screening in quasi-1D plasmons is addressed in reference [6]. Finally, there are also two papers that deal with 2D materials [7, 8] and a paper on InGaAs/AlAsSb multi-quantum wells [9].

We thank all the contributors to this special issue, and hope it will stimulate further research into this exciting and intriguing topic.

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