



(Geodynamo magnetic fields, from Gary Glatzmaier, UCSC)

## Spring 2022 – PHYS 390/590: Magnetohydrodynamics

Magnetohydrodynamics (MHD) is essential for understanding many interesting phenomena in astrophysics, space weather and planetary science. This course will review the fluid mechanics, thermodynamics and electromagnetism, as well as the mathematical models and computational methods needed to understand various stellar and planetary magnetism, using the Sun and the Earth as primary examples. The basic equations of fluids and magnetofluids will be introduced, with application to nonlinear processes, turbulence and dynamo action. This course is intended primarily for graduate students interested in planetary and space science. Well-prepared undergraduate students may also take the course and will be graded separately from graduate students. Previous exposure to fluid dynamics is not required, although courses in classical mechanics, electromagnetism and thermodynamics are prerequisites. Topics covered will be:

- I. Introduction
- II. Math Methods
- III. Review of Electrodynamics
- IV. Multipole Magnetic Fields
- V. Thermodynamics
- VI. Basic Fluid Mechanics
- VII. Fundamentals of MHD
- VIII. MHD Turbulence
- IX. Geodynamo, Solar Dynamo
- X. Astrophysical MHD

(For 590, graduate students will be assigned a small project or extra homework.)

**Instructor:** Dr. John Shebalin ([jshebal@gmu.edu](mailto:jshebal@gmu.edu); please contact if you have any questions)

**Prerequisites:** PHYS 303, 305, 307.

**Class time:** Thursday, 1:30 pm – 4:10 pm. **Classroom:** Exploratory Hall 1004 or online

**Text:** Copies of lectures and additional reference material will be provided as needed.

**Conduct:** Please follow the Physics & Astronomy Department Code of Professional Conduct