Department of Physics
McMICKEN COLLEGE OF ARTS AND SCIENCES

SUMMER RESEARCH OPPORTUNITIES
FOR UNDERGRADUATE WOMEN

APPLICATION DEADLINE: March 2, 2015

The Department of Physics is pleased to offer the following research project for the summer of 2015. Interested students are urged to contact the faculty member(s) directing the project that most interests them. By contacting the faculty member, you can discover more about the project, learn what your responsibilities will be and, if possible, develop a timetable for the twelve-week research period.

PROJECT TITLE: ENTANGLEMENT IN CLASSICAL MAGNETS

Professor Carlos J. Bolech
Department of Physics
427 Geol-Phys Building
Cincinnati, OH 45221-0011
Tel: (513) 556-0529
Fax: (513) 556-3425
Email: cj.bolech@uc.edu

Project Description

The Ising Model is one of the simplest models of classical statistical physics, but it captures a surprising range of phenomena pertaining to the physics of magnetic materials. The model describes the interaction of microscopic magnetic degrees of freedom called spins and is thus able to explain macroscopic ferromagnetism. A detailed study of the Ising model requires some of the most advanced techniques of mathematical physics (like statistical field theories of critical phenomena and the Renormalization group) or computational physics (like Cluster Monte Carlo Methods). Yet, a very intuitive understanding of the physics of the Ising model is possible on a single page of calculations and using only elementary mathematics by resorting to the so called Mean Field Approximation (MFA).

In this project, we intend to revisit the MFA for the Ising model and extend it to consider *matrix mean fields*. These will be built in the modern language of tensor networks, which have the ability to capture information about the entanglement among spins in the model. We expect to be able to recover some of the results obtained with the more advanced techniques but while keeping the calculations a lot simpler in relative terms. The work will be partly analytic and partly computational. Familiarity with basic programming and the use of computers for data plotting is required. Knowledge of thermal physics is a plus but not a prerequisite. The undergraduate student working on this project will also interact with graduate students who are working on similar ideas but for quantum systems.