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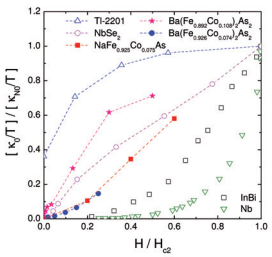
Highlights from the previous volumes

Evidence for nodeless superconducting gap in $NaFe_{1-x}Co_xAs$ from low-temperature thermal conductivity measurements

The discovery of high-temperature superconductivity in iron pnictides has attracted great attention. Many efforts have been devoted to determine the symmetry and structure of their superconducting gap, which is one of the keys to understand the electronic pairing mechanism. Recently, there were controversial experimental results on the gap structure of the "111" superconductor $NaFe_{1-x}Co_xAs$. High-resolution angle-resolved photoemission spectroscopy (ARPES) measurements on $NaFe_{0.95}Co_{0.05}As$ showed nearly isotropic superconducting gaps with similar magnitudes on all three Fermi surfaces, but London penetration depth measurements claimed a nodal (highly anisotropic) gap in $NaFe_{1-x}Co_xAs$ from the underdoped to the overdoped range ($0.02 \leq x \leq 0.10$). More experiments are highly desired to resolve this important issue.

The ultra-low–temperature heat transport measurement is a bulk technique to probe the gap structure of superconductors. Whether there is a finite residual linear term κ_0/T in zero field is a good judgment on the existence of gap nodes. The field dependence of κ_0/T can provide complementary information on the gap structure.

In this paper, we have measured the thermal conductivity of optimally doped $NaFe_{0.972}Co_{0.028}As$ and overdoped $NaFe_{0.925}Co_{0.075}As$ single crystals down to 50 mK. The absence of κ_0/T in zero field for both compounds gives strong evidence for nodeless gaps. The field dependence of κ_0/T also suggests the low anisotropy, or ratio between the magnitudes of different superconducting gaps in $NaFe_{1-x}Co_xAs$. Our results are consistent with previous ARPES experiments. Therefore the issue of the gap structure in $NaFe_{1-x}Co_xAs$ has been clarified.



Normalized residual linear term κ_0/T of overdoped $NaFe_{0.925}Co_{0.075}As$ as a function of H/H_{c2}. For comparison, similar data are shown for the clean s-wave superconductor Nb, the dirty s-wave superconducting alloy InBi, the multi-band s-wave superconductor $NbSe_2$, an overdoped d-wave cuprate superconductor Tl-2201, the optimally doped $Ba(Fe_{0.926}Co_{0.074})_2As_2$ and overdoped $Ba(Fe_{0.892}Co_{0.108})_2As_2$.

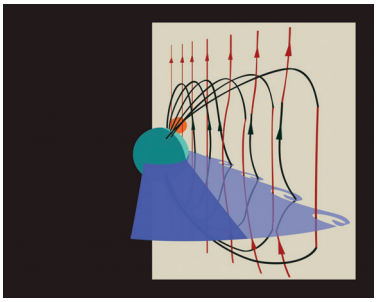
Original article by Zhou S. Y. *et al.*
EPL, **101** (2013) 17007

Double mid-latitude dynamical reconnection at the magnetopause: An efficient mechanism allowing solar wind to enter the Earth's magnetosphere

The solar wind flow interacts with the Earth's magnetosphere in a three-dimensional configuration that changes with the magnetic field orientation of the solar wind. This interaction causes mixing between the magnetospheric and the solar wind plasmas. Fluid instabilities, Kelvin-Helmholtz and Rayleigh-Taylor, and plasma instabilities, magnetic reconnection (MR), drive this process. When close to the Earth's equatorial plane the magnetospheric field lines and those carried by the solar wind are nearly parallel, these instabilities combine and MR is driven by the Kelvin-Helmholtz instability (KHI) that winds up the magnetic field lines frozen in the turning plasma.

This mechanism was proposed some years ago addressing only the plasma evolution near the equatorial plane. The present paper investigates this mechanism in a 3-dimensional setting accounting for the stabilization of the KHI at high latitudes and for the tying of the magnetospheric field lines at the Earth's polar regions. It provides a different perspective of the plasma and magnetic field evolution identifying an "action at a distance" effect between the KHI that develops in the equatorial region and MR that develops almost symmetrically in the north and south hemispheres at mid-latitudes.

