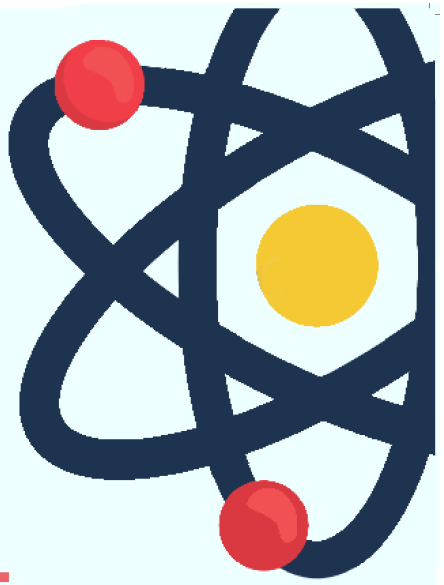


SOCIETY OF PHYSICS STUDENTS

PRESENTS:

PHYSICS ELECTIVE INFOSESSION

Not sure how to choose your physics electives? We will have panel of physics faculty to help you decide.

Tuesday, April 30th
5:30PM-6:30PM
SSB 170

Emphasis tracks

A way of organizing electives around a theme.

- **no selected concentration** (6-8 units)
  any two upper division physics electives (or outside physics with approval)
- **Atomic/Molecular/Optical/Condensed Matter (AMO/CM) Physics** (11-12 units)
  3 of PHYS 109 (soft matter), PHYS 141 (condensed matter), PHYS 144 (AMO), PHYS 148 (optics), PHYS 172 (quantum information)
- **Biophysics** (12-13 units)
  PHYS 104 (biophysics) + 2 of various biology (10) and bioengineering (3) courses
- **Mathematical Physics** (12 units)
  PHYS 116 (math methods) + 2 of various math courses
- **Custom** (12 units)
  three upper division physics electives (or outside physics with approval)
  Need faculty advisor approval at least two semesters prior to completion of degree.

For any emphasis: also, do PHYS 195/196 research in selected area.

Modern Atomic Physics

PHYS 144, Prof. Lin Tian, spring 2020 and spring 2022

Atomic, Molecular, and Optical physics is a growing field with continuous development of modern techniques in manipulating atoms and photons in the single-quantum level. Many of the techniques have been utilized towards quantum computing and quantum information.

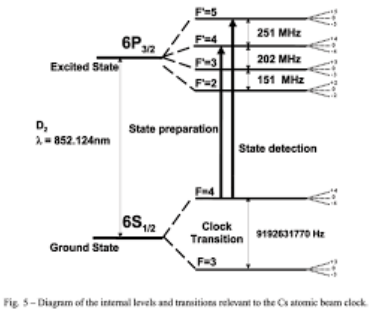
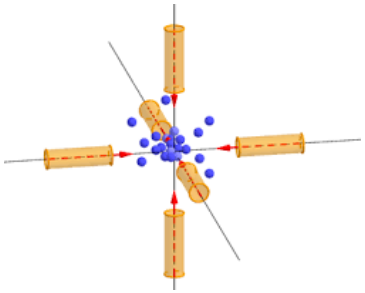
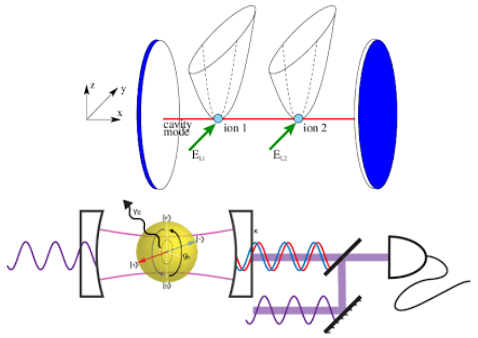


Fig. 5 – Diagram of the internal levels and transitions relevant to the Cs atomic beam clock.





