

Seminar: Contemporary Physics/PHY 685A

Spring 2026

Location: Dow 208

Time: Friday 1-2 pm

Instructor: Dr. Valeri Petkov, Dow 232

Office: (989) 774-3395, E-mail: petko1vg@cmich.edu

Office hours: by arrangement

General Information:

Course description: The main objective of the class is to help students learn how to grasp major concepts of research done by others and communicate major concepts of their own research to others. Emphasis is placed on **critical reading of research papers, oral communication, and synthesis of ideas across subfields.**

Students will lead discussions, critique seminal and recent papers, make poster presentations and develop a short research proposal by the end of the term.

Learning Objectives

By the end of the course, students will be able to:

- Read and critically analyze advanced physics literature
- Identify assumptions, approximations, and open questions in research
- Communicate physics ideas clearly to peers
- Place their own research within a broader scientific context
- Formulate and defend a feasible research proposal

Course Structure

Each week includes:

- **Primary reading** (required)
- **Secondary reading** (optional or background)
- **Student-led discussions and/or presentations**
- **Short written response/proposal** (a few pages)

Weekly Schedule & Readings

Week 1 — How Physicists Read Papers

Topic: Anatomy of a research paper

Reading:

- M. K. Keshav, “*How to Read a Paper*” (recommended)
- P. W. Anderson, “*More Is Different*”, *Science* (1972)

Activity: Group discussion of a paper

Week 2 — What Is a Good Theory?

Topic: Models, approximations, and predictive power

Reading:

- E. P. Wigner, “*The Unreasonable Effectiveness of Mathematics in the Natural Sciences*”
- N. Goldenfeld & L. P. Kadanoff, “*Simple Lessons from Complexity*”

Activity: Group discussion of a paper

Week 3 — Symmetry and Conservation

Topic: Symmetry as an organizing principle

Suggested Reading:

- E. Noether, “*Invariant Variation Problems*” (excerpts)
- A. Zee, *Fearful Symmetry* (selected sections)

Activity: Group discussion of a paper

Week 4 — Emergence and Effective Theories

Topic: Why microscopic laws are not enough

Suggested Reading:

- S. Weinberg, “*Effective Field Theory, Past and Future*”
- P. W. Anderson, “*Basic Notions of Condensed Matter Physics*” (selected chapters)

Activity: Group discussion of a paper

Week 5 — Quantum Foundations

Topic: Measurement, realism, and interpretation

Suggested Reading:

- J. S. Bell, “*On the Einstein-Podolsky-Rosen Paradox*”
- W. H. Zurek, “*Decoherence and the Transition from Quantum to Classical*”

Activity: Group discussion of a paper

Week 6 — Statistical Physics Beyond Equilibrium

Topic: Irreversibility and fluctuations

Suggested Reading:

- L. Onsager, “*Reciprocal Relations in Irreversible Processes*”
- U. Seifert, “*Stochastic Thermodynamics*” (review)

Activity: Group discussion of a paper

Week 7 — Mid-Semester Student Presentation of a Poster

Topic: Student-selected poster related to their research

Activity: Presentation of a poster & discussion

Week 8 — Information as a Physical Concept

Topic: Entropy, information, and computation

Suggested Reading:

- R. Landauer, “*Information Is Physical*”
- J. Preskill, “*Quantum Computing in the NISQ Era*”

Activity: Group discussion of a paper

Week 9 — Experiment vs Theory

Topic: When data challenges models

Suggested Reading:

- A. Einstein, “*Physics and Reality*”
- Selected recent paper with experimental–theoretical tension (instructor-chosen)

Activity: Group discussion of a paper

Week 10 — Interdisciplinary Physics

Topic: Physics beyond traditional boundaries

Suggested Reading (choose one track):

- Active matter: M. C. Marchetti et al., “*Hydrodynamics of Soft Active Matter*”
- Biological physics: W. Bialek, *Biophysics: Searching for Principles*
- Astrophysics: B. P. Abbott et al., “*Observation of Gravitational Waves from a Binary Black Hole Merger*”

Activity: Group discussion of a paper

Week 11 — Ethics, Reproducibility, and Scientific Culture

Topic: How science actually works

Suggested Reading:

- J. P. A. Ioannidis, “*Why Most Published Research Findings Are False*”
- APS Ethics Guidelines (excerpts)

Activity: Group discussion of a paper

Week 12 — My Future in Physics Research

Topic: Research proposal and career goals

Final Presentations: Research proposals (5-7 pages, including motivation, methods and expected impact on science and carrier path).

Assignments & Grading

Component	Weight
Participation & Discussion	30%
Paper Critiques (weekly)	25%
Midterm Poster Presentation	15%
Final Research Proposal (oral + written)	30%

Prerequisites: Enrollment in the MS in Physics or permission of the instructor.

Format of the instruction: The class will meet **each Friday** for discussions and/or presentations. Note that Thursday seminars (every other week) organized by the Department of Physics are a part of the course and attendance is required.

Central Michigan University complies with the Americans with Disabilities Act and Sect 504 of the Rehabilitation Act. If you have a disability and anticipate needing accommodations in this course, please register with the Office of Student Disability Services (Park Library, Room 120, 989-774-3018) and contact me with a letter of accommodations as soon as possible. Retroactive requests for accommodations

will not be honored. For more information, see
<https://www.cmich.edu/ess/studentaffairs/SDS/Pages/default.aspx>.

Central Michigan University, an AA/EO institution, strives to maintain our campus as a place of work and study for faculty, staff, and students that is free of all forms of prohibited discrimination and harassment based upon age, color, disability, ethnicity, familial status, gender, gender expression, gender identity, genetic information, height, marital status, national origin, political persuasion, pregnancy, childbirth or related medical conditions, race, religion, sex, sex-based stereotypes, sexual orientation, veteran status, or weight. Any student who has concerns about such behavior should contact their instructor or the Office of Civil Rights and Institutional Equity at 989-774-3253 or ocrie@cmich.edu.