PH705 Foundations in Experimental Physics

Credit: 3-0-1-4 Approval: Approved in 1st Senate

Prerequisite: Consent of the faculty member

Students intended for: Ph.D.
Elective or core: Elective Semester: Odd

Course objectives:

To enrich experimental knowledge by studying old experiments that have great impact on physics and also few experiments from frontier research area in physics to gain hand-on experience on advanced experiments in physics.

Course content:

PART-A. Lectures on experiments, which made an impact on physics or lectures on new/modern experiments of current importance to frontier research in Physics. (Lecture Hours: 24)

A1: Great Experiments in Physics:

Starting with Galileo's experiments with motion, the study of 25 crucial discoveries include Newton's laws of motion, Chadwick's study of the neutron, Hertz on electromagnetic waves, and more.

A2: Top 10 beautiful experiments:

1. Young's double-slit experiment applied to the interference of single electrons
2. Galileo's experiment on falling bodies (1600s)
3. Millikan's oil-drop experiment (1910s)
4. Newton's decomposition of sunlight with a prism (1665-1666)
5. Young's light-interference experiment (1801)
6. Cavendish's torsion-bar experiment (1798)
7. Eratosthenes' measurement of the Earth's circumference (3rd century BC)
8. Galileo's experiments with rolling balls down inclined planes (1600s)
9. Rutherford's discovery of the nucleus (1911)
10. Foucault's pendulum (1851)

Others experiments:

1. Archimedes' experiment on hydrostatics
2. Roemer's observations of the speed of light
3. Joule's paddle-wheel heat experiments
4. Reynolds's pipe flow experiment
5. Mach & Salcher's acoustic shock wave
6. Michelson-Morley measurement of the null effect of the ether
7. Röntgen's detection of Maxwell's displacement current
8. Oersted's discovery of electromagnetism
9. The Braggs' X-ray diffraction of salt crystals
10. Eddington's measurement of the bending of starlight
11. Stern-Gerlach demonstration of space quantization
12. Schrödinger's cat thought experiment
13. Trinity test of nuclear chain reaction
14. Wu et al.'s measurement of parity violation
15. Goldhaber's study of neutrino helicity
16. Feynman dipping an O-ring in water

PART-B. Actual Laboratory experiments (Lecture Hours: 14)

Experiments will be chosen from the list below:

1) Four probe method

2) Michelson Interferometer (white light)

3) Sand piles and rice piles, avalanche distribution

4) X-Ray of an NaCl single crystal

5) Directed percolation - spreading of ink on paper

6) Viscous fingering - effect of viscosity

7) Hall effect

8) Measurement of Band Gap in a semiconductor

9) Construction of a hologram

10) Zeeman Effect

11) Kerr Effect

12) Short noise and Johnson noise - measurement of Boltzmann constant -Absolute zero of temperature and charge of electron

13) Preparation (CVD) and characterization (AFM, STM) of thin films

14) Experiments on photon squeezing, Bose-Einstein condensation, parity-violation inweak interactions

PART-C. Demonstrations in the Experimental Laboratories in our Institute (LectureHours: 18)

References:

1. Firsthand Accounts from Galileo to Einstein- by Morris H. Shamos,ISBN: 0486253465

2. http://physicsweb.org/articles/world/15/9/2

3. Microwave Journal | Date: September 1, 1991 | Author: Webb, Denis C.; Nisenoff, M.

4. ‘High temperature superconductivity space experiment (HTSSE)' Authors: NisenoffM.; Gubser D.U.; Wolf S.A.; Ritter J.C.; Price G.Source: SuperconductorScience and Technology, Volume 4, Number 9, 1991, pp. 449-452(4).

5. Very high resolution Photoelectron spectroscopy, Stephan Hufner(ed.), 2007.