We will discuss

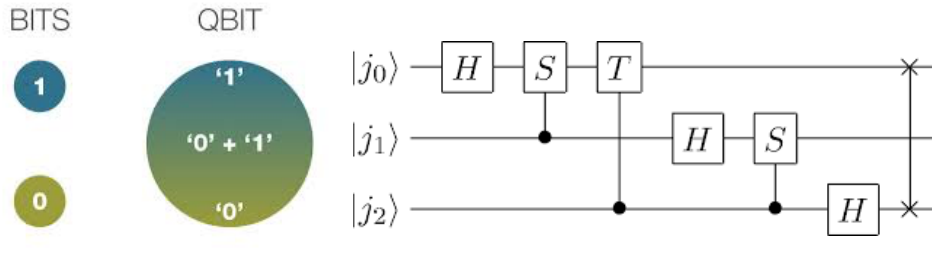
- Atomic structures: spin-orbital interaction, hyperfine states, Zeeman effects,
- Light-matter interaction: manipulation of atomic states, Doppler effect
- Recent progress in: optical trapping and cooling, optical tweezer, optical lattices, magnetic trapping, and Bose-Einstein condensation,

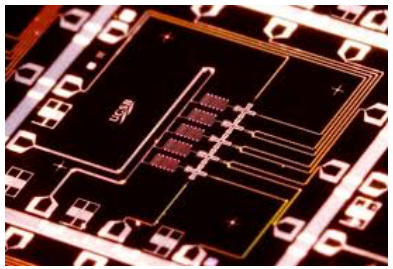
➢ Emphasis: AMO/CM. Prerequisite: PHYS 137 or instructor approval. Conjoined with 244.

Advanced Quantum Computing/Quantum Information

PHYS 192 & PHYS 172, Prof. Lin Tian. Spring 2021 and 2023.

Quantum technology could profoundly change the way that we compute and communicate. In quantum computers, the basic logic element is a quantum bit (qubit) that functions under the law of quantum mechanics and can be in a superposition to become the Schroedinger's cat. Quantum parallelism and entanglement give us the ultimate power.





We will discuss

- Quantum computing and algorithms: quantum Fourier transformation, quantum search
- How to build superconducting qubits and perform quantum logic gates
- Recent progress in: quantum simulation, adiabatic quantum computing, sampling, quantum supremacy, and hybrid systems

- Most topics are related to my research – it's going to be fun
- Emphasis: AMO/CM. Prerequisite: PHYS 137 or instructor approval. Conjoined with 292/272.

PHYS 112: Statistical Mechanics

- Who may find it useful: Students planning to take soft matter/biophysics track or CM/AMO track.
- Offered in the spring semester every year. Spring 2020 instructor: Chih-Chun Chien.
- Co-convened with PHYS 212: Statistical Mechanics (Graduate core course)
- Content: Probability theory, classical equilibrium and nonequilibrium statistical mechanics, quantum equilibrium statistical mechanics, statistical estimations and tests.
- Evaluation: Two midterms, one final exam, one team research project.
- Emphasis: none, currently. Pre-reqs: PHYS 108.

PHYS 116: Mathematical Methods

- Who may find it useful: students planning to go to graduate school, students interested in theoretical or computational research.
- Offered: Fall 2019, Fall 2021. Next instructor: Carrie Menke.
- Content: linear algebra, partial differential equations, Fourier transforms. Applications to relevant physics problems. Computational exercises.
- Emphasis: mathematical physics. Pre-reqs: PHYS 9, MATH 23 and 24.

- Planned for the future: a second class on numerical methods for physics (Strubbe will teach), fall 2020? PHYS 116 would be pre-requisite.

PHYS 104: Biophysics

- Offered: Fall 2020, Fall 2022. Next instructor: Jing Xu.
- Content: diffusion, fluids, entropic forces, motor proteins, enzymes, nerve impulses, networks and evolution.
- Co-convened with graduate PHYS 204.
- Emphasis: biophysics. Pre-reqs: PHYS 8, PHYS 9.

PHYS 109: Soft Matter

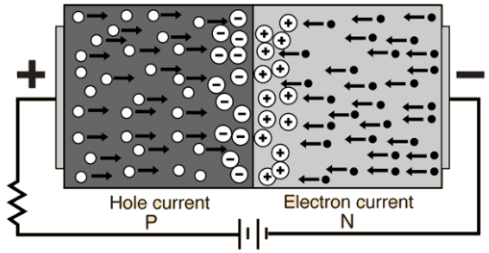
- Offered: Spring 2021, Fall 2023. Next instructor: Linda Hirst.
- What is soft matter? liquid crystals, polymers, colloids, surfactants, biological examples, … Use the tools of classical and statistical mechanics to understand.
- “Hard condensed matter”: PHYS 141. Semiconductors, metals, rocks, ceramics, glass.
- Co-convened with graduate PHYS 209.
- Emphasis: AMO/CM. Pre-reqs: PHYS 108.

