In 1976, Italian physicists G. Alzetta, A. Gozzini, L. Moi, and G. Orriols noticed that when illuminating of sodium vapors with multimode laser beam, in the presence of non-uniform magnetic field, apart from bright lines in the fluorescence spectrum, also dark lines appeared, which were assigned to sodium atomic levels, but they apparently were not involved in the light emission process. These lines were called "Dark Lines" and the corresponding electronic states were called "Dark States" (DS). It has been explained that the reason for this phenomenon is the coherent superposition of atomic quantum states (coherent population trapping), an extremely interesting quantum phenomenon associated with destructive interference of the wave functions of atomic states, revealed by the fact that dark states cannot emit or absorb light waves.

Than it was noticed that the same “blocking mechanism” of light waves interacting with DS concerns not only free "atoms", but also appear in mesoscopic objects like Quantum Dots (QD) with characteristic energies in the *meV* range. Thus microwave fields can be used to detect DS in such systems.

> *The project entitled "Dark States in atomic structures on ordered surfaces.", provides an opportunity to investigate whether dark states, such as observed in Na vapors and semiconductor quantum dots, arise also in a few atom systems, in particular in atomic chains on crystalline surfaces. In these atomic systems characteristic energy scale is in the order of eV. The research will connect the concepts from optical physics (with coherent states in the presence of laser light fields) with nanoscopic physics of real multi-atomic structures.*

Instead of light or microwave radiations that stand for a probe for coherent DS we suggest the use of the scanning tunneling microscope (STM) atomic tip. There are manifold functions of the STM predicted in the project - as an instrument for topographic images of atomic systems, see Figure 1, as an analyzer of their electronic structure, as a detector of dark states, and as an electrode which influences the electronic properties of these atomic systems.

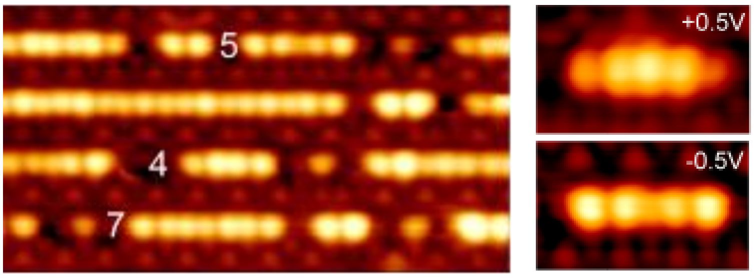


Fig. 1 Topographic images of Si atomic chains (left panel). The images on the right panels show the topography of 5-atom chain for two polarities. The influence of dark states is revealed by strong modulation of the voltage-dependent topography.

Atomic systems in the form of chains and clusters of atoms will be fabricated on vicinal (stepped) Si crystalline surfaces and on the ultra-thin metallic layers which reveal the quantum size effect (QSE). Such substrates allow to control the geometry of atomic systems and can influence the electronic structure of atoms with DS. All technological processes and measurements of tunneling microscopy and, additionally, atomic force microscopy AFM, as well as high-energy electron diffraction RHEED will take place in UHV conditions, in a vacuum of $10^{-11}$ mBar.

Coherent electron states (such as DS) are of great interest because of their direct connection to a physical phenomenon known as quantum communication. They play an important role in chemical processes taking place in DNA molecules. It is believed that dark states could be used to build multi-bit DS memory, and could be also used in spintronics and in construction of quantum computers.