Magnetic field lines act as "rods" that transfer the forcing exerted by the KHI to locations far from the region where the forcing is applied, contrasting the effect of the magnetic line tying at the solar caps. This "double mid-latitude reconnection" process creates magnetic field flux tubes that are part of the Earth's magnetosphere but are connected to the solar wind at low latitude, thus providing a channel for the colder denser solar wind plasma to enter the Earth's magnetosphere.



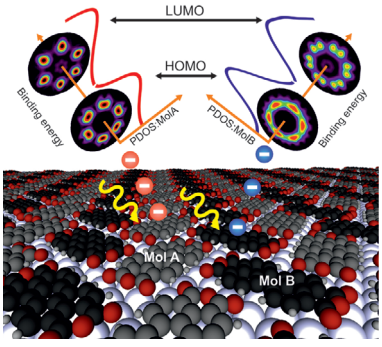
Sunward view of the reconnecting field lines on a magnetospheric flank. Magnetospheric lines (black), solar wind lines (red), once-reconnected lines (black-red), twice-reconnected lines (black-red-black).

Original article by Faganello M. *et al.*
EPL, **100** (2012) 69001

Orbital tomography for highly symmetric adsorbate systems

The alignment of electronic energy levels at interfaces strongly influences the electronic properties of multilayer systems like, *e.g.*, organic thin films. One very powerful technique to investigate this level alignment and determine electronic binding energies is the angular resolved photoelectron spectroscopy (ARPES). This method also allows assigning the spectroscopic resonances to molecular orbitals, since the angular distribution of the photoelectron yield can be understood as a fingerprint of the orbitals in momentum space. So far the possibilities of this emerging concept have only been demonstrated for low symmetric surfaces and adsorbates with only few molecular orientations.

We have extended this approach to highly symmetric surfaces by studying the monolayer structure of the prototypical molecule 3,4,9,10-perylene-tetra-carboxylic-dianhydride (PTCDA) on the Ag(111) surface. This structure is particularly challenging since it contains two inequivalent molecules per unit cell (Mol A and Mol B, see the figure) in six rotational domains, *i.e.*, in total six differently oriented molecules of each type. However, the ARPES signal from both molecules could still be separated and an almost perfect match between the experimental data and the calculated moment space distributions was found for the highest occupied and the lowest unoccupied molecular orbital (HOMO and LUMO). Furthermore, the contributions of both molecules to the ARPES data were analyzed regarding their binding energy by a two-dimensional fitting algorithm called "orbital tomography". The result, (experimentally obtained) densities of states projected on molecules A and B (PDOS), turned out to agree very well with scanning tunneling spectroscopy results reported earlier. Our findings clearly indicate that even for complex surface structures containing many differently oriented molecules the orbital tomography technique allows reliable investigations of the electronic structure of individual molecular species in thin organic films.



Schematics of the PTCDA/Ag(111) herringbone structure and a momentum space representation of its photoelectron angular distribution.

Original article by Stadtmüller B. *et al.*
EPL, **100** (2012) 26008

The dark side of the optical force

Lithium and potassium are the only alkali species possessing stable fermionic isotopes, and as such, they have played a key role in the recent development of quantum simulation of strongly correlated systems using cold atoms. These two species also share an excited hyperfine structure hindering efficient laser cooling below the Doppler limit. In this letter, we have implemented a laser-cooling scheme based on dark resonances which allowed us to achieve record high phase-space densities for laser-cooled ^{40}K atoms. This strategy was initially developed in the early 90s and relies on the existence of a family of so-called dark states in which the atoms do not interact with light and do not scatter photons. These states alleviate some of the detrimental effects of traditional schemes, such as spontaneous emission or multiple photon scattering which respectively limit the final temperature and density of "bright" optical molasses. This scheme is rather general and can be extended to other atomic species, such as lithium, as demonstrated by preliminary results obtained in our group.

Original article by Rio Fernandes D. *et al.*
EPL, **100** (2012) 63001