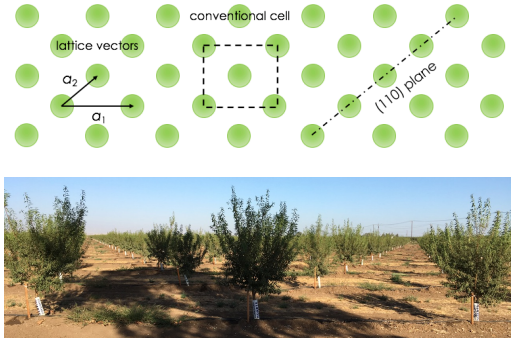
PHYS 141: Condensed-Matter Physics
Prof. David Strubbe, fall 2019 and fall 2021

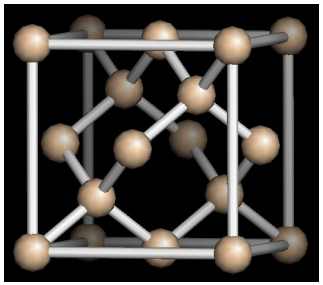
Topics: crystal structure, bonding, amorphous materials, X-ray scattering, magnetism in materials, phonons (vibrations), electronic band structure, heat capacity, electronic and thermal conductivity, metals, semiconductors, devices (solar cell, LED, transistor, thermoelectrics)

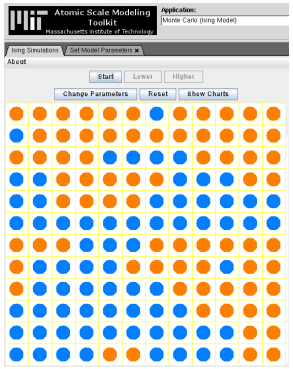
Applications: solar energy, electronic devices, quantum computing, superconductors, spintronics, topological insulators, nanotechnology

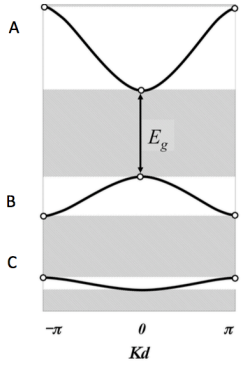
Special features: computational exercises with nanoHUB.org to illustrate concepts; conjoined with graduate PHYS 241

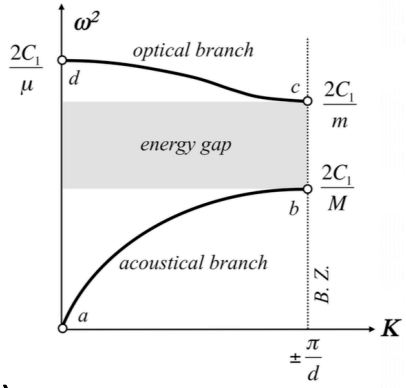












Emphasis track: AMO/CM. Pre-reqs: PHYS 10. (PHYS 108 and PHYS 137 helpful)

Phys148: Modern Optics

- Offered: Fall 2020, 2022, …
- Instructor: Prof. Scheibner
- Course content:
  - Geometrical optics,
  - radiative transfer,
  - partial coherence,
  - lasers,
  - quantum optics

Lab component: Lab visits and/or mini internships

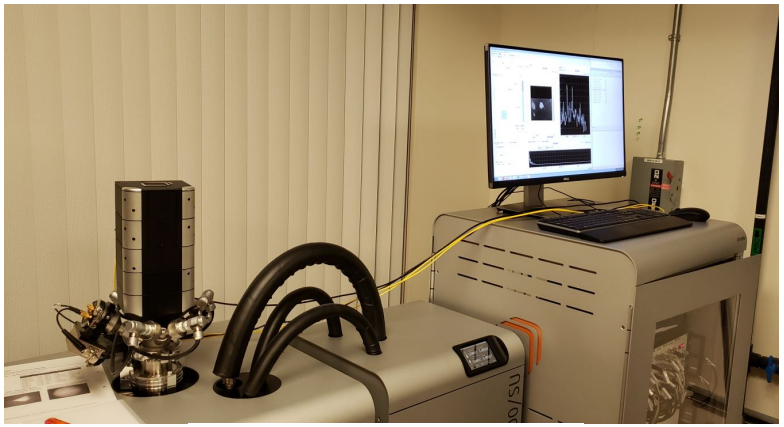
(Excursion: Advanced Light Source, National Ignition Facility, or Lick Observatory)

