One-dimensional molecular systems with exotic quantum states

P. Jelinek [1]

[1] Insitute of Physics of Czech Academy of Sciences, Czech Republic
pavel.jelinek@fzu.cz

Low dimensional materials offer very interesting material and physical properties due to reduced dimensionality. At present, 2D materials are the focus of attention. However, 1D systems often show far more exotic features, such as Tomanaga-Luttinger liquid or Peierls distortion not presented in 3D and 2D materials. On the other, an exploitation of 1D system was affected by our limited opportunities for their growth and characterization. Nevertheless, recent progress of on-surface chemistry [1] paved the way for the synthesis of molecular chains with atomic precision. Moreover, scanning probe microscopy represents the unique tool, which enables to characterize their structural and electronic structure with the unprecedented spatial resolution [2].

In this talk, we will briefly discuss several examples of 1D molecular system featuring interesting physical and chemical properties.

First, we will introduce a novel strategy to synthesize [3] a new class of intrinsically quasi-metallic one-dimensional (1D) π-conjugated polymers featuring topologically non-trivial quantum states. Furthermore, we unveiled the fundamental relation between quantum topology, π-conjugation and metallicity of polymers [4]. Thus, we will make a connection between two distinct worlds of topological band theory (condensed matter physics) and π-conjugation polymer science (chemistry).

In second part, we will demonstrate unusual mechanical and electronic properties of hydrogen bonded chains formed on a metallic surface driven by quantum nuclear effects within the chain [5]. We will show, that the concerted proton tunneling not only enhances the mechanical stability of the chain, but it also gives rise to new in-band gap electronics states localized at the ends of the chain.

References

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