# 

For the complete bibliography with references as well as an explanation of the classification scheme go to:

[Demonstration Bibliography](http://physicslearning.colorado.edu/Pira.asp)

The **demonstration name** listed in the bibliography is either the name listed on the reference or, if none is given, a simple descriptive name. In cases where there are several common names for a demonstration, the committee has chosen a preferred name.

The **description** is very brief. It is not intended to be a summary of the reference. One sentence is, in general, sufficient to describe the unique characteristics, if any, of an item. Each source has a unique numbering format. These unique formats are used identify references in the Bibliography.

The formats for the **reference** column and links to the sources are listed below:

|  |  |
| --- | --- |
| **Reference** | **Source** |
| M-1 | [Sutton](http://physicslearning.colorado.edu/PiraHome/Sutton/Sutton.htm) |
| Ma-1 | [Freier & Anderson](http://www.aapt.org/Store/description.cfm?ID=OP-40&Category=All&Type=Print%20Products&Level=All&Keywords=&Site=) |
| M-1d | [Hilton](http://www.abebooks.com/servlet/SearchResults?an=wallace+hilton&y=0&tn=Physics+Demonstration+Experiments&x=0) |
| 8-2.8 | [Meiners](http://www.amazon.com/exec/obidos/tg/detail/-/0471067598/qid=1114018608/sr=1-2/ref=sr_1_2/002-3048814-4251265?v=glance&s=books) |
| M-108 | [Dick & Rae](http://physicslearning.colorado.edu/Pirahome/index.htm) |
| 1A 12.01 | [University of Minnesota Handbook](http://groups.physics.umn.edu/demo/old_page/) |
| AJP 52(1),85 | [American Journal of Physics](http://scitation.aip.org/ajp/) |
| TPT 15(5),300 | [The Physics Teacher](http://scitation.aip.org/tpt/) |
| Disc 01-01 | [The Video Encyclopedia of Physics Demonstrations](http://www.physicsdemos.com/) |
| PIRA 200 | [Physics Instructional Resource Association](http://physicslearning.colorado.edu/Pirahome/pira200/pira200.htm) |
| PIRA 500 | [PIRA 500](http://physicslearning.colorado.edu/Pirahome/index.htm) |
| PIRA 1000 | [PIRA 1000](http://physicslearning.colorado.edu/Pirahome/index.htm) |

**Each demonstration is listed in only one location, even if** **it is commonly used to illustrate several concepts.**

11/20/2023

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[Laser Polarization and Intensity - Modes 40](#_Toc78185462)

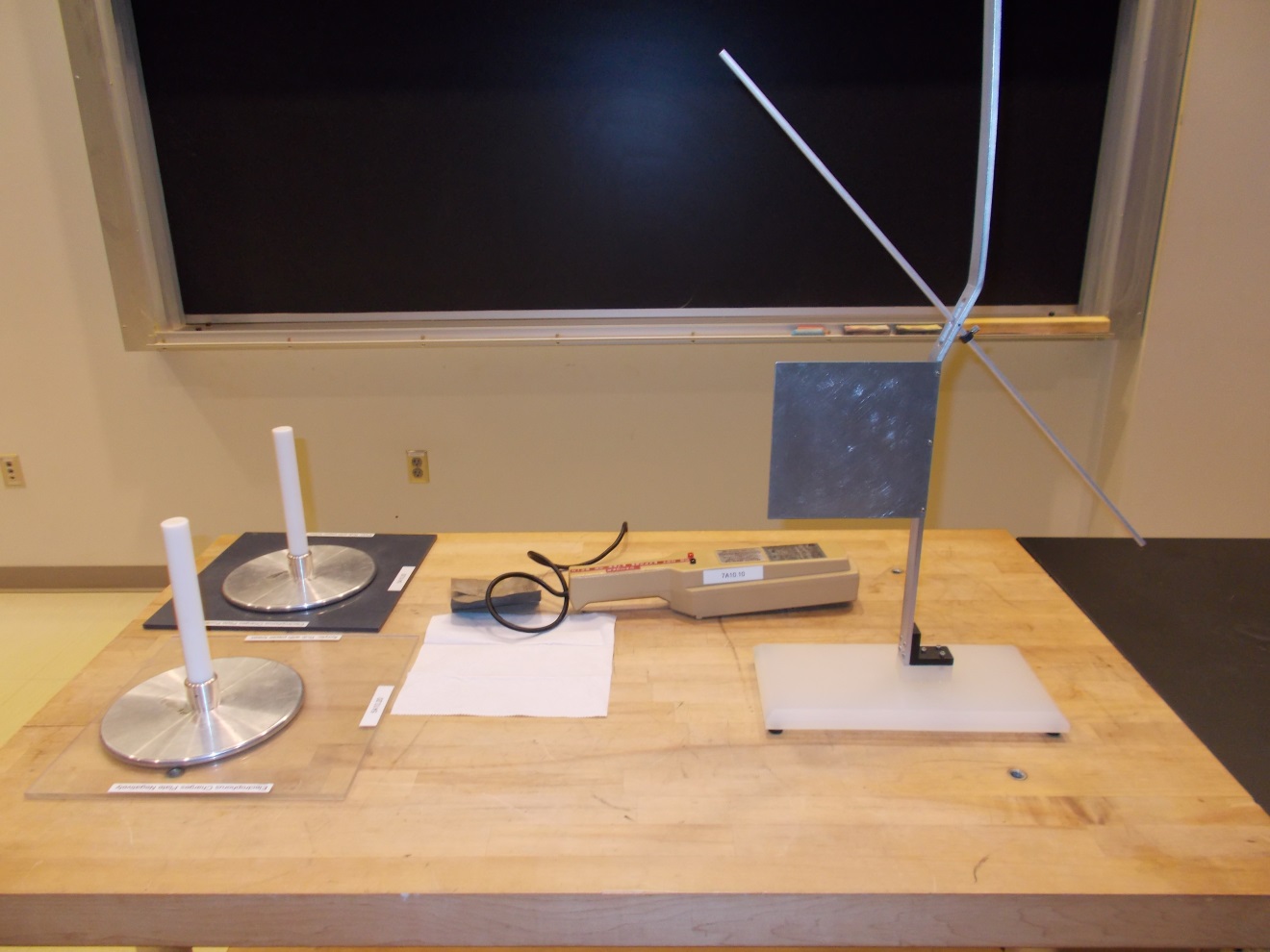
[Optical Resonator 40](#_Toc78185463)

|  |  |  |
| --- | --- | --- |
| THERMODYNAMICS | 4D10.10 | KINETIC THEORY |
| ****Brownian Motion**** | | |
| Brownian Motion Cell | | |
|  | | |
| 4d1010 | Observe the motion of particles in a smoke cell through a microscope. The balls are about 1 micron in diameter. Put a drop of the solution on a slide then place a cover slide on top of it. Use a drop of oil with the oil immersion objective. The well slide works best (less systematic movement); if you use it, place a drop in the well then dilute it with water. | |

