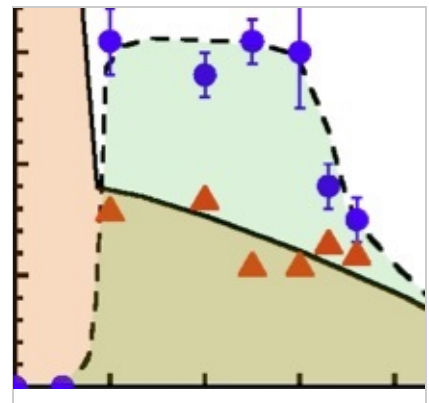


Scientific Highlights from PSI's research departments

NUM (Condensed Matter Research with Neutrons and Muons)^[1]

Correlated Trends of Coexisting Magnetism and Superconductivity in Optimally Electron-Doped Oxypnictides

We report on the recovery of the short-range static magnetic order and on the concomitant degradation of the superconducting state in optimally F-doped $\text{SmFe}_{1-x}\text{Ru}_x\text{AsO}_{0.85}\text{F}_{0.15}$ for $0.1 \leq x \leq 0.5$. The two reduced order parameters coexist within nanometer-size domains in the FeAs layers and eventually disappear around a common critical threshold $x_c \sim 0.6$. Superconductivity and magnetism are shown to be closely related to two distinct well-defined local electronic environments of the FeAs layers. The two transition temperatures, controlled by the isoelectronic and diamagnetic Ru substitution, scale with the volume fraction of the corresponding environments. This fact indicates that superconductivity is assisted by magnetic fluctuations, which are frozen whenever a short-range static order appears, and totally vanish above the magnetic dilution threshold x_c .



Facility: SμS

Reference: S. Sanna et al, Physical Review Letters **107**, 227003 (2011)

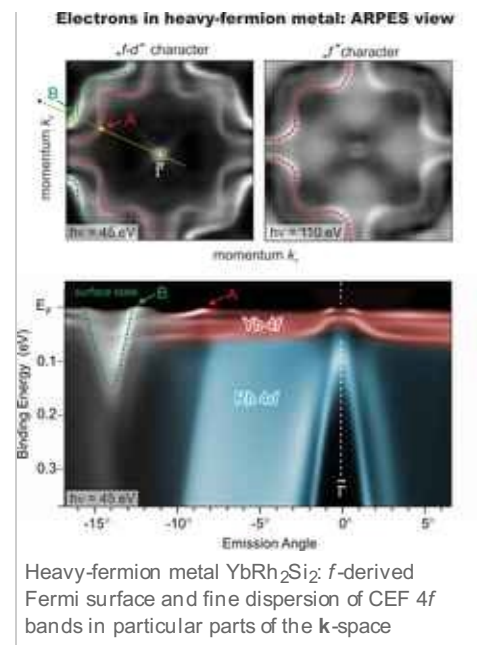
Read full article: [here](#)^[2]

SYN (Synchrotron Radiation and Nanotechnology)^[3]

A close look at correlated electrons in heavy-fermion metal through ARPES

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Showing astonishing properties like magnetism, superconductivity, Kondo and heavy-fermion (HF) behavior, rare-earth intermetallic compounds have been at the forefront of modern solid state physics for many years. Most of these properties are related to a delicate interplay between the partially filled 4*f*-shell and conduction electrons. Studying HF system YbRh₂Si₂ we made the observation of crystal-electric field (CEF) splittings of a 4*f* state by means of *k*-resolved photoemission. Their interaction with extended valence bands can force the localized CEF-split 4*f* states to become dispersive and induce Fermi level crossings in specific parts of the *k*-space. This can change the ground-state symmetry as well as the occupancy, number, energy separation, energy order and degeneration of the CEF-split magnetic 4*f* states *k*-dependently, i.e. very different from the widely believed scenario based on non-interacting atomic-like 4*f* orbitals. We got direct access to the Fermi surface of this system and: (i) detected its strong *f*-character, (ii) disentangled its topology and features reflecting *f*-*d* coupling at the surface and bulk of the material, (iii) explored evolution of the iso-energy surfaces closely below the Fermi energy that indeed change dramatically at the meV range.



Facility: SLS

Reference

Insight into the *f*-Derived Fermi Surface of the Heavy-Fermion Compound YbRh₂Si₂

S. Danzenbächer et. al.

Phys. Rev. Lett. 107, 267601 (2011) / DOI: [10.1103/PhysRevLett.107.267601](https://doi.org/10.1103/PhysRevLett.107.267601)^[4]

***k* Dependence of the Crystal-Field Splittings of 4 *f* States in Rare-Earth Systems**

D. V. Vyalikh et. al.

Phys. Rev. Lett. 105 237601 (2010) / DOI: [10.1103/PhysRevLett.105.237601](https://doi.org/10.1103/PhysRevLett.105.237601)^[5]

