PHYSICS 441 FALL 2017
RECOMMENDATIONS FOR A FIRST EXPERIMENT

ALPHA INDUCED X-RAY EMISSION
Use a precision solid state detector to study x-ray energy spectra of x-rays from a number of sources. Nuclear x-ray sources are used to calibrate the device to high precision. Then, bombardment from an alpha source is used to stimulate atomic x-ray transitions in a number of materials. The x-ray energies reveal the atomic level spacings with great clarity, and can be used to determine the spectral dependence on atomic number. The characteristic x-ray lines of the elements are then used to determine the composition of unknown samples
ATOMIC AND MOLECULAR SPECTROSCOPY
Examine the quantized energy levels in various atoms and molecules. A commercial fiber-optic-coupled spectrometer is used to examine emission spectra from plasma discharge sources. The results are analyzed quantitatively and allow you to verify the Bohr model for hydrogen, verify the famous spin-orbit splitting in Na, and also to understand the structure and excitation dynamics of the N2 molecule.
FARADAY OPTICAL ROTATION EFFECT
Study the optical rotation of light in refractive media in a magnetic field from a classical and quantum mechanical point of view and its relationship to the Zeeman Effect.
FRANCK-HERTZ EXPERIMENT
Electrons are accelerated and pass through mercury vapor, where they lose energy by inelastic scattering as they excite mercury atoms from the ground state to an excited state. The energy transferred is confirmed to be quantized.
MASS SPECTROSCOPY
Measure the mass, or more correctly the mass/charge ratio, of ionized atoms and other electrically charged particles using an electric quadrupole mass filter.
RAMAN SPECTROSCOPY
Use inelastic photon scattering to study the vibrational and rotational modes of polyatomic molecules.
GAMMA RAY SPECTROSCOPY
Gamma rays are high energy photons created in the decay transitions of radioactive nuclei. The gamma ray energy spectrum measures the energy levels of the nuclear states in the same way that visible line spectra measure atomic structure. In this experiment you measure the spectra of several well-known gamma emitters using a “scintillation counter”, modular electronics, and some histogramming software.
X-RAY ATTENUATION, IMAGING, BRAGG REFLECTION, ETC.
Learn about the production, attenuation, and scattering of x rays. Record x-ray images, CT scans, and verify Bragg reflection.
ZEEMAN EFFECT
Study the splitting of degenerate energy levels in mercury under application of a strong magnetic field. The spectrum is measured using a sensitive Fabry-Perot interferometer, imaged by a computer-controlled CCD. The ability to explain the splitting using the "spin-orbit" coupling is one of the triumphs of atomic spectroscopy, and was also understood by Lorentz as early as 1897 to be evidence that the electron was "in orbit" in the atom.