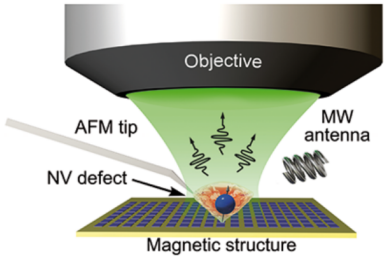
- Course Content cont.: (special topics)
  - Nano-photonics
  - Special light sources
  - Imaging technologies
    - Real world applications (medical, security,..)
    - at extreme scales
      - Beating the diffraction limit
      - Imaging distant astronomical objects
  - Spectroscopy techniques
    - Raman-scattering
    - Photoluminescence
    - Magneto-optics
    - Ultrafast spectroscopy
    - Single photon counting

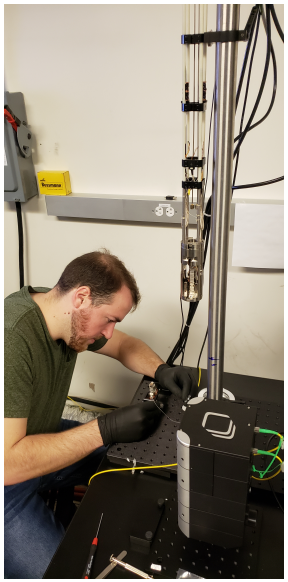
Emphasis track: AMO/CM. Pre-reqs: PHYS 9, MATH 23 and 24.

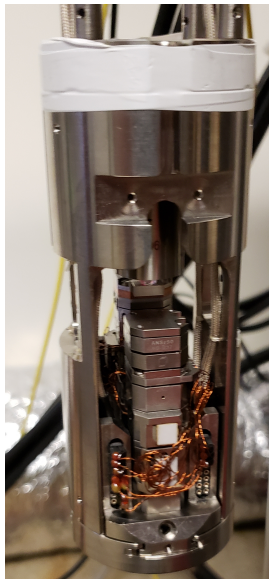
Lab internship example:

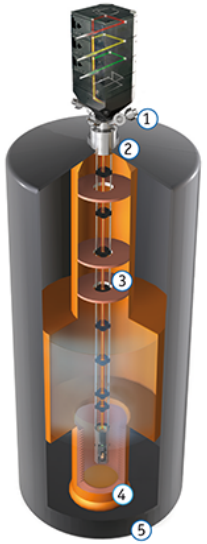
Hands-on Quantum Materials Lab: temperatures 4-300 K, magnetic fields 0-9 T atomic force/confocal microscopy system











1. LT and HV compatible feedthroughs
2. vacuum window
3. microscope insert
4. superconducting magnet (optional)
5. liquid He dewar (optional)

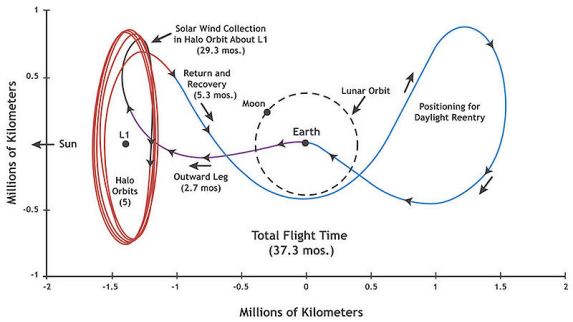
Funded by DoD, Award-#: W911NF-17-1-0452

