

University of Northern Iowa

UNI ScholarWorks

Summer Undergraduate Research Program
(SURP) Symposium

2020 Summer Undergraduate Research
Program (SURP) Symposium

Jul 31st, 1:00 PM - 3:30 PM

Modeling the Griffiths Phase in Manganese Intercalated Tantalum Disulfide [Poster]

Aaron Janaszak
University of Northern Iowa

Lukas Stuelke
University of Northern Iowa

See next page for additional authors

Let us know how access to this document benefits you

Copyright ©2020 Aaron Janaszak, Lukas Stuelke, and Paul Shand

Follow this and additional works at: <https://scholarworks.uni.edu/surp>

 Part of the [Physics Commons](#)

Recommended Citation

Janaszak, Aaron; Stuelke, Lukas; and Shand, Paul, "Modeling the Griffiths Phase in Manganese Intercalated Tantalum Disulfide [Poster]" (2020). *Summer Undergraduate Research Program (SURP) Symposium*. 13.

<https://scholarworks.uni.edu/surp/2020/all/13>

This Open Access Presentation is brought to you for free and open access by the CHAS Conferences/Events at UNI ScholarWorks. It has been accepted for inclusion in Summer Undergraduate Research Program (SURP) Symposium by an authorized administrator of UNI ScholarWorks. For more information, please contact scholarworks@uni.edu.

Offensive Materials Statement: Materials located in UNI ScholarWorks come from a broad range of sources and time periods. Some of these materials may contain offensive stereotypes, ideas, visuals, or language.

Author

Aaron Janaszak, Lukas Stuelke, and Paul Shand

Background

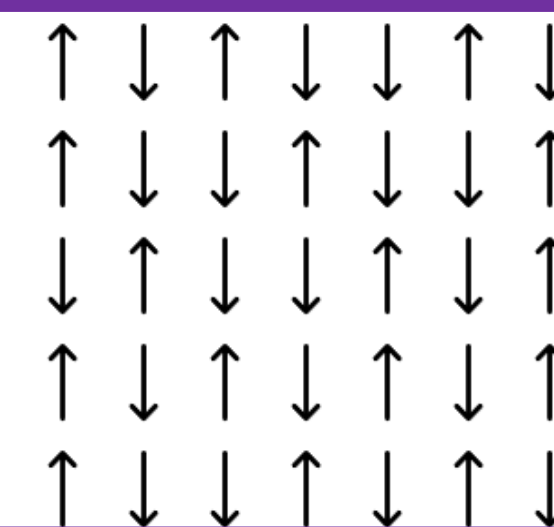
Paramagnetism:

- The magnetic moments in a paramagnetic material are randomly oriented in the absence of a magnetic field and more aligned in the presence of one.
- Exhibited at high temperatures

