Can we see s-wave spinon pairing for $T < T_C$ in overdoped high-T_C superconductors ?

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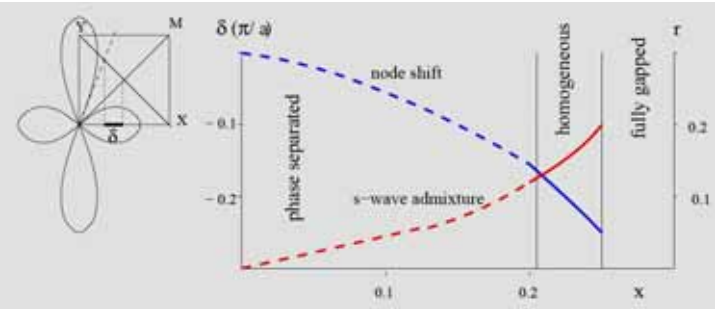
In the 'Quantum Electron Matter' group, part of the hard condensed matter research cluster at the Van der Waals-Zeeman institute, we are involved in the investigation of high T_C superconductors (HTSC). These systems break many of the accepted theoretical rules for the behaviour of electrons in crystalline solid matter, and thus are not only of interest as a result of their superconducting critical temperatures reaching up to half of room temperature (in Kelvin). Solving the high T_C puzzle remains perhaps the top fundamental challenge in the physics of condensed matter.

> *Embedded within this research programme into the electronic states of HTSC cuprates and colossal magnetoresistant manganites, we have an opening for an ambitious and committed BSc student for the following project.*

One of the more daring theoretical suggestions[1] as regards the nature of the superconducting state in the HTSC materials has been put forward by Prof. Jan Zaanen and his group in Leiden. They suggest that - within SU(2) theory [originated by Wen and Lee] - at a high level of overdoping in holes, a spinon-pairing gap should become visible in angle-resolved photoemission data as a shifting of the nodal lines in data probing the superconducting gap as a function of position on the Fermi surface. A spinon is the spin-carrying entity that results when the electron 'falls apart' (into spinons and holons), a phenomenon peculiar to low dimensional, strongly correlated electron systems.



Prediction from Leurs, Luna & Zaanen's SU(2) theory, showing an increasing s-wave component to the gap in the overdoped regime. The d+s mixture means the nodal lines of the superconducting energy gap will shift from the Brillouin zone diagonals.

In this BSc research project we'd like to try to take a first look as to whether indications for the existence of this d+s wave scenario can be found in high resolution angle-resolved photoemission data of overdoped $Bi_2Sr_2CaCu_2O_{8+\delta}$ single crystals. Dr. Huang - our crystal wizard - has already grown some excellent samples suited to this research, and the in-house FAMoS microscope is ideally suited to start the hunt for a possible shift of the nodal lines in the gap function in overdoped HTSC.

This project is - scientifically speaking - a high-risk, high-gain venture. Whatever the outcome, a good student would gain hands-on experience in a fast-moving and global field of research and become versed in various ultrahigh vacuum techniques including LEED and ARPES. Of course, the project research would have significant impact if we succeed to either provide firm support for or arguments against the d+s wave scenario.

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[1] see http://arxiv.org/PS_cache/arxiv/pdf/0707/0707.3709v1.pdf