A Sneak Peek at the Universe
Physics-UA 800

Professors
Gregory Gabadadze
Frank Moscatelli

A course to help students contemplating, or intending, a major in Physics acquire a modern, big-picture of how the universe works from its smallest to its largest scales. The emphasis will be on current frontier areas of physics research. Math skills up to, but not including, calculus will be assumed.

Meeting Time: M/W 4:55 – 6:10

Location: Rm. 1045, 726 Broadway

Professors’ Locations:
G. Gabadadze, Rm 1031, 726 Broadway
F. Moscatelli, Rm 838, 726 Broadway

Course Assistant: Nitya Doddamane

Recitations: TBA

Professors’ Office Hours: Moscatelli: Tu, Th, 1 – 2 PM or by appointment.
Gabadadze: TBA


Topics

Necessary Physics Background
Classical waves and particles
Superposition, interference, wave packets
Electromagnetic waves, spectra
Thermal radiation and applications
Boltzmann factor and Planck’s Law
Statistical physics, ideal gas equation of state

The Strange Quantum World
History, black body, photoelectric effect, Hydrogen spectrum
DeBroglie and matter waves, Bohr atom
Quantum formalism, states, probabilities, measurement
Examples: spin, entanglement, exclusion principle, periodic table,
Helium levels, coherent state, degeneracy pressure, radio astronomy of H 21 cm,

States of Matter on Earth
- Gases, cold atoms, Bose-Einstein Condensates
- Superfluid
- Superconductivity

States of Matter in the Sky
- Plasma, the sun, stars
- Nuclear physics, fusion
- Neutrinos, elementary particles
- White Dwarfs
- Neutron stars

Black Holes
- General relativity, flat vs curved geometry, gravitational waves

Cosmology
- Galaxies and dark matter
- The Hubble Law, expansion
- Dark Energy
- Cosmic microwave background, CMB

The Early Universe
- Big Bang
- Inflation
- Fundamental forces
- Nuclear synthesis; hydrogen and helium
- CMB spectrum
- History and fate of the universe

Examinations

Midterm I: date TBA

Midterm II: date TBA

Final: Monday, 18 Dec. 6:00 – 7:50

Grade composition: Midterms 25% each; final 30%; homework 20%.