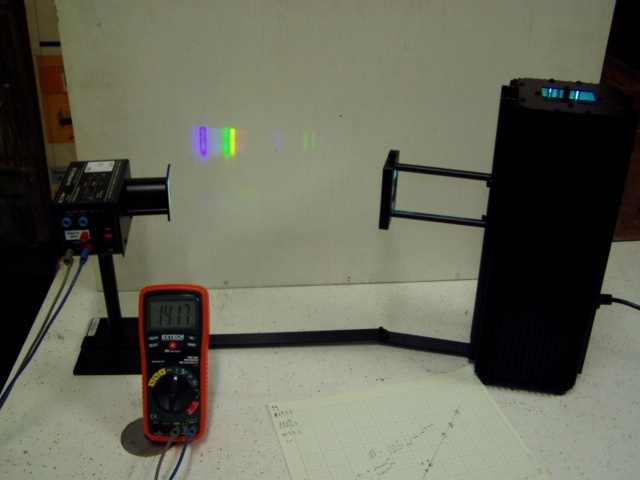


Location: Ga3

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7A10.10 | QUANTUM EFFECTS |
| ****Photoelectric Effect**** | | |
| Discharging Zinc Plate | | |
|  | | |
| 7a1010 | A polished (with fine abrasive paper) zinc plate sits atop an electroscope. Charge the electroscope with a rod. Turn on the UV light. Expose the zinc plate to the UV rays. Do not turn the UV light towards the students. Compare what happens when you charge the plate positively with what happens when you charge it negatively. | |

Location: Ka2, Gc1, Gd1

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7A10.30 | QUANTUM EFFECTS |
| **Photoelectric Effect** | | |
| Stopping Potential | | |
|  | | |
|  | h/e apparatus. Measure the stopping potential of the lines of the mercury spectrum with a photodiode. | |

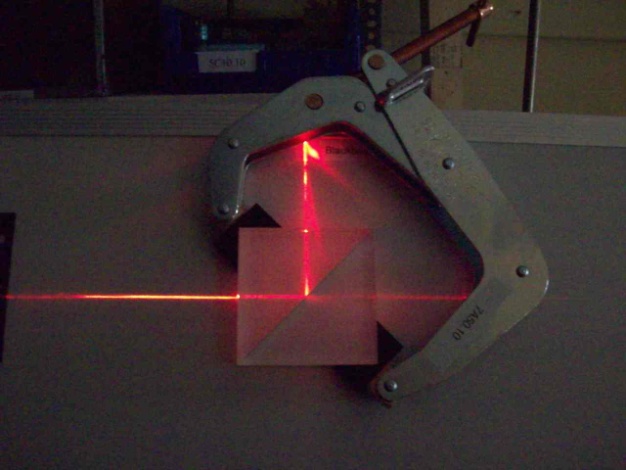
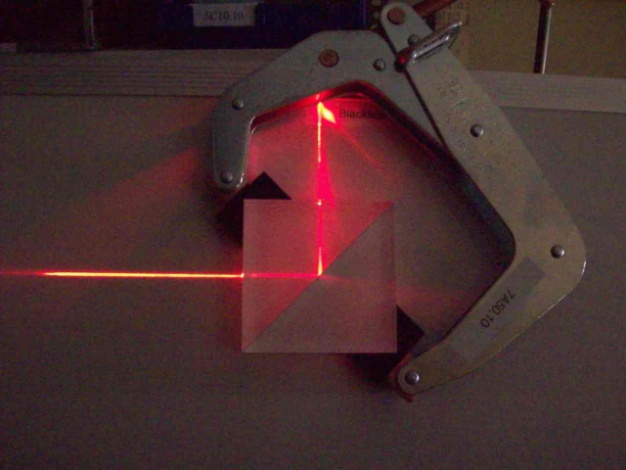
Location: Ka2

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7A15.10 | QUANTUM EFFECTS |
| ****Millikan Oil Drop**** | | |
| Millikan Oil Drop Experiment | | |
|  | | |
|  | The oil drop experiment. | |



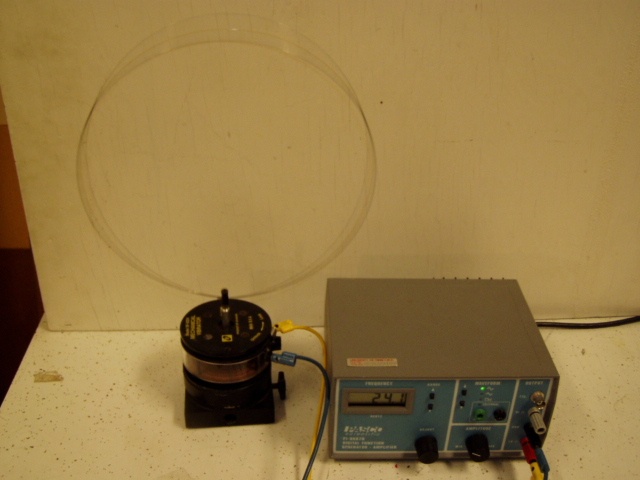
Location: Ka3

|  |  |  |
| --- | --- | --- |
| **MODERN PHYSICS** | **7A50.10** | **QUANTUM EFFECTS** |
| ****Wave Mechanics**** | | |
| Frustrated Total Internal Reflection | | |
|  | | |
|  | Squeeze two right angle prisms together using a C Clamp and some notched blocks of wood while directing a beam of light at the interface. Use the blackboard optics equipment for this. | |

