SEVERO OCHOA 2022 FPI. PROJECT DATA

TITLE: Engineering Spin Qbits Supported by Atomically Precise Carbon Nanostructures

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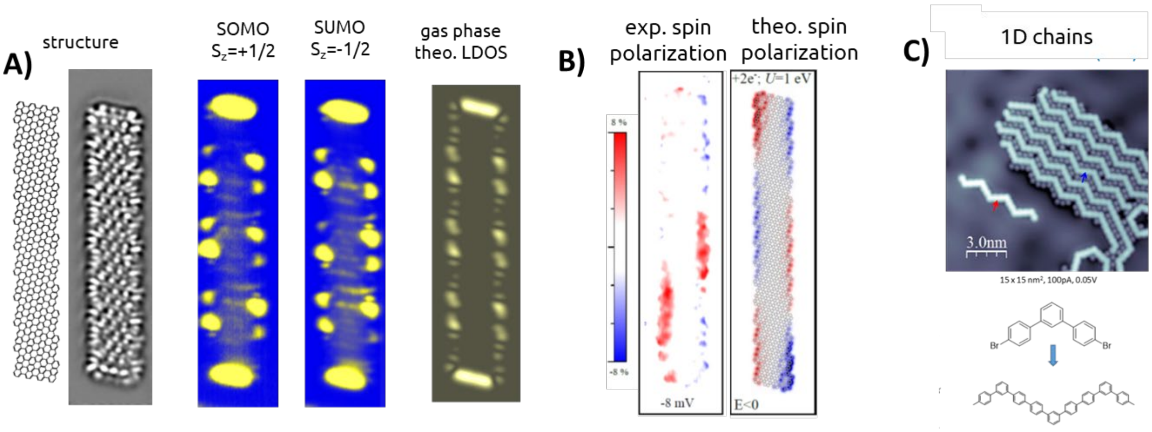
RESEARCH TOPIC

Nowadays experimental realizations of quantum bits/dits are based on superconducting resonators, point defects or nuclear spins. There is, however, a much more natural and cost efficient quantum system with two or more differentiated states: the spin of atomic electronic states. This approach is not being implemented because atomic orbitals are subject to strong interactions with the environment, which introduces multiple decoherence paths for the quantum superperposition. We propose that this vision is coming to an end thanks to the irruption of π-orbital magnetism in atomically controlled nanographenes (NGR) [1], i.e. highly conjugated polycyclic hydrocarbons.

π-orbital magnetism arises in a finite graphene like structure when all carbon p_z states of the aromatic macrocycle cannot be paired, and so a radical state remains (delocalized at some extent) which is singly occupied (and thus with spin 1/2). Now, the spin-orbit coupling in carbon atoms, which is the main source for spin relaxation of atomic states, is virtually zero [2,3], and consequently, competitive coherence times [4] with qbits of operational quantum computers are envisioned. The shape of the nanographenes, as well as the location of individual spin moments that typically appear around edges with long zig-zag segments [5], can be designed with atomic precision using on-surface-synthesis (OSS, see ref. [6]). Fig. 1 illustrates some examples prepared at INMA by us. In panel A we show a longitudinal NGR with alternating zig-zag edges. Thanks to our expertise in atomic manipulation, we have been able to reposition NGRs over insulating MgO patches. Here we demonstrate a correlation gap around Fermi level formed by longitudinally extended edge states containing exactly one 1/2-spin electron [7]. Panel B shows the spin polarization of the same type of NGRs, for which we have recently proven that this kind of spins can be controlled by exchange coupling to a magnetic surface [9].



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