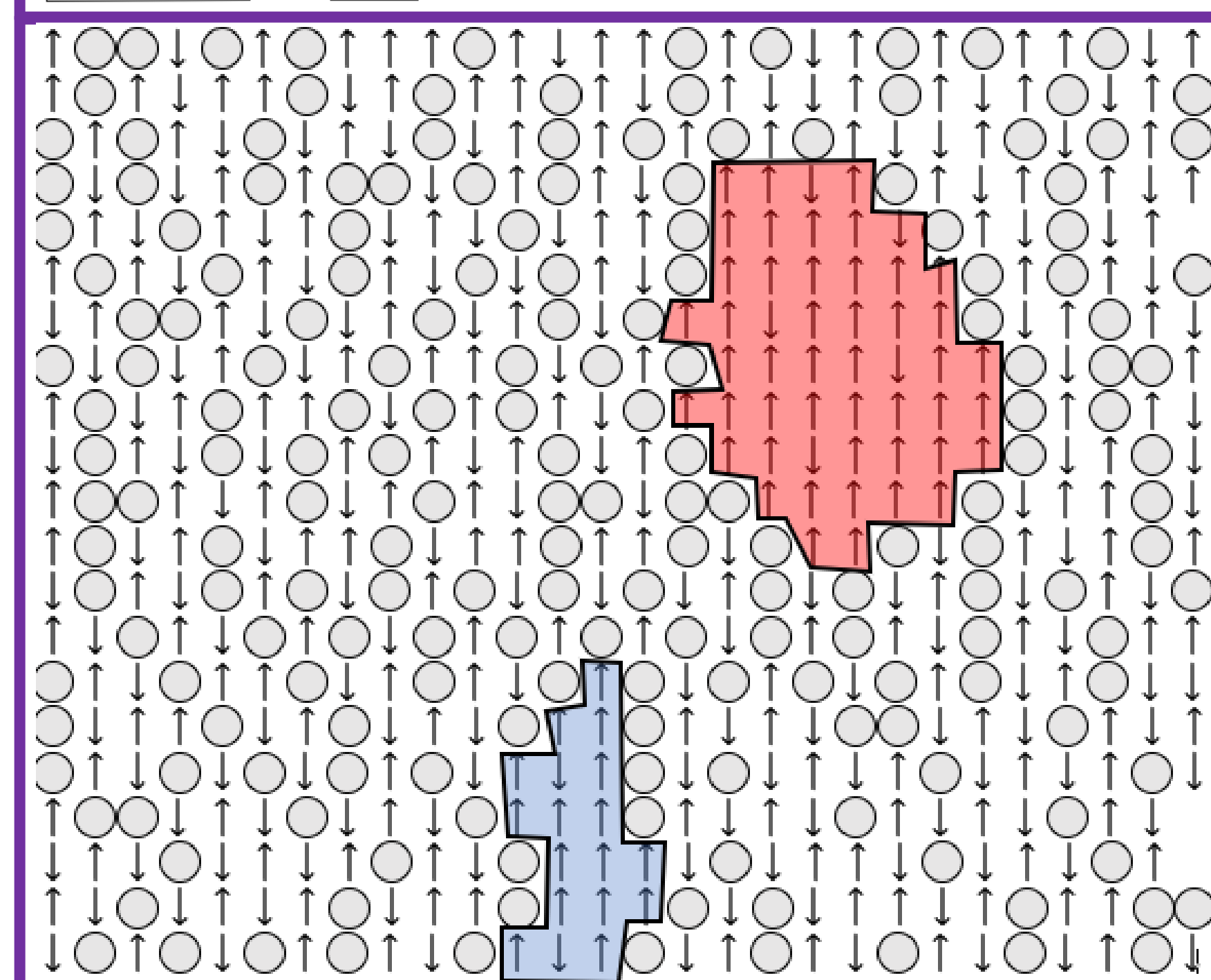
Ferromagnetism:

- Ferromagnetic materials have ordered magnetic moments even without an external magnetic field.
- Their moments in the domains align in a strong external magnetic field
- They produce their own magnetic field as a result