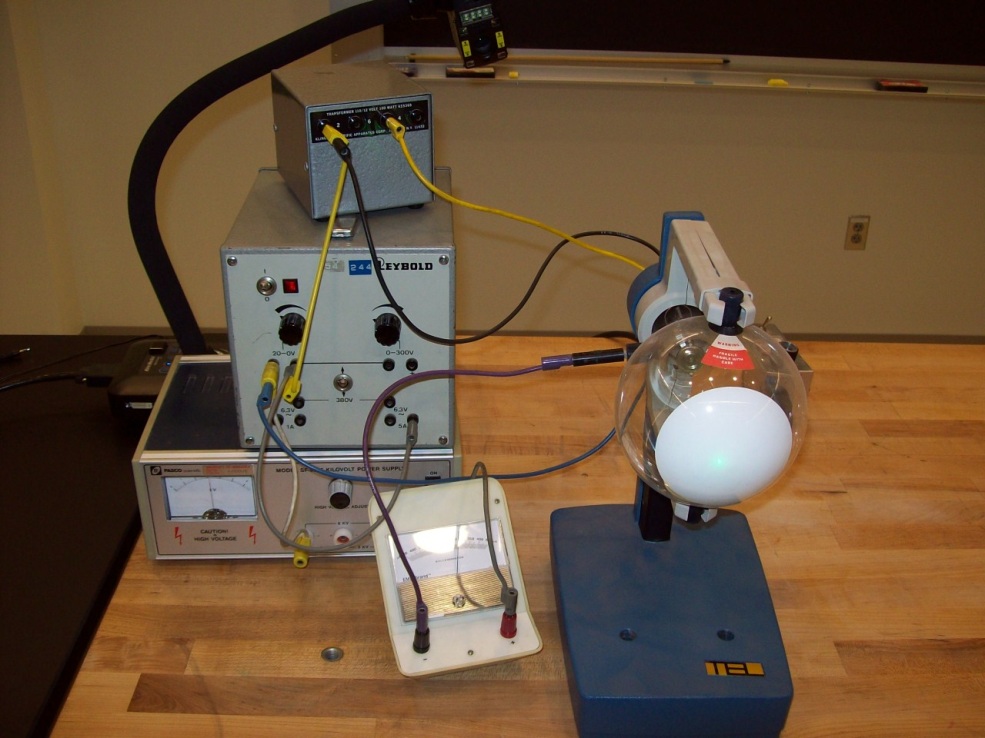


Location: Blackboard Optics Cart

|  |  |  |
| --- | --- | --- |
| **MODERN PHYSICS** | **7A50.40** | **QUANTUM EFFECTS** |
| **Wave Mechanics** | | |
| Vibrating Circular Wire | | |
|  | | |
| 7a5040 | The PASCO signal generator drives the PASCO mechanical vibrator. The three node resonance is at 20Hz. Turn up the amplitude after finding the resonance. Other resonances are at 60, 100, and 140 Hz. Pin the wire at 180 degrees from the mechanical vibrator to get full numbers of waves. | |

Location: Ka3, Ec2, Fb4

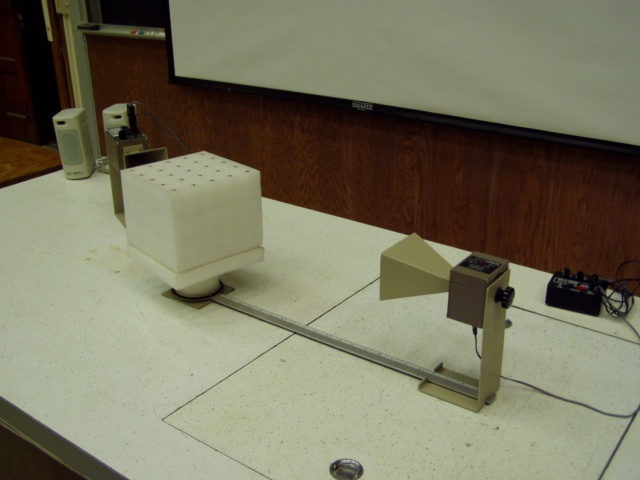
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| --- | --- | --- |
| MODERN PHYSICS | 7A60.10 | QUANTUM EFFECTS |
| ****X-ray and Electron Diffraction**** | | |
| Electron Diffraction | | |
|  | | |
|  | Rings or spots diffraction patterns can be shown to the class using a TV camera. The beam and bias will already be adjusted. Turn up the HV until the pattern appears. Do not let the current exceed 170 microamps. Turn down the HV when you are done. The small jack at the back has a negative bias (20 V or so) on it. The filament voltage is 6.3 V and one side is connected to the common ground for the HV and negative bias supply. | |





Location: Ka4

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7A60.50 | QUANTUM EFFECTS |
| **X-ray and Electron Diffraction** | | |
| Microwave Bragg Diffraction | | |
|  | | |
|  | Microwave diffraction is observed from a crystal model made of steel ball bearings mounted in a Styrofoam cube. | |

Location: Ia7, Ka5

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7A60.95 | QUANTUM EFFECTS |
| **X-ray and Electron Diffraction** | | |
| Sample X-Ray Tube | | |
|  | | |
|  | Show a large X-ray tube. | |

Location: Kd1

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7A70.20 | QUANTUM EFFECTS |
| ****Condensed Matter**** | | |
| Quantum Levitation and Flux Pinning | | |
|  | | |
|  | A thin film superconductor levitates over a magnet pinned in place by flux quanta. | |

Location: Ga5

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7A70.40 | QUANTUM EFFECTS |
| **Condensed Matter** | | |
| Electron Conduction Model | | |
|  | | |
|  | The Air Cushion Table is used to show bound charge carriers in an insulator; a free charge in an insulator, conduction in a semiconductor (N type and P type. Air Cushion Table manual: 2.4.9, 2.4.10, 2.4.11, 2.4.12, 2.4.13. | |

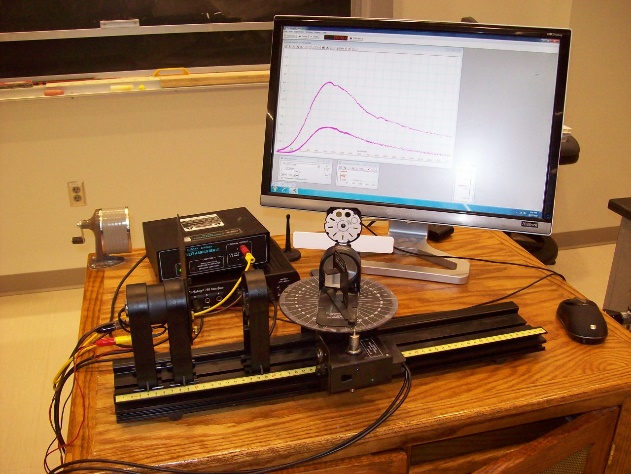
Location: Ga5

|  |  |  |
| --- | --- | --- |
| OPTICS | 6B40.20 | PHOTOMETRY |
| ****Blackbodies**** | | |
| Hole in a Box | | |
|  | | |
|  | A box that is painted black has a hole in a hinged door. The hole appears blacker than the box, When the door is opened, you see the box is actually painted white on its inside surfaces. Use an infrared camera to look at a hole in a heated aluminum block (100 C). | |



Location: Jb2, Fc5, FLIR Cabinet

|  |  |  |
| --- | --- | --- |
| OPTICS | 6B40.40 | PHOTOMETRY |
| **Blackbodies** | | |
| Black Body Spectrum | | |
|  | | |
|  | A spectrometer and bolometer connected to Science Workshop is used to record the spectrum from an incandescent bulb at various temperatures. The second version uses a bulb, grating, variac and TV camera. Use fixed focus and exposure. Change the variac setting to show the spectrum shift. | |



Location: Science Workshop Cabinet, Optics Table Cabinet, Kb2, Ib2

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7B10.10 | ATOMIC PHYSICS |
| ****Spectra**** | | |
| Student Gratings and Line Sources | | |
|  | | |
| 7b1010 | Pass out the 1"x1" gratings to the students. These have 13,400 lines per inch. Turn on one of the light sources. There is a single filament white light source and three discharge tubes, Hg, He, and Ne. The Didymium filter can be placed in front of the white light source to show selective absorption. Also shown is a spectrometer with a TV camera showing hydrogen Balmer lines and the Ride Tide USB spectrometer showing the line spectrum on the computer. Use the door lite curtains to darken the room. | |