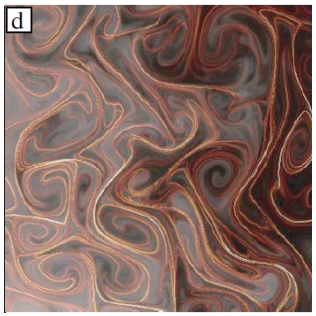
PHYS 180: Nonlinear Dynamics

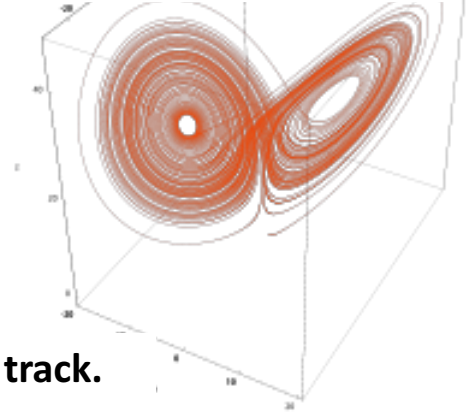
Instructor: **Kevin Mitchell**
Next offering: **Spring 2021**

Prereqs: **PHYS 8/8H/18, MATH 23, MATH 24**
Counts as a "crossroads" course

Overview: Most processes encountered in nature are inherently nonlinear. This course introduces the main topics of low-dimensional nonlinear systems, with applications to a wide variety of disciplines, including physics, engineering, mathematics, chemistry, and biology. Specific topics include maps and flows in one and two dimensions, phase portraits, bifurcations, chaos, and fractals.







Particularly good for students in the Mathematical Physics track.

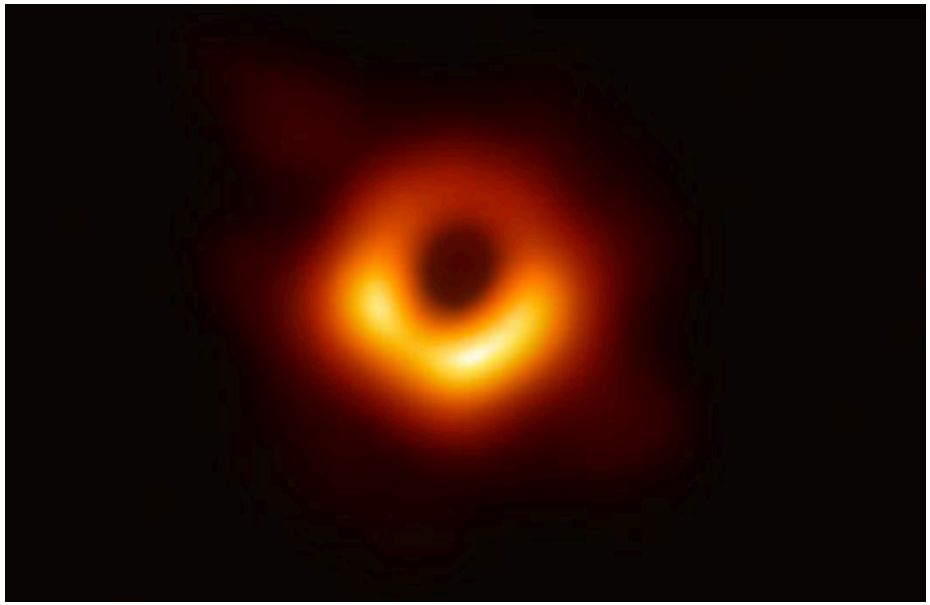
PHYS 192: (Special Topics in Physics) 21st Century Physics
Prof. Roland Winston, fall 2019, 2020, 2021

This course will review some of the most exciting topics in physics in this millennium:

- Black holes
- Gauge theory
- Higgs Boson
- entangled states in quantum mechanics

Conjoined with grad PHYS 292.

Some familiarity with quantum mechanics and relativity would be helpful, but the main prerequisite is the willingness and desire to learn contemporary physics and be open to new ideas.



Darkness Visible, Finally: Astronomers Capture First Ever Image of a Black Hole

Astronomers at last have captured a picture of one of the most secretive entities in the cosmos.

Event Horizon Telescope Collaboration, via National Science Foundation

Emphasis track: none. Pre-reqs: PHYS 9, 9H, or 19.

Pending engineering capstone option

- Current requirement:
  PHYS 195/196 senior thesis: research with a physics faculty member
  Recommended for those wanting to go to graduate school.

- New option:
  ENGR 193/194 Engineering Capstone Design: physics-related project
- Coordinated by Prof. Alejandro Gutiérrez from engineering
- PHYS 160 (modern physics lab) has been added as a pre-requisite
- May be of interest for students wanting to go into industry or engineering

- This will be an option for physics majors starting fall of 2020.