- In an ideal paramagnet, magnetic moments fully occupy every lattice point

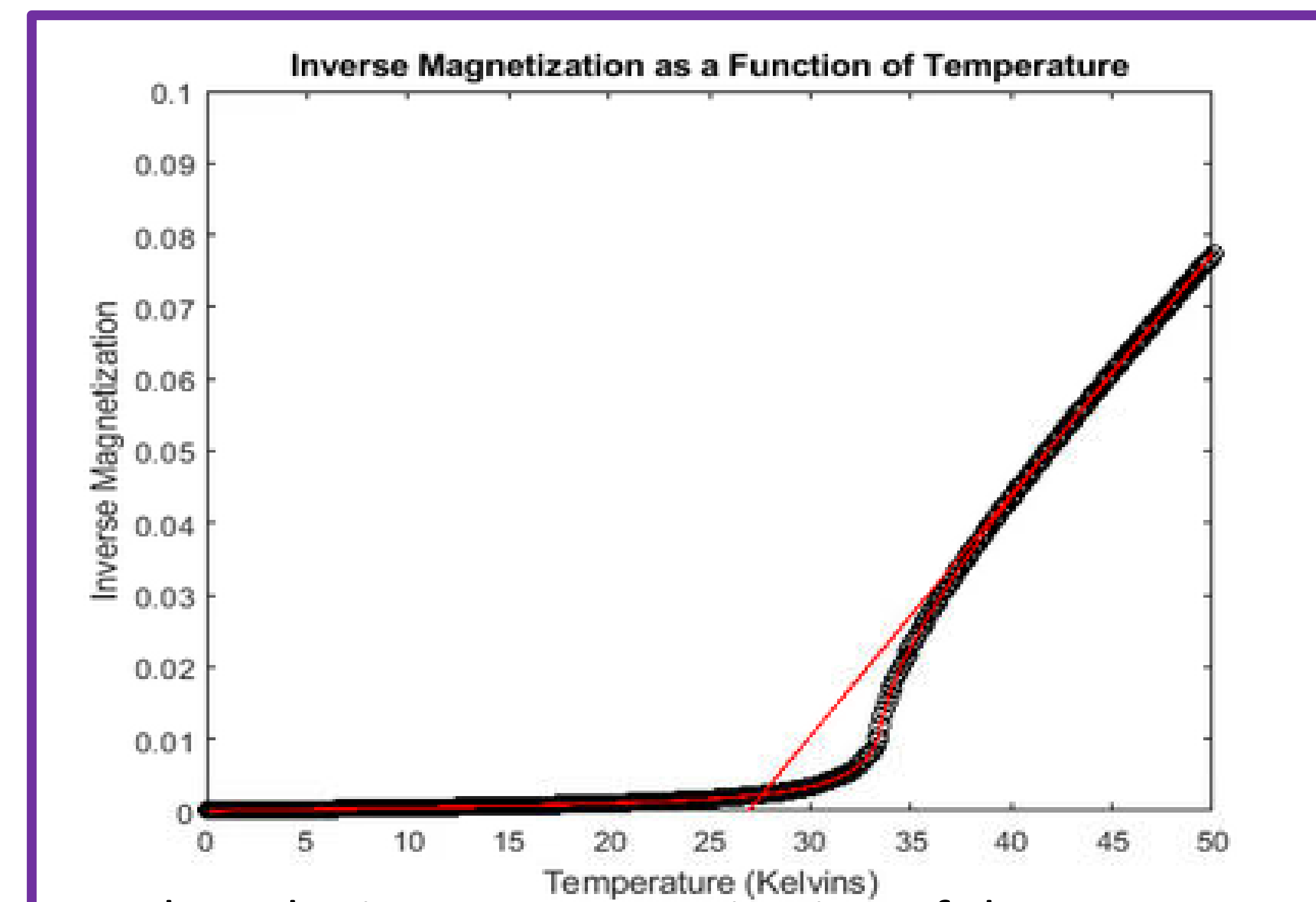


- As disorder is introduced, magnetic moments are removed and remaining moments form clusters



- Very large clusters (red) become very rare
- These clusters dominate the overall magnetization of the system due to their size

What is the Griffiths Phase?