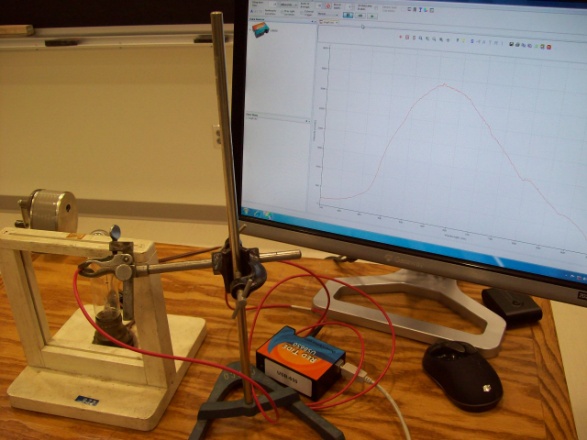
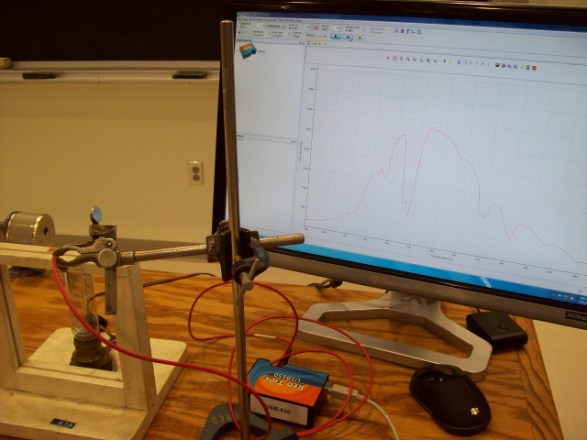
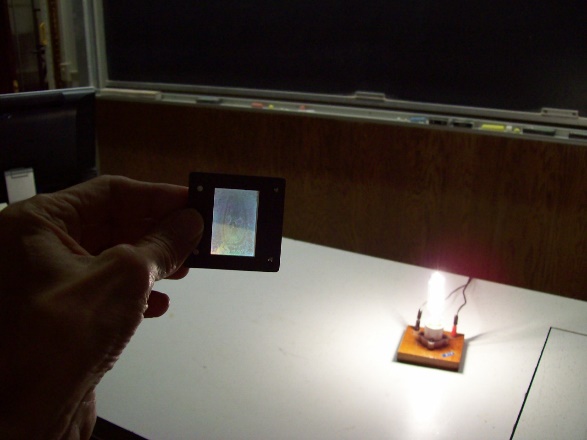
Location: Ka1, Kb2

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| --- | --- | --- |
| MODERN PHYSICS | 7B10.10a | ATOMIC PHYSICS |
| **Spectra** | | |
| Spectrum With TV Camera | | |
|  | | |
|  | A TV camera, grating and monitor are used to display a spectrum. Use fixed focus and exposure. | |



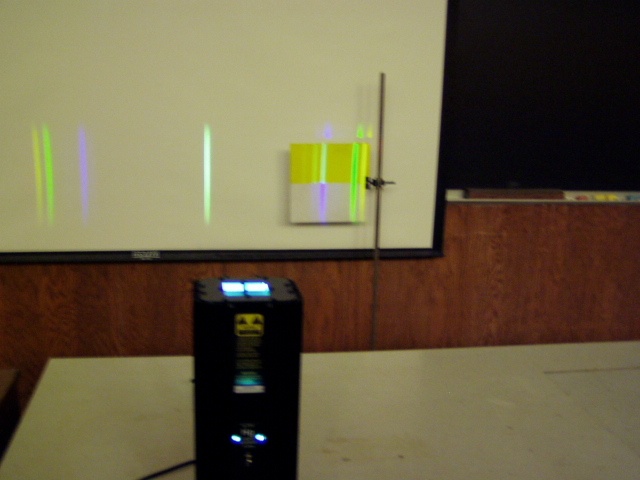
Location: Ka1, Kb2

|  |  |  |
| --- | --- | --- |
| OPTICS | 7B11.65 | ATOMIC PHYSICS |
| ****Absorption**** | | |
| Band Absorption Spectrum | | |
|  | | |
|  | Didymium glass is used to show band absorption. The Reveal 60 bulb is used with both a grating and the Red Tide spectrometer to show the bands. An ordinary bulb is shown for comparison. Use fixed focus and exposure for the TV camera. | |



Location: Jb2, Ib1

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| --- | --- | --- |
| MODERN PHYSICS | 7B13.42 | ATOMIC PHYSICS |
| ****Resonance Radiation**** | | |
| Projected Mercury Spectrum | | |
|  | | |
|  | The UV lines of the projected spectrum are made visible using a fluorescent board | |

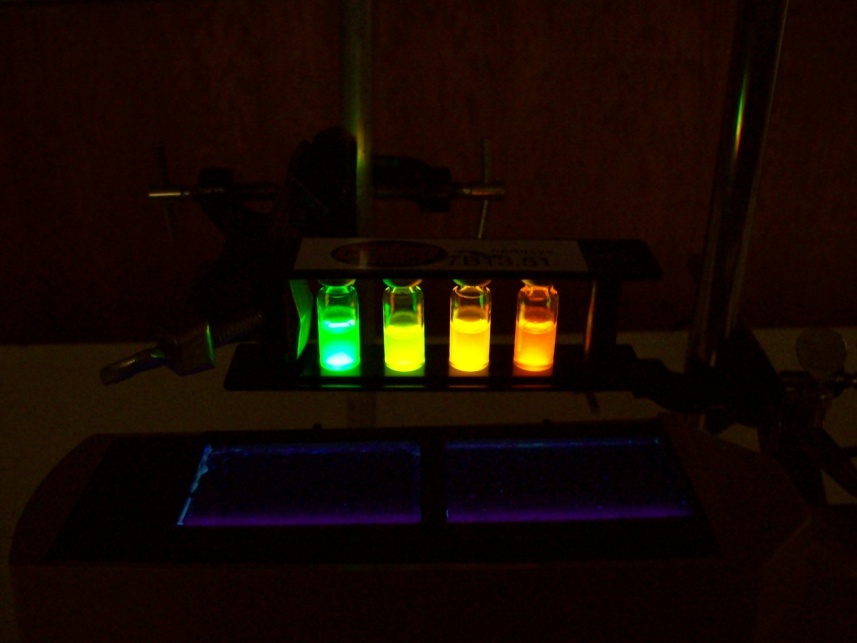
Location: Ka2

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| MODERN PHYSICS | 7B13.50 | ATOMIC PHYSICS |
| **Resonance Radiation** | | |
| Fluorescence and Phosphorescence | | |
|  | | |
|  | Fluorescent and phosphorescent materials are shown with a black light. | |



