# MIT Department of Physics

Academic Programs Office

## For advisors: new and revised Physics subject offerings and enrollment information Fall 2022

**Academic Advisors:**
Below are a few changes or items of note about our fall term offerings. Please share this information with your academic advisees.

**8.01L Physics I**
Lecturer: Pablo Jarillo-Herrero

While hardly a new subject, and one your undergraduate majors will be unlikely to need to enroll in, we wanted to let you know that the 8.01L teaching team (which includes Richard Milner and Byron Drury) is restructuring 8.01L this fall to be taught in an 8.01/8.02-like TEAL format.

**8.041 Quantum Physics I** **TR 11:00-12:00**
Lecturer: Vladan Vuletic

We now have an established set of two versions of both 8.04 and 8.05, one traditional lecture and one 'flipped-classroom' style in which students watch lectures on line before attending recitation classes. 8.041 (digital) and 8.05 (lecture) will be fall offerings; 8.04 (lecture) and 8.051 (digital) will be spring classes.

**8.05 Quantum Physics II** **MW 12:30-2:00**
Lecturer: Barton Zwiebach

Please note this updated subject description, consistent both with several years of recent teaching and, even more recently, with a review of our undergraduate queantum sequence overseen in 2021-22 by Bob Jaffe:

Vector spaces, linear operators, and matrix representations. Inner products and adjoint operators. Commutator identities. Dirac's Bra-kets. Uncertainty principle and energy-time version. Spectral theorem and complete set of commuting observables. Schrodinger and Heisenberg pictures. Axioms of quantum mechanics. Coherent states and nuclear magnetic resonance. Multiparticle states and tensor products. Quantum teleportation, EPR and Bell inequalities. Angular momentum and central potentials. Addition of angular momentum. Density matrices, pure and mixed states, decoherence.

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Room 4-315
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**8.13 Experimental Physics** **MW 9:00-12:00, 2:00-5:00; TR 9:00-12:00, 2:00-5:00**

The pandemic caused a good bit of backup in 8.13, such that we have had to limit and carefully monitor enrollment for the past two years. Demand now seems to have just about caught up with supply, as we have 37 students pre-registered and 48 places available. Ideally we'll be able to fit in everyone who wants to take 8.13 this fall, but please advise any sophomores who are interested that they are low on the priority list and therefore may not be able to be accommodated. After Registration Day we'll be better able to confirm enrollment.

**8.372 Quantum Information Science III** **TR 2:30-4:00**

Lecturer: Aram Harrow

Now a new permanent subject, this third course in QuIS was a successful pilot in fall 2020, and has quickly become popular among grad students and advanced undergraduates alike.

**8.398 Selected Topics in Graduate Physics** **W 12:00-1:00**

Lecturer: Jesse Thaler

Advisors of first-year graduate students are reminded that all first-years must enroll in this seminar that touches on both scientific and pedagogical topics important for beginning PhD students; enrollment in this 6-unit subject is required in both fall and spring of the first year.

**8.590 Topics in Biophysics and Physical Biology** **F 12:00-2:00**

Lecturers: Jeff Gore, Nikta Fakhri

This subject has not been offered for three years but is soon to be under the direction of Course 8 after original 'ownership' by Course 20. Still in the process of being officially updated in the MIT subject listings; will be offered Fridays, 12:00-2:00 pm.

**8.821 String Theory** **MW 4:30-6:00 (time may shift 15-30 minutes later)**

Lecturer: Hong Liu

Subject may also be taken as 8.251 for undergraduate credit

Please note this updated subject description:

> An introduction to holographic duality and string theory. Basics of quantum black holes and holographic principle; large N theories; light-cone quantization of the relativistic bosonic string and superstrings; D-branes; Basics of the AdS/CFT duality.

**8.871 Special Topics in Theoretical Particle Physics TR 1:00-2:30**

Lecturer: Will Detmold

The focus of this seminar will be Lattice Field Theory:

This class will discuss non-perturbative aspects of quantum field theory as accessible using a spacetime lattice regulator. Theoretical and numerical aspects of lattice field theory will be covered and applications to quantum chromodynamics and other strongly interacting QFTs will be presented.