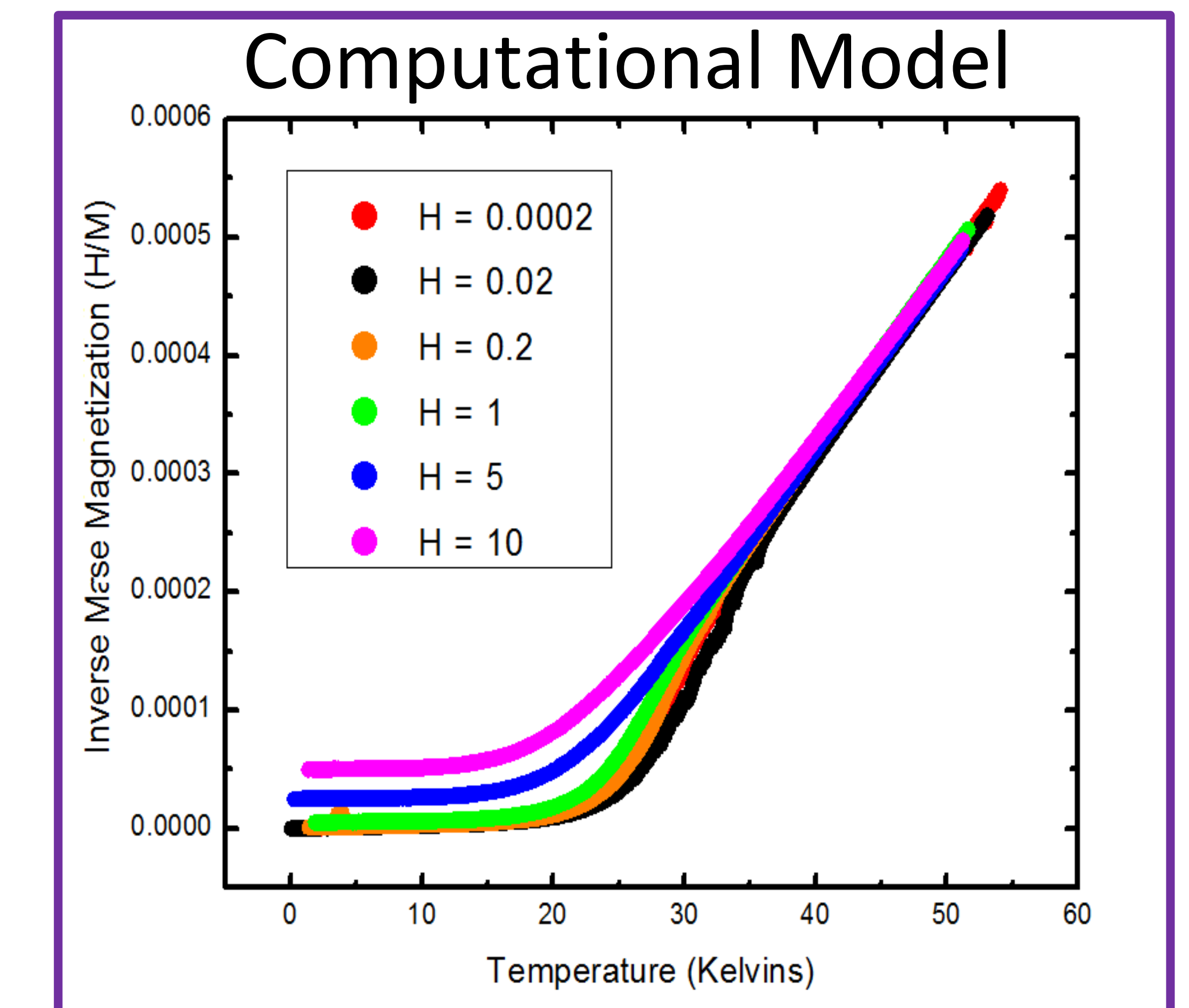