Location: Kb3

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7B13.51 | ATOMIC PHYSICS |
| **Resonance Radiation** | | |
| Particle in a Box | | |
|  | | |
|  | Nanobeads (quantum dots) of 4 different sizes in solution fluoresce when illuminated with a UV light. The energy calculation is based on the calculation of a particle in a potential sphere (see the appendix of the instructions for more info).  The quantum "sphere" or "box" is not empty but filled with a semiconductor.  In order for the students to understand this they must first start with the derivation of a 1D particle in a box calculation, the sphere is basically the same physical concept with a different mathematical geometry.     Using the Red Tide spectrometer the peaks from the different fluorescing vials can be measured and compared with theory. | |



Location: Kb3

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| --- | --- | --- |
| MODERN PHYSICS | 7B30.45 | ATOMIC PHYSICS |
| ****Ionization Potentials**** | | |
| Photoionization in a Glow Lamp | | |
|  | | |
|  | In a glow lamp, when the potential across it is high enough, electrons will ionize the gas. The positive ions get attracted to the cathode and shield the electrons from the anode in the sense that there's a much reduced electric field beyond the cathode glow and Faraday dark space, so the electrons just scatter off of the neutral atoms without imparting much energy to them in that region. Between the cathode and dark space (the cathode fall), the electric field is strong enough to accelerate the electrons to excite the neon atoms causing them to glow they also provide ionizing energy to sustain the glow. If the potential is not high enough, the electrons just scatter off the neutral atoms never gaining enough energy to ionize them or excite them to emit light.  The glow does not come from the ions recombining with electrons, but a level-to-level transition in the neon atoms. The ions just serve to let the electrons accelerate to high enough energy to excite the atoms. So, when you shine the violet laser on or near the cathode when the potential across the tube is below the striking voltage, you're just initiating the formation of the ion cloud, which allows the electrons to attain enough energy in the cathode fall to excite the atoms. If a red laser is used instead, there is not enough photon energy to ionize the neon atoms and the tube remains dark. The tube can also be started by holding an electrically charged rod nearby | |



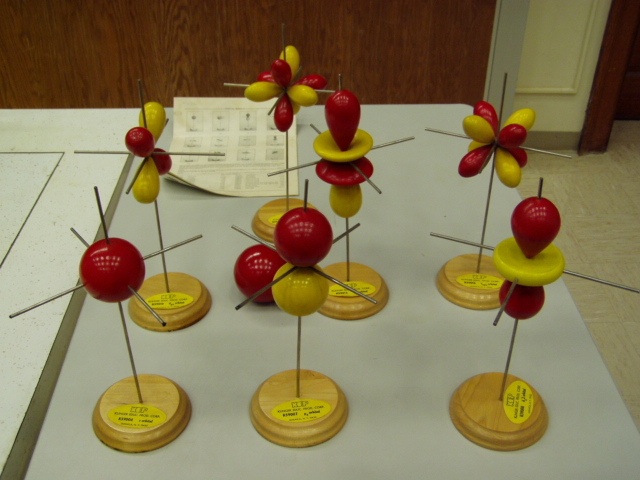
Location: Gc1, Ha5, Jc2

|  |  |  |
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| MODERN PHYSICS | 7B35.75 | ATOMIC PHYSICS |
| ****Electron Properties**** | | |
| Plasma Globe | | |
|  | | |
|  | Commercial plasma tubes are discussed. Bring your hand near the globe. | |



Location: Kb4

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7B50.10 | ATOMIC PHYSICS |
| ****Atomic Models**** | | |
| Electron Orbital Models | | |
|  | | |
|  | A set of Klinger electron orbital models. | |