**8.S30 Special Subject: Observational Stellar Archeology TR 2:00-3:30**

Lecturer: Anna Frebel

This course follows a new concept of doing an extensive research project in the classroom. It will prepare you for further research projects as well as graduate school. The topic will be on the oldest stars in the universe, the chemical evolution of the Milky Way galaxy, and how stellar populations move within the galaxy. A variety of scientific methods and approaches to research problem solving will be taught. Lectures on the weekly topics and methods will be presented for about half of the class time. Students will spend the other half of the class time working on weekly worksheets that describe the research tasks, under the guidance of Prof Frebel. Worksheets will then be completed by students on their own time in lieu of problem sets. This setup mimics the normal research process.

Each student (in a team of two) will get their own ancient ~12-billion-year-old metal-poor star to discover and analyze! The main task is a spectroscopic analysis, paired with a kinematic analysis to establish the star's origin scenario, i.e. establishing if it formed in a small dwarf galaxy that was later accreted by the Milky Way or in the Milky Way. Knowing about the origin helps to interpret the chemical abundance pattern derived from the spectrum. In mid-October, students are invited to participate in remote night observing with the Magellan telescope in Chile.

The course is rounded out with lectures on science communication (writing and speaking) since the final “exam” is a detailed paper that reports all the research findings and interpretation, and an in-class slide presentation by each team. There will be no midterm. “Searching for the Oldest Stars -- Ancient relics from the Early Universe” by A. Frebel will be the accompanying text. For questions, please email afrebel@mit.edu

## 8.S998 Special Subject: Mentorship Pedagogy and Practice

***Intended audience:***
First time physics mentors and others interested in improving their knowledge and skills in teaching one-on-one and in small groups, particularly TEAL TAs, graduate student TAs, and all others interested in education

***3-unit class (2-0-1):***
- 1-hour weekly class on pedagogy topics
- 1-hour weekly Physics Mentoring Community of Practice (CoP) meeting; the Community of Practice meetings will also be attended by continuing physics mentors
- 1-hour weekly homework consisting of reading/listening/watching material to prepare for in-class discussion and writing reflections after the classes

***Instructors:***
Prof. Edmund Bertschinger, Dr. Byron Drury, Dr. Michelle Tomasik

***Learning Objectives:***
*For Pedagogy class:*
● Learn about cognition, metacognition, and the role of affect as applied to mentoring/teaching
● Strengthen communication skills (practice listening, questioning, and eliciting student ideas)
● Learn about the roles of motivation and mindset in learning, and how to foster them
● Learn how to foster belonging and self-efficacy through peer mentorship
● Learn how to facilitate small-group interactions to enhance peer instruction and learning
● Learn physics-specific learning strategies, such as how to teach/learn problem solving
● Learn and practice research-based techniques for effective mentorship in STEM
● For all elements of the pedagogy course
  - Practice role-playing interactions with students working on physics problems
  - Reflect on how the content applies to their own teaching/mentoring, as well as their own learning experiences

*For students attending CoP meetings only:*
● Increase participants' skills in their role as mentor or TA including
  - Learn from other's experiences mentoring/teaching.
  - Refresh the theory and practice skills related to teaching and mentoring (update every semester based on students and larger context).
  - Reflect on one's practice of mentoring/teaching.
  - Refresh/learn the support resources for MIT students.
● Increase participants' self-efficacy in their role as mentor or TA.
● Build community among the students and others.

***Grading for the class:***
8.S998 is a Pass/Fail 3-unit class. To pass you must:
1. Complete the mentor training workshop

2. Attend and actively participate in at least 10 pedagogy sessions and 10 CoP sessions
3. Satisfactorily complete at least 10 of the 12 reflections

### *Physics Mentoring Program*

The Physics Mentoring Program, in operation since 2020 Spring, provides academic and psychosocial support to students enrolled in first- and second-year physics subjects through course-based near-peer mentorship. Mentees who join this optional program receive academic assistance for a particular course as well as general support and advising in weekly meetings with a trained mentor. Mentors are paid and are students (undergraduate and graduate) and postdocs who are proficient with the physics content of the subject and who participate in ongoing training in mentorship skills through a weekly Community of Practice Meeting. The program seeks to help mentees through academic and social support, develop the skills of the mentors, and build community in the Physics Department.