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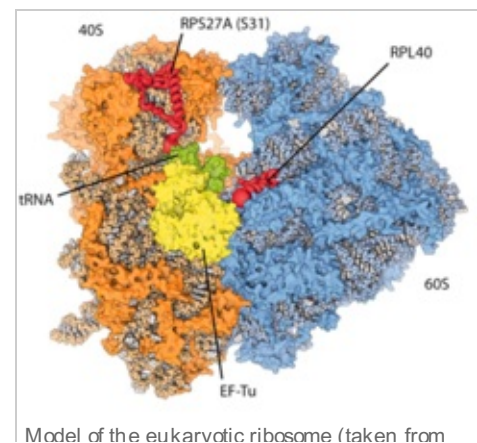
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New insights into the cell's protein factory

Eukaryotic ribosomes are among the most complex cellular machineries of the cell. These large macromolecular assemblies are responsible for the production of all proteins and are thus of pivotal importance to all forms of life. Two independent research groups at the ETH Zürich and the Institute of Genetics and Molecular and Cellular Biology in Strasbourg have obtained new insights into the atomic structure of the eukaryotic ribosome. The results have been published in the journal Science. All diffraction data were measured with synchrotron light at the Swiss Light Source macromolecular crystallography beamline AUTHOR_WWW/SLS.X06SA at the Paul Scherrer Institute.



Facility: SLS

Reference

Crystal structure of the eukaryotic 60S ribosomal subunit in complex with initiation factor 6

Klinge S, Voigts-Hoffmann F, Leibundgut M, Arpagaus S, Ban N.
Science Vol. 334 (6058), 2011 / DOI: [10.1126/science.1211204](https://doi.org/10.1126/science.1211204)^[7]

The Structure of the Eukaryotic Ribosome at 3.0 Å Resolution

Ben-Shem A, Garreau de Loubresse N, Melnikov S, Jenner L, Yusupova G, Yusupov M.
Science 2011 Nov 17 Epub

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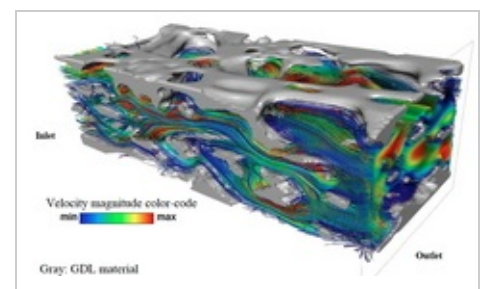
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ENE (General Energy)^[8]

Flow modeling in gas diffusion layers of PEFCs at the micro- and mesoscale.

The optimization of thermochemical and electrochemical conversion systems is of high importance for a sustainable energy future society. Of particular interest regarding the performance of polymer electrolyte fuel cells (PEFCs) is the study of the gas flow in the gas diffusion layers (GDL). More specifically, permeability and diffusivity measurements in a model PEFC under normal operating conditions are highly desirable. As laboratory-measurements of these quantities under such conditions are very demanding, an alternative is the use of computer-based simulations. For this, two key elements are needed: a) an advanced numerical tool capable of modeling key microscale processes, and b) in-situ X-ray tomographic microscopy (XTM) scans of the GDL material. Physical modeling of 3D gas flows is accomplished through novel mesoscale computational algorithms based on the lattice Boltzmann method (LBM).



The provided figure illustrates computed flow streamlines through the GDL porous structure (carbon fiber paper Toray TGPH 060, domain size: 444x222x160 microns). The GDL microstructures, wherein the produced liquid water can be distinguished from the solid material, are obtained at the TOMCAT beamline of the Swiss Light Source (SLS). The results show that permeability and relative effective diffusivities of dry and partially liquid saturated GDL samples follow a relation proportional to $(1-s)^x$, where (s) is the saturation level and the exponent x is approximately 3.

Presentation slides^[9]

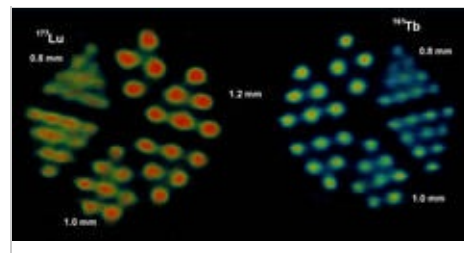
Publications: [1] N. I. Prasianakis, T. Rosen, J. Kang, J. Eller, J. Mantzaras, F. N. Büchi, *Simulation of 3D porous media flows with application to polymer electrolyte fuel cells*, Comm. in Comp. Phys. (in press) (2012). [2] T. Rosén, J. Eller, J. Kang, N. I. Prasianakis, J. Mantzaras, F. N. Büchi, *Saturation dependent effective transport properties of PEFC gas diffusion layers*, (submitted) (2012)

BIO (Biology and Chemistry)^[11]

The low-energy β^- and electron emitter ^{161}Tb as an alternative to ^{177}Lu for targeted radionuclide therapy

Research Department Biology and Chemistry (BIO), Radionuclide Development Group, Head Konstantin