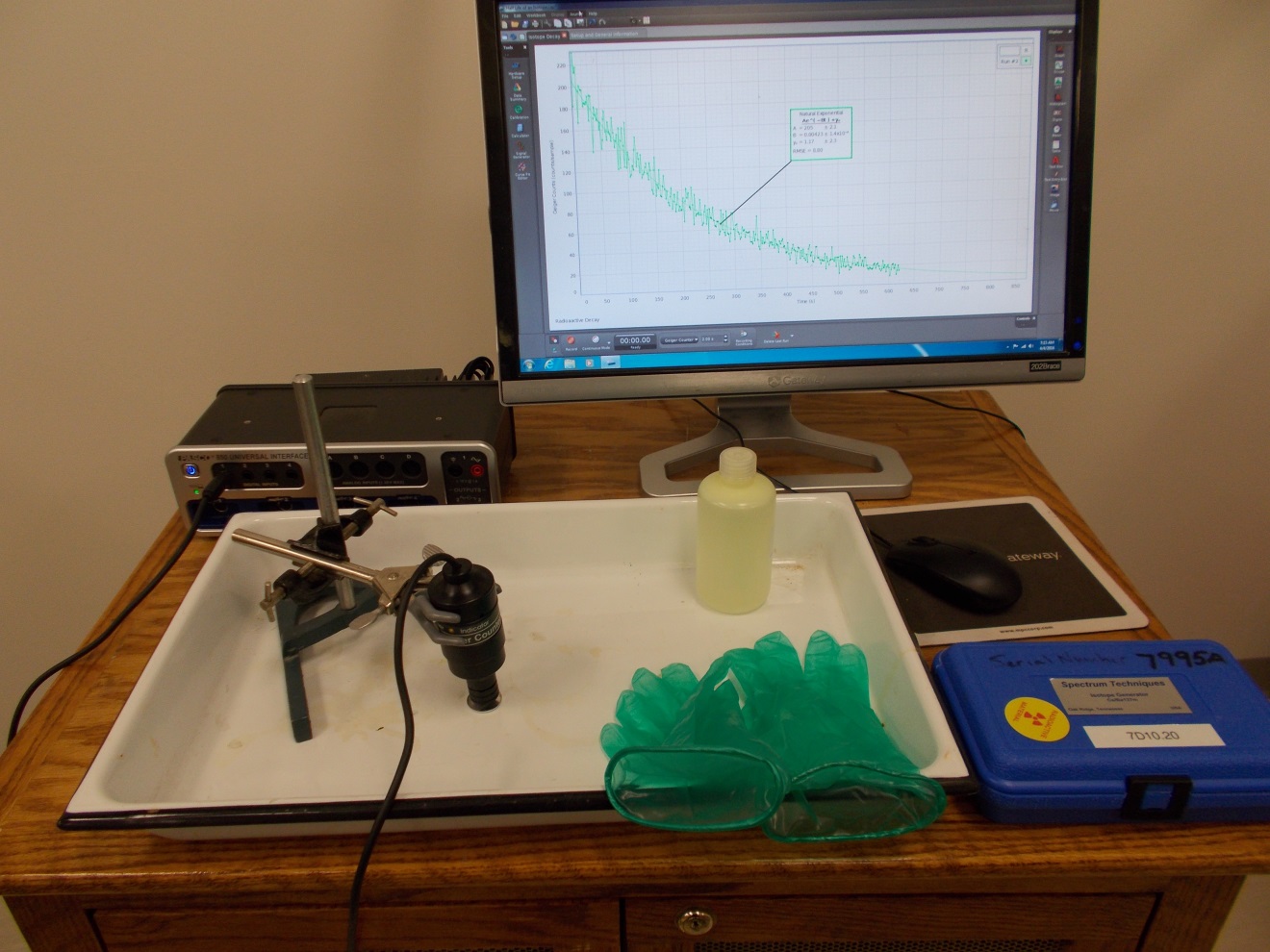
Location: Kb5

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| --- | --- | --- |
| MODERN PHYSICS | 7D10.10 | NUCLEAR PHYSICS |
| ****Radioactivity**** | | |
| Geiger Counter and Samples | | |
|  | | |
| 7d1010 | Turn on the counter and place sample under Geiger Tube. Test to see how distance from the sample affects the count. Place objects like: paper, wood, lead and other items between the source and the tube to check their shielding properties. The alpha paddle can be used to selectively detect alpha particles only. | |



Location: Kb6

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7D10.20 | NUCLEAR PHYSICS |
| **Radioactivity** | | |
| Half Life with Isotope Generator | | |
|  | | |
|  | Follow the instructions on how to “milk” the generator. It is good practice to survey the work area before and after for contamination. The Geiger counter can be connected to the computer and using Capstone (Half Life of an Isotope.cap) one can plot the count rate as a function of time and fit an exponential curve to it.. | |

Location: Kb6

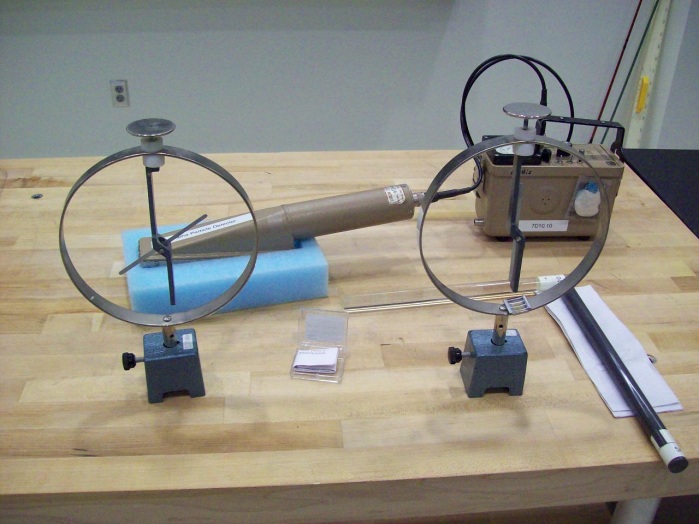
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| --- | --- | --- |
| MODERN PHYSICS | 7D10.33 | NUCLEAR PHYSICS |
| **Radioactivity** | | |
| Half Life of Silver | | |
|  | | |
|  | Measure the half life of silver activated by a neutron source. Use a glove to handle the “hot” silver as it is a beta emitter. Leave as the closest position to the neutron source for a few minutes to activate it. | |



Location: Advanced Lab, Kb6

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| --- | --- | --- |
| MODERN PHYSICS | 7D10.80 | NUCLEAR PHYSICS |
| **Radioactivity** | | |
| Cosmic Rays | | |
|  | | |
|  | Scintillator detectors show the passage of a cosmic ray by coincidence counting. | |

|  |  |  |
| --- | --- | --- |
| Electricity and Magnetism | 5D40.30 | RESISTANCE |
| **Conduction in Gases** | | |
| Discharge an Electroscope | | |
|  | | |
|  | Charge the electroscope either positively or negatively by induction. Then place the Po-210 source (0.5 mCi when new) in the electroscope and watch the electroscope discharge in a couple of seconds. Use safety protocols when handling the source. | |



Location: Kb6, Gc2

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7D20.10 | NUCLEAR PHYSICS |
| ****Nuclear Reactions**** | | |
| Mousetrap Chain Reaction | | |
|  | | |
|  | A 72 mousetraps with corks set on them. Trigger with a single “neutron” (cork). This requires about 20 minutes and nerves of steel to set up. Each trap stores about a joule of energy when set. | |

