NEW APPLICABLE SUPERCONDUCTIVITY WILL BE REVOLUTIONARY

Superconductivity intrigues researchers across the board – from Nobelists to dissertationists. Whoever solves the issue of how to achieve superconductivity in practice that allows the transfer of energy with almost no electrical resistance in regular or financially feasible conditions, will take a place in the history of science.

- Superconductivity does exist. We have verified the phenomenon for instance in temperatures 90 Kelvin with liquid nitrogen, says Matti Lindroos, researcher and lecturer of physics in the Technical University of Tampere and visiting professor at Northeastern University in Massachusetts, USA.

- Today we have two main lines of research for the origin of superconducting. A highly complex many body theory and the other line is empirical characterization of material. In theory we can assume how superconductivity works, so we test the assumptions. If they disagree with our experiments, we discard the proposed theory as invalid. But then one day we will find the right theory of the origin of superconductivity. With this knowledge we can try to tailor materials and conditions that make superconductivity possible in room temperature and also feasible to take into use. I represent the one working on photoemission phenomena which is wide used probe for electronic structure of materials.

It is known that superconductivity occurs in many materials such as in simple elements like tin and aluminum. Also various metallic alloys are heavily-doped superconductors. Superconductivity does not occur in noble metals like gold and silver or in pure samples of ferromagnetic metals.

Huge capacity for number crunching

When Matti Lindroos is researching outside lecture times, the key to making progress is the capacity to compute is the key to running practically endless variables.

- We look at materials, properties of light and temperature, and get to very small details in photoelectron spectroscopy as the research approach. We look at electronic structures of super conductors by executing with multiple variables, check the results and slightly adjust the combinations, says Matti Lindroos.

- Results gained this way can be very difficult to interpret. Insufficient analyses can be misleading and for this we need extensive computation in our analyses.

There are only two centers in the world that research photoemission on the basis of heavy calculations.

- We at the Tampere University of Technology have today an extraordinary opportunity to approach the mystery of superconductivity thanks to Techila Distributed Computing Solution. We are able to do computing and to keep adjusting variables, and we get results in minutes rather that many hours or the next day.

- Another way to describe what the distributed computing solution does for research is that now we produce during one study semester the equivalent

TECHILA

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www.techila.fi/downloads/

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amount of analysis data as we used to produce in 20 years, Matti Lindroos says.

- It is actually amazing how powerful the distributed computing environment used at the Tampere University of Technology is. We want to make sure it is used only for the most ambitious research and yet its capacity is in very high demand.

- All in all, this century has been a time of tremendous development for measuring instruments. We have access into more details than ever.

A research community

- I am a visiting Professor at the Northeastern University in Boston, Massachusetts, and I spend most of my off-semester time there. Although I do most of my research in Tampere, in Boston I have a community around me that shares the same research passion, Matti Lindroos says.

- Because online supercomputer time is in short supply in Boston, as it is in practically any research institute, I do my computing on the Tampere University of Technology distributed computing environment also when I am in Boston. With the current excellent network connections I do my runs from my personal laptop mostly during Finnish night time when more capacity is available in Tampere, and get the result in minutes.

- To my fellow researchers in Boston, Techila was a miracle at first, then something to be eager to get access to. I have direct access to computation capacity while the other researchers have to queue for their slot at the supercomputer and make only slow progress. Now they would like to see this technology taken into use at Northeastern.

Any university has a vast amount of PCs as well as idle server capacity.

- Even if individuals should not want to give their PCs' unused capacity to be linked to the distributed computing environment, any computer classes or research units has PCs on premises. It is a waste if their capacity is allowed to sit idle.

Techila is not an answer to all computation challenges as distributed computing does not match every need. On the other hand, should a major share of research computing be run using the distributed computing, old fashionable supercomputer time would be made easier available to those who absolutely need it.

- In computation done in superconductivity research Techila is an enabler. In the past, I had to more or less sit around to wait for results, while now I barely have time to get a cup of coffee before the results are in.

Personal Profile: Dr. Matti Lindroos

•Dr, Docent, Department of Physics, Tampere University of Technology

•Visiting professor, Northeastern University, Boston, MA

Selected Publications

•V. Arpiainen A. Bansil and M. Lindroos Circular Dichroism in the Angle-Resolved Photoemission Spectrum of the High-Temperature Bi2Sr2CaCu2O8+? Superconductor: Can These Measurements Be Interpreted as Evidence for Time-Reversal Symmetry Breaking Phys Rev Lett. 103(2009)067005.

•V. Arpiainen and M. Lindroos,Effect of Symmetry Distortions on Photoelectron Selection Rules and Spectra of Bi2Sr2CaCu2O. Phys. Rev. Lett. 97, 037601 (2006).

•A. Mans, I. Santoso, Y. Huang, W. Siu, S. Tavaddod, V. Arpiainen, M. Lindroos,H. Berger, V. N. Strocov, M. Shi, L. Patthey and M. S. Golden. Experimental proof of a structural origin for the shadow Fermi surface of Bi2Sr2CaCu2O Phys. Rev. Lett. 96(2006)107007.

•S. Sahrakorpi, M. Lindroos, A. Bansil, and R.S. Markiewicz Evidence for Latent 3-Dimensionality in Photoemission of Midgap States in LSCO. Phys. Rev. Letters 95,157601 (2005).

Techila in use since 2006