Zhernosekov. The low-energy β^- emitter ^{161}Tb is very similar to ^{177}Lu with respect to half-life, beta energy and chemical properties. However, ^{161}Tb also emits a significant amount of conversion and Auger electrons. Greater therapeutic effect can therefore be expected in comparison to ^{177}Lu . It also emits low-energy photons that are useful for gamma camera imaging. The $^{160}\text{Gd}(n,\gamma)^{161}\text{Gd}\rightarrow^{161}\text{Tb}$ production route was used to produce ^{161}Tb by neutron irradiation of massive ^{160}Gd targets (up to 40 mg) in nuclear reactors. A semiautomated procedure based on cation exchange chromatography was developed and applied to isolate no carrier added (n.c.a.) ^{161}Tb from the bulk of the ^{160}Gd target and from its stable decay product ^{161}Dy . ^{161}Tb was used for radiolabeling DOTA-Tyr3-octreotate; the radiolabeling profile was compared to the commercially available n.c.a. ^{177}Lu . A ^{161}Tb Derenzo phantom was imaged using a small-animal single-photon emission computed tomography camera. Up to 15 GBq of ^{161}Tb was produced by long-term irradiation of Gd targets. Using a cation exchange resin, we obtained 80%–90% of the available ^{161}Tb with high specific activity, radionuclide and chemical purity and in quantities sufficient for therapeutic applications. The ^{161}Tb obtained was of the quality required to prepare ^{161}Tb -DOTA-Tyr3-octreotate. We were able to produce ^{161}Tb in n.c.a. form by irradiating highly enriched ^{160}Gd targets; it can be obtained in the quantity and quality required for the preparation of ^{161}Tb -labeled therapeutic agents.



Citation: S. Lehenberger, C. Barkhausen, S. Cohrs, E. Fischer, J. Grünberg, A. Hohn, U. Köster, R. Schibli, A. Türlér and K. Zhernosekov, Nuclear medicine and biology (2011)

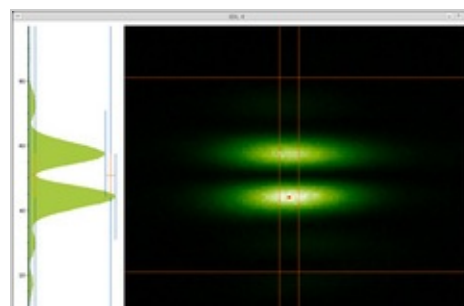
Publication: <http://dx.doi.org/10.1016/j.nuclmedbio.2011.02.007>

Further publications: LCH Homepage^[12]

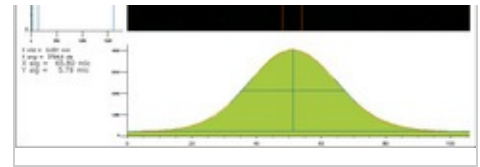
GFA (Department Large Research Facilities)^[13]

Minimum emittance coupling in the SLS

Recent measurements of the vertical beam size in the SLS have shown that the value of the vertical emittance is ~ 3.2 pm-rad, close to the fundamental limit set by the quantum nature of synchrotron radiation (~ 0.5 pm-rad). The vertical beam size was determined using an optical imaging device especially built for this purpose. In this device the images are formed from vertically polarised light emitted by the electron beam in the visible to UV part of the spectrum. The new monitor allows determination of vertical beam sizes below 10 microns with sub-micron accuracy. The emittance is determined from the measured beam size and prior



knowledge of the betatron and dispersion functions at the source point, determined by other means. This extremely small vertical emittance testifies to the careful reduction of transverse emittance coupling (0.05%) obtained in the SLS by virtue of carefully adjusting the settings of the ring lattice. To the best of our knowledge, this is the lowest reported coupling in an electron storage ring.



URLs:

- [1] : <http://www.psi.ch/science/num-highlights>
- [2] : <http://dx.doi.org/10.1103/PhysRevLett.107.227003>
- [3] : <http://www.psi.ch/science/syn-highlights>
- [4] : <http://link.aps.org/doi/10.1103/PhysRevLett.107.267601>
- [5] : <http://link.aps.org/doi/10.1103/PhysRevLett.105.237601>
- [6] : http://www.psi.ch/sls/ScienceResearch_HighlightsEN/201112_sls-highlight_euka-ribosome_vo2.pdf
- [7] : <http://www.sciencemag.org/content/334/6058/941>
- [8] : <http://www.psi.ch/science/ene-highlights>
- [9] : <http://www.psi.ch/ene/SHLENEflowmodPEFCEN/Mantzaras-Buechi.pdf>
- [10] : <http://ecl.web.psi.ch/publications.html>
- [11] : <http://www.psi.ch/science/bio-highlights>
- [12] : <http://lch.web.psi.ch/webcontent/research/surface/Literature.html>
- [13] : <http://www.psi.ch/science/gfa-highlights>

<http://www.psi.ch/science/scientific-highlights>