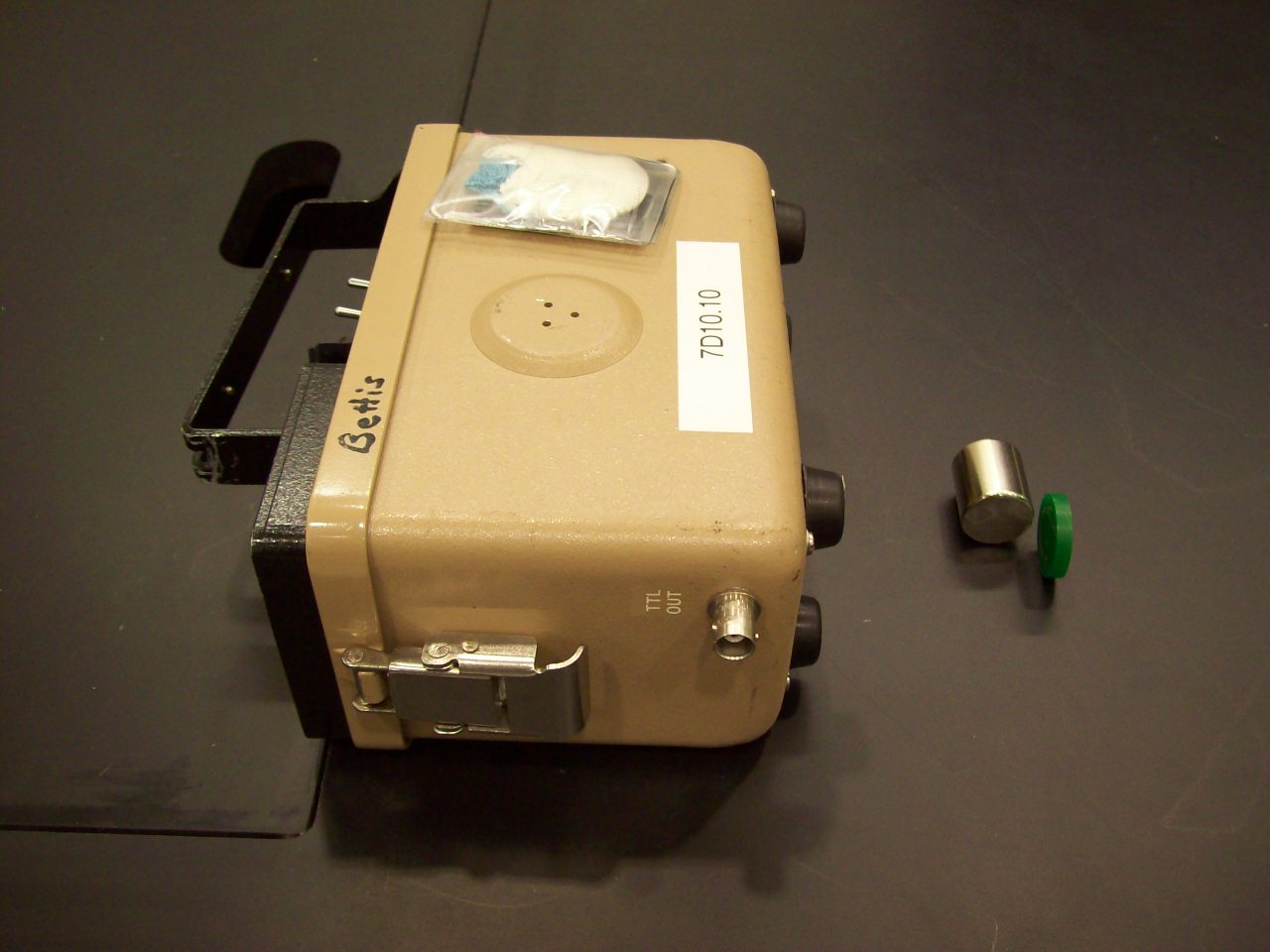


Location: KbT

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7D30.05 | NUCLEAR PHYSICS |
| ****Particle Detectors**** | | |
| Ludlum Detectors | | |
|  | | |
|  | Ludlum hand held alpha, beta and gamma detectors are used with a variety of sources. | |

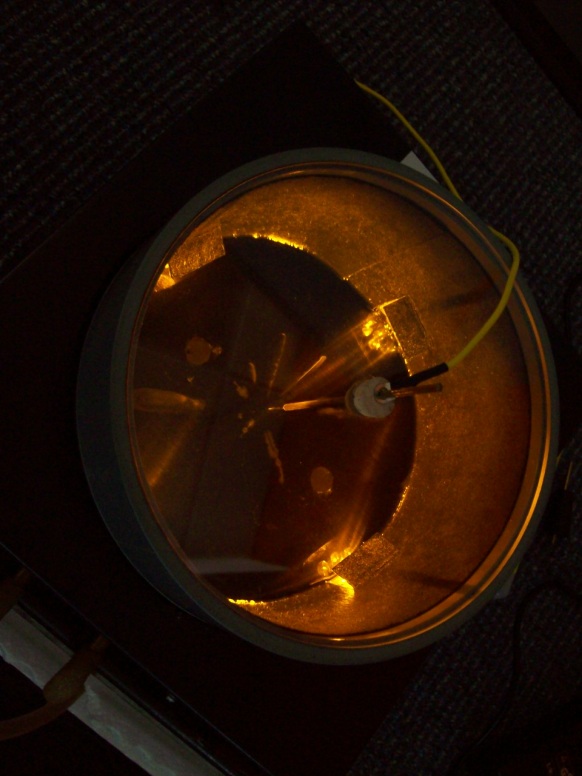
Location: Kb6

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7D30.30 | NUCLEAR PHYSICS |
| **Particle Detectors** | | |
| Deflection of Beta Rays | | |
|  | | |
|  | Turn on the counter and lay it on its side. Open the beta window. Place a beta source nearby, being sure the emitting side is toward the counter. Then bring a strong magnet near the source. The count rate will drop. | |



Location: Kb6, Hd5

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7D30.60 | NUCLEAR PHYSICS |
| **Particle Detectors** | | |
| Diffusion Cloud Chamber | | |
|  | | |
|  | This demo requires advance notice to obtain ice and let the chamber cool (about 40 minutes). Tracks are most impressive if the students are allowed to view individually. The TV works quite well too. Use either ambient cosmic rays or Pb 210 as a source. | |

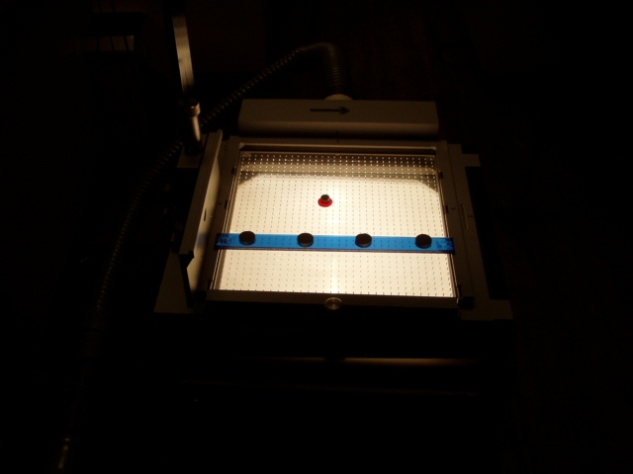


Location: Kc1

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7D50.10 | NUCLEAR PHYSICS |
| ****Models of the Nucleus**** | | |
| Rutherford Scattering | | |
|  | | |
|  | Balls roll down a ramp onto a potential surface to model Rutherford scattering. | |

Location: Kc2

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7D50.14 | NUCLEAR PHYSICS |
| **Models of the Nucleus** | | |
| Rutherford Scattering on an Air Table | | |
|  | | |
|  | The Air Cushion Table is set up with a plastic platform that holds a magnet which repels a magnetic puck that is set in motion beneath it (Air Cushion Manual, 2.5.1). One can also illustrate the scattering of alpha particles through a foil using a foil made of a 1D lattice four magnets that repel a magnetic puck that is set in motion toward it (Air Cushion Table Manual 2.5.2. | |

