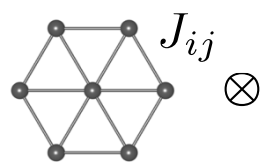


# Mourigal Lab Research: Quantum Magnetism

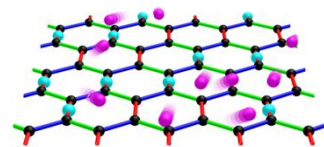
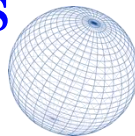
## Idea



$$\mathcal{H} = \sum_{(ij)} \hat{\mathbf{S}}_i J_{ij} \hat{\mathbf{S}}_j$$



$\hat{\mathbf{S}}$



magnetic material

Heisenberg model

lattice-space

spin-space

emergent quantum behavior

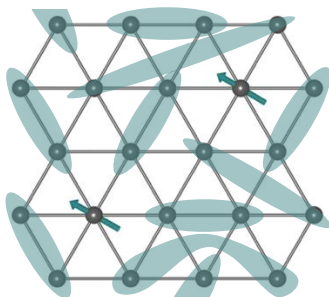
## Challenge

topological order

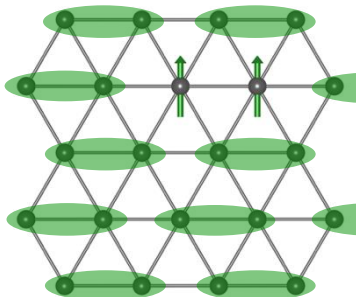
entanglement

local order

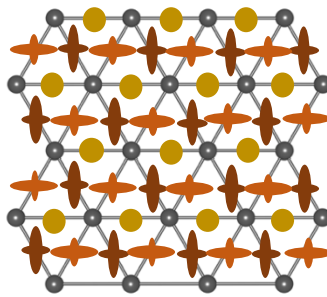
disorder



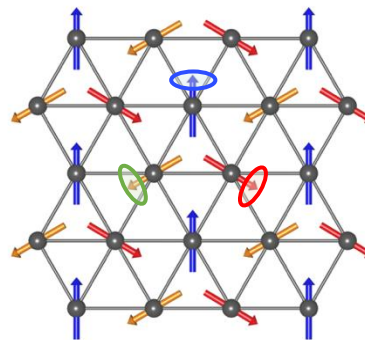
Quantum spin liquid



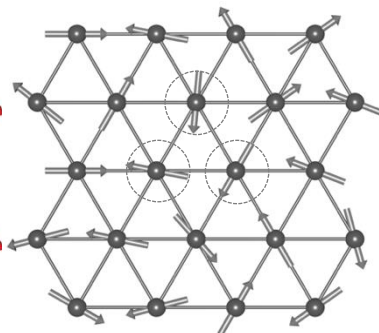
Quantum paramagnet



Quadrupolar order

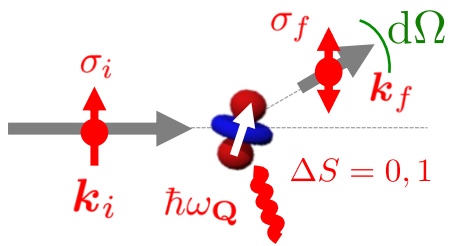


Dipolar order



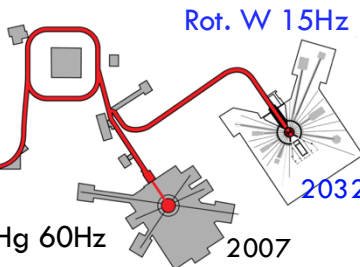
Paramagnet

## Approach



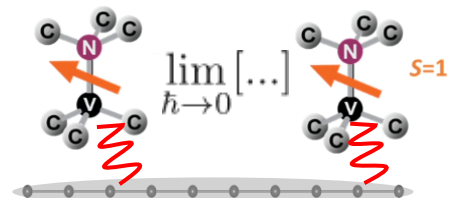
Inelastic neutron scattering

Proton Pow Upg. (2024)



ORNL Spallation Neutron Source

## Applications?



Transduction of quantum information

Quantum bus

# Doctoral Thesis

## Course Information

- **Instructor:** Martin Mourigal (mourigal@gatech.edu)
- **Course Prefix and Number:** PHYS 9000 MM
- **Term:** Fall 2026

## Course Description

This course provides academic credit for independent thesis research conducted under the supervision of a Georgia Tech faculty advisor. The course does not involve regular class meetings, assignments, or examinations. The scope and direction of research are determined by the student in consultation with the thesis advisor, consistent with the requirements of the degree program.

## Course Learning Outcomes

By enrolling in this course, students will:

1. Engage in independent research under faculty supervision.
2. Gain experience in formulating research questions and applying methods appropriate to their discipline.
3. Communicate research activity through interactions with their thesis advisor and, as applicable, their Thesis Advisory Committee.

## Required Course Materials

No textbooks or materials are required. Resources for research are determined in consultation with the thesis advisor.

## Grading Policy

This course is graded on a **Satisfactory (S) / Unsatisfactory (U)** basis.

- A grade of **Satisfactory (S)** indicates that the student has made acceptable progress in their research toward degree completion, consistent with the number of thesis credit hours for which the student is enrolled for the semester.
- A grade of **Unsatisfactory (U)** indicates that the student did not meet the expectations for satisfactory performance during the term.

## **Attendance Policy**

This course does not include scheduled class meetings. Students conduct independent research under the supervision of a thesis advisor. The frequency and format of student–advisor contact are determined by mutual agreement.

## **Academic and Research Honesty/Integrity Statement**

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review the [Student Code of Conduct](#) and the [Academic Honor Code](#), especially [Appendix A: Graduate Addendum to the Academic Honor Code](#).

Students are expected to perform research in an ethical and responsible manner. All Doctoral and Master’s Thesis students are required to take the [Responsible Conduct of Research training](#), and it is expected that students abide by the principles taught in that training while performing research for this thesis course.

Allegations of scientific or scholarly misconduct are handled in accordance with the procedures outlined by the [Policy for Responding to Allegations of Scientific or Other Scholarly Misconduct](#).

## **Core IMPACTS**

Not applicable.

## **Accommodations for Students with Disabilities**

If you are a student with learning needs that require special accommodation, [contact the Office of Disability Services](#) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

## **Expectations of Advisors and Advisees**

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgment, and responsibility between faculty members and the student body. [The Expectations of Advisors and Advisees](#) articulates some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.