Monte Carlo Renormalization Group Study of the 2D XY Model
Ryan Young
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The 2D XY model is a well understood yet sophisticated statistical spin model. It exhibits an infinite order phase transition from a disordered high-temperature phase to a quasi-long range ordered low-temperature phase that consists of a line of fixed points. This unique phase transition is the result of topological vortices with a U(1) symmetry that was first described by Berezinsky, Kosterlitz, and Thouless .Theories with similar phase structures are conjectured to be present in higher dimensional conformal models. Such conformal models or near-conformal models are important in the study of beyond Standard Model physics, especially Technicolor theory. Given the difficulty of calculations on these 4D conformal models, the 2D XY model provides an ideal and testing ground for methods that can then be applied to the study of higher dimensional conformal models.

Monte Carlo Renormalization Group (MCRG) has been used and tested on both spin systems and gauge model. It is not fully understood how MCRG methods will function when applied to conformal models. The goal of this study is to test MCRG methods on the 2D XY model in a high statistics simulation study.

Project Time Line (2011)

April: Finishing writing an Monte Carlo XY model code and compare against known results. A Wolff cluster update algorithm will be implemented to ensure sufficiently fast computational speed so that a high level of statistical significance can be achieved.

May: Develop and test various renormalization (blocking) schemes.

June: Write necessary analysis code, and interpret results of the study.

July: Began writing undergraduate Honors Thesis. If the results have merit write an academic paper for publication.

Fall: Defend Honors Thesis in late September or early October.

Bibliography

Binney, J. J., N. J. Dowrick, A. J. Fisher, and M. E. J. Newman. 1992. *The Theory of Critical Phenomena: An Introduction to the Renormalization Group*. Oxford University Press, USA, July 16.

Decker, K. 1988. Singular renormalization group transformations and first order phase transitions (II). Monte Carlo renormalization group results. *Nuclear Physics B* 295, no. 1 (1): 21-35. doi:10.1016/0550-3213(88)90225-8.

Kosterlitz, J. M. 1974. The critical properties of the two-dimensional xy model. *Journal of Physics C: Solid State Physics* 7: 1046.

Wolff, Ulli. 1989. Collective Monte Carlo Updating for Spin Systems. *Physical Review Letters* 62, no. 4 (January 23): 361. doi:10.1103/PhysRevLett.62.361.

Application to Graduate with Honors

Student ID: _810 - 68 - 3791_

I plan to defend in: (FALL) SPRING   of 20_11_

Personal Information:

Academic Information:

Name: _Ryan E Young_

Address: _2730 17th St._

Boulder, CO, 80304

CU E-mail: _youngre @ colorado.edu_

I am an: (IN-STATE / OUT-OF-STATE student

☑ I plan to graduate with *Departmental Honors* in:

~~Physics~~ Engineering Physics

☐ I plan to graduate with *General Honors*

Cumulative GPA: _3.18_

Please attach a brief **PROSPECTUS**, **BIBLIOGRAPHY**, and **TIMELINE** of your thesis project to this application. When summarizing your work, consider the following:

- What is the problem you are investigating?
- What is the hypothesis you are testing?
- What is the focus of your study?
- What is your goal in this study?

Primary thesis advisor: Name: _Anna Hasenfratz_   Dept: _Physics_

List the other members of your committee: Name: _Anne M. Dougherty_   Dept: _Applied Math_

Name: _Jun Ye_   Dept: _Physics_

Name: _____   Dept: _____

Name: _____   Dept: _____

Departmental and General Honors Committee Checklist:

- ☑ Applicant has a total of at least three committee members.
- ☑ At least one Honors Council Representative is included on committee.
- ☑ At least one committee member from an outside department.

Please initial if you are pursuing Departmental Honors:

√ I have consulted with my department and have completed (or am completing) the requirements they have established.

For Honors Council Representative:

I have met with applicant and approve him/her for departmental honors.

Printed Name: _____ Signature: _____

Please initial if you are pursuing General Honors:

_____ I have completed (or am completing) the requirements for graduating with General Honors. Please list the courses you have or are taking toward General Honors:

_____ _____ _____ _____

_____ _____ _____ _____

For General Honors Council Member:

I have met with applicant and approve him/her for general honors. I agree to be on his/her defense committee.

Printed Name: _____ Signature: _____

For the Thesis Advisor:

I have met with the applicant to discuss the proposed work and agree to provide the necessary help and direction for this thesis project.

Printed Name: _Anna Hausodntz_ Signature: _____

For the Student:

I have read the requirements for graduating with honors at the University of Colorado. I also understand that my designation will be sent to the CU email address that I have provided and will not be given out over the phone.

Signature: _____ Date: _4/11/2011_

For additional graduation information including requirements, guidelines and deadlines, you can download them online at www.colorado.edu/honors