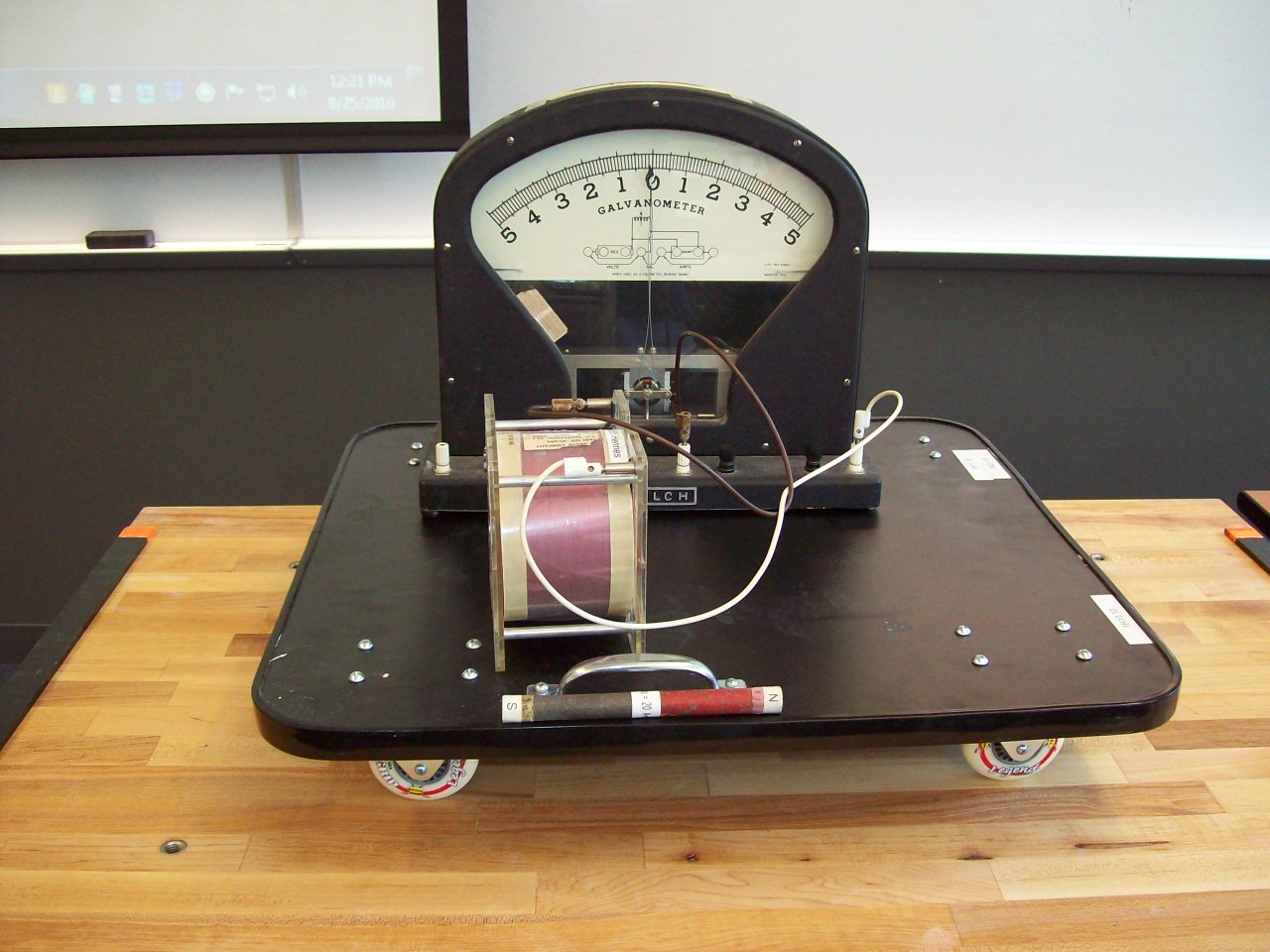


Location: Ga4

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7D50.25 | NUCLEAR PHYSICS |
| **Models of the Nucleus** | | |
| Rutherford Model | | |
|  | | |
|  | The Air Cushion Table is set up with a plastic platform that holds a magnet which attracts a magnetic puck that is set in motion beneath it (Air Cushion Manual, 2.5.3). The moving puck goes into orbit beneath the attracting magnet. | |

Location: Ga4

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| MODERN PHYSICS | 7F10.35 | RELATIVITY |
| ****Special Relativity**** | | |
| Induction Coil Relativity | | |
|  | | |
|  | On using the simple induction coil and galvanometer as a special relativity demonstration: AJP 48(9), 780. | |



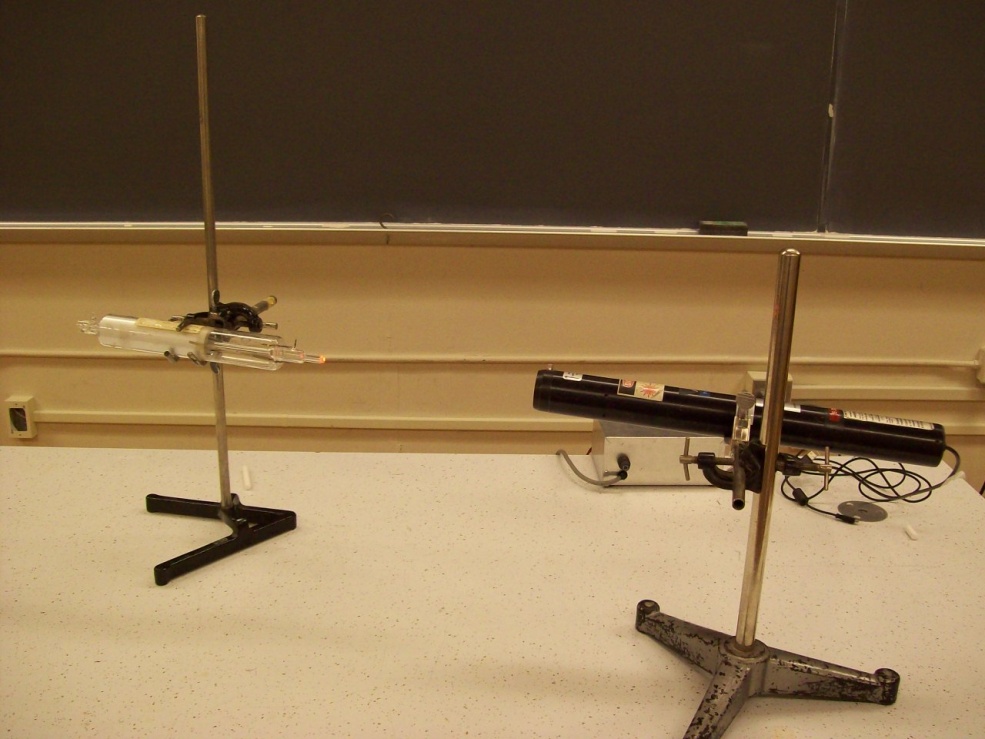
Location: BdT, Hc2, Ib3

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7F10.60 | RELATIVITY |
| **Special Relativity** | | |
| Lorentz Transformation / Time Dilation | | |
|  | | |
| 7f1060 | The Mechanical Universe, chapter 42, and the Hewitt film "Relativistic Time Dilation" | |



Location: Ad5

|  |  |  |
| --- | --- | --- |
| MODERN PHYSICS | 7G20.20 | Lasers |
| ****Laser Polarization and Intensity - Modes**** | | |
| Optical Resonator | | |
|  | | |
|  | Light from a laser is directed down the optical cavity of an old laser tube. The cavity acts as an optical resonator and as the exciting laser warms up, its frequency slews through a spectrum of frequencies. As the frequencies match resonate frequencies in the old tube (it can be thought of as a Fabry Perot interferometer), light is transmitted through it and shows up as a spot on a screen placed down beam from the exit side. Various modes can be observed as the exciting lasers frequency changes. | |



Location: Ia1, Ja6