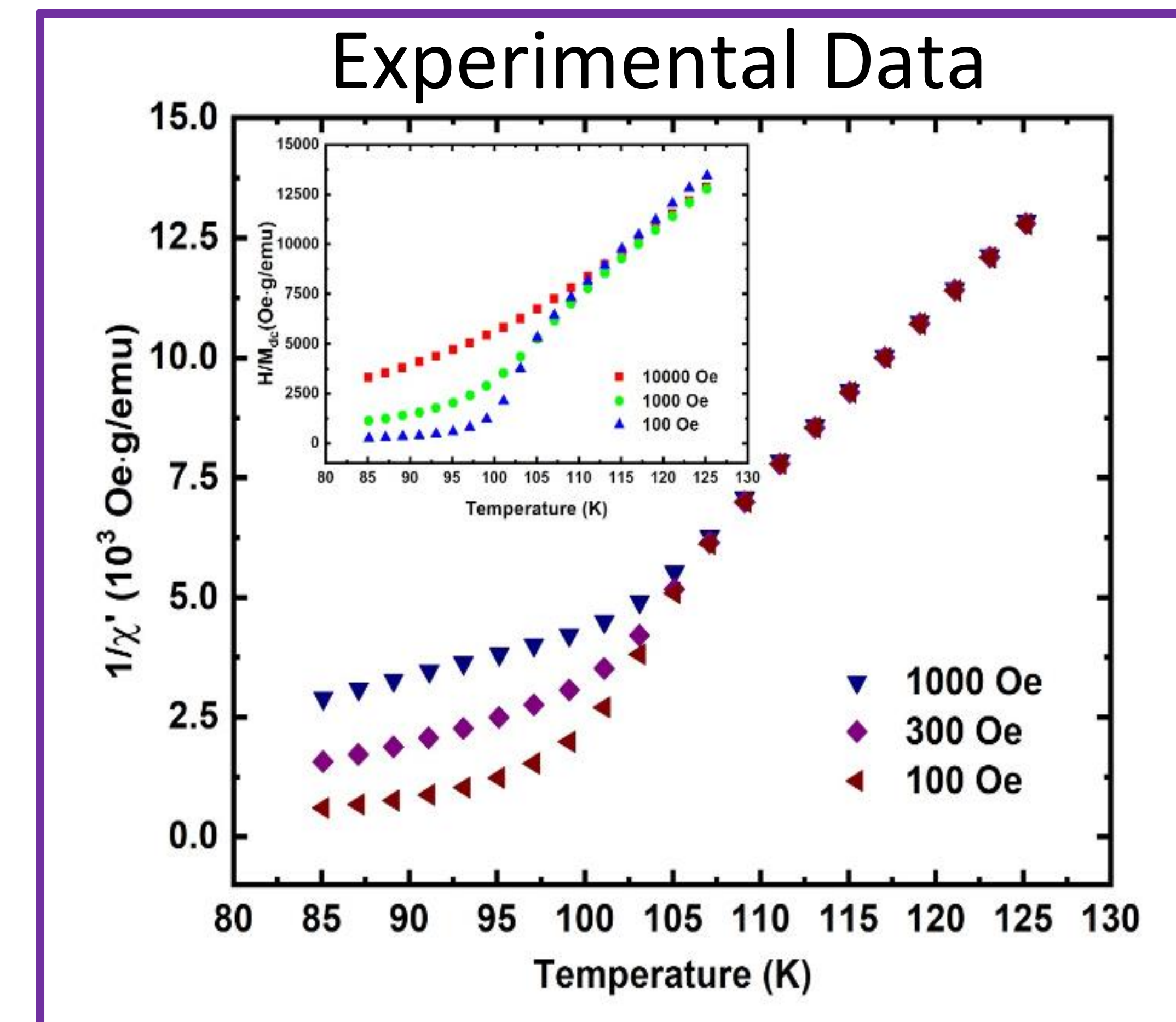


