Examensarbeten – Diploma work projects

Development of caloric methods for sub-microgram sample studies

Caloric measurements play an essential role in the study of new materials. Interesting physics often take place in connection with phase transitions, that are advantageously probed by the calorimeter. The well-known, classical phase transitions involve changes in the atomic arrangement, such as the melting of ice to water. But many modern transitions involve only the electrons (or a fraction of the electrons) of the material; in superconductivity the electrons pair together into cooper pairs, magnetic materials undergo transitions of the electron spin arrangements, and in quantum phase transitions an external parameter such as a magnetic field may even induce a change between order and disorder at absolute zero temperature.

The use of small samples may give access to new quantum mechanical properties, higher-quality crystals, and experimental information that would otherwise be unavailable, such as time dependence and size effects. In order to gain access to sub-microgram sample studies, we have developed a miniature calorimeter based on the steady-state AC method, where the sample temperature oscillates with a small amplitude around a steady-state condition. This method has the advantage of a very high relative resolution, which is needed to study energy changes involving only fractions of the total heat capacity.

To further this research, we are looking for two students interested in the following projects:

1. This diploma work is aimed at developing a system that integrates a real-time data acquisition system with ADC and DAC boards with an FPGA to enable pseudo-adiabatic measurements using pulse methods for improved absolute accuracy of the heat capacity and observations of latent heat from sub-microgram samples.
2. This diploma work is aimed at designing and constructing a state-of-the-art, computer-based lock-in amplifier using high-resolution ADC cards and a real-time system for simultaneous, continuous sampling of five parallel, sub-nanovolt signals from the calorimeter. The purpose is to overcome the limitations of the instrumentation and maintain the calorimeter in optimal conditions while changing temperature or other conditions.

Both diploma works will involve advanced LabVIEW programming (no prerequisites required), some electronics construction, low-noise analog signal analysis methods, and caloric measurements at cryogenic temperatures.

If you are interested, please contact:

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