- When the inverse magnetization of the system deviates below the Curie-Weiss Line (as shown above)

Computational Details

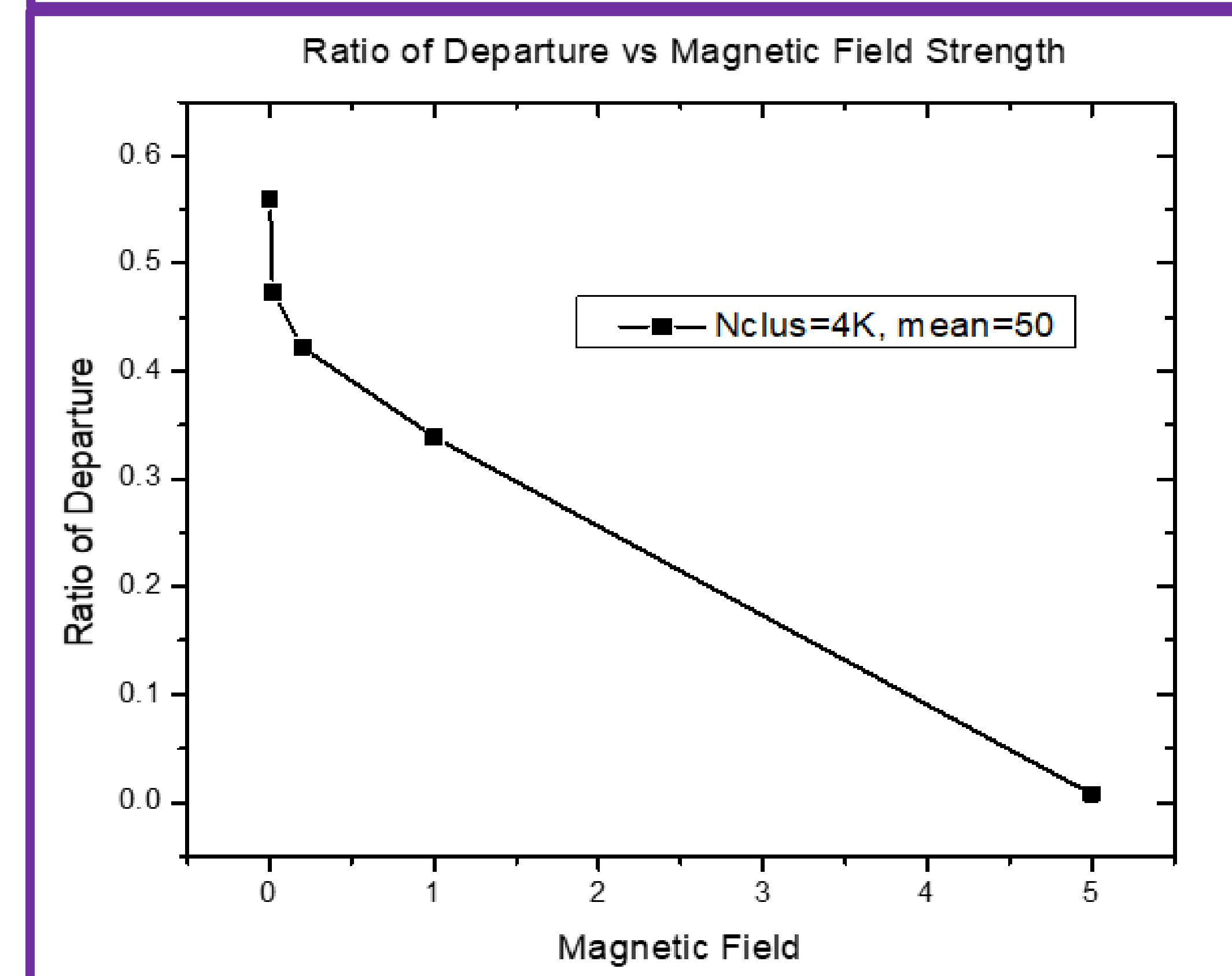
- Utilizing MATLAB, we were able to use the Langevin function to simulate the behavior of clusters and the resultant magnetization of that system.
- Interaction between magnetic moments was simulated via a molecular field taken to be proportional to the magnetization.
- A conditional segment of the code allowed us to account for values above and below the Curie temperature and calculate the overall magnetization.
- A secondary code was written to analyze the Curie-Weiss line and subsequent computational deviation from that line in a process that allowed us to quantitatively compare the affects that a changing magnetic field had on the Griffiths Phase, coined "Ratio of Departure".

Results



Effect of the External Magnetic Field on the Griffiths Phase

Quantifying the maximum ratio between the Curie-Weiss Line and computational data points allowed us to examine the strength of the Griffiths Phase as we modified variables.



Conclusion

The Griffiths Phase is a result of a spontaneous increase in the overall magnetization of the system primarily influenced by the rare, large clusters transitioning to a ferromagnetic state at the Curie Temperature. We were able to create a MATLAB program that exhibits this trend by using the Langevin function to simulate clusters. Comparing the two graphs, above, the trends of the computational model follow the behaviors of the experimental data as the external magnetic field is increased.

Future Work

Going forward, we would use this program to explore more variables and distribution types of the data in an attempt to better understand the Griffiths Phase.

Acknowledgements

The researchers would like to thank Dr. Shand for his leadership and guidance, and Paul White for his assistance. This research project is possible due to funding by the UNI Physics Department and the Department of Energy, Grant # DE-SC0020334