Electrooptics Student Presentations

Schedule

Tuesday November 27th

7:00 Tania Zaleski

7:12 Ankit Brahmbhatt

7:24 Adnan Alam

7:36 Alexander Glatvchev

7:48 Chirs Sakai

8:00 Jennifer Hall

Thursday November 29th

7:00 Neil Troy

7:12 Chris White

7:24 Pradeep Senanayake

7:36 Reid Greenberg

7:48 Dan Rose

8:00 Peter Relich

Abstracts

Stimulated Brillouin Scattering Phase Conjugation in a High-Peak-Power Glass Laser System
Tania Zaleski

This talk will discuss phase conjugation solutions in high peak power laser systems. The use of non linear optic interactions such as stimulated Brillion scattering and its application as a phase conjugator will be covered.

Silicon Laser Optical Modulators
Ankit Brahmbhatt

Optical modulation has in the past been primarily accomplished by means of the electro-optic effect in which an electric field is varied through a material which subsequently yields changes in its index of refraction. However, recent strides at Intel have been made in modulation in which speeds of 40 Gigabits/second modulation has been achieved with the use of more cost-effective materials; more specifically, with the increased demands of photonic integrated circuits in the fiber optics communications industry, the recent breakthrough with the silicon laser modulator has served as an alternative to the conventional modulation devices. Instead of relying on the Pockels electro-optic effect as is done with most optical modulators, the silicon modulator must rely on the free-carrier plasma dispersion effect. The design utilizes a Mach-Zehnder interferometer with a reverse-biased pn junction in each of the arms. The effect occurs by applying a reverse voltage to the junction whereby the free carriers are pulled from the junction which changes the index of refraction of the silicon. This allows light to be modulated within the silicon which could prove valuable due to the low-cost and ease of production.

Silicon Photonics
Adnan Alam

Data transmission, rate and amount, via conventional electronic interconnection is limited; but high bandwidth, low cost, efficient and reliable optical communication is one of the way through which this limitation can be dealt with. Since silicon is used in the electronics industry, there is a desire for photonics to be siliconized, so that the existing technologies can be employed to develop silicon based devices. The major issue with silicon is that it doesn't emit light due to its indirect bandgap effect. Using stimulated Raman scattering (a nonlinear optical effect) light emission and amplification within silicon can be achieved. Employing silicon-on-insulator (SOI) technology a silicon waveguide is developed, in order to bring light from point 1 to point 2 amplified, and without loss. In order for Raman amplification to take place, the problem of two-photon-absorption effect had to taken care of by having the silicon waveguide within a reversed biased p-i-n junction diode. Therefore, it is shown that even though silicon doesn't emit light, using the Raman amplification and silicon waveguide along with the p-i-n junction diode, the light emission and amplification within silicon is achieved.

Optical Activity/Faraday Rotation Polarimeter for Measuring Blood Glucose
Alexander Glatvchev

This presentation will describe devices and techniques that can be used to measure blood glucose levels for diabetes monitoring. There exist several invasive ways to measure blood sugar levels, including taking direct blood samples. However, those may turn out expensive and inconvenient if patients require daily monitoring. These devices use non-invasive techniques, such as aiming a light beam at the aqueous humor of the eye, which is known to contain blood serum. Blood glucose shows good optical activity/rotation when polarized light is sent through a sample. The devices use optical activity/Faraday rotation to measure polarization changes. The concentration of glucose and the optical path of the beam in glucose contribute to the polarization rotation.

Design and Function of Spectra-Physics QuantaRay Harmonic Generator
Chirs Sakai

The Harmonic Generator (HG) is a water cooled, self contained module that can be added to a Spectra-Physics Quanta Ray Laser system (Nd:YAG Flashlamp pumped, Q-switched). I will show the design features corresponding to critical aspects of efficient Harmonic Generation. Specifically the Physical characteristics of the Crystals used, the mounting and manipulation capabilities of the crystals for Phase Matching and Crystal selection within the device. I will relate the topics of Phase Matching, both angle tuning and crystal type, Conversion Efficiency, Crystal Dimensions and type from the material covered in the course notes, to the specific design of the Spectra-Physics HG.

The Charged-Coupled Device (CCD)
Jennifer Hall

The Charged-Coupled Device, or CCD, invented in 1969 by Boyle and Smith at Bell Labs, is a solid state device that shifts an analog signal (or electric charge) across the device into an output amplifier and readout circuit, converting it into a digital signal. The CCD was primarily used as an imaging device in astronomy after its invention; only becoming commonplace in the field in the late 1970s. Today it is found in nearly all fields of observational science, medical imaging, and digital photography, to name a few. The science of the CCD is based on the unique properties of silicon, the photoelectric effect and manipulation of charges through applied voltages (electric field) to the device. After a brief introduction to the terminology of the CCD, this presentation will cover the construction and design of a CCD; the properties that make it an efficient and reliable visible wavelength imaging device; and the storage and readout of the accumulated charge into a digital signal. The three-phase CCD will be discussed, covering both the surface channel and buried channel CCD. The Charge-Coupled Device is a small, highly sensitive and reliable imaging detector. It requires a low supply voltage and is cheap and simple to manufacture. The CCD is a valuable imaging device and has found its way into many areas of science and society.

Auto-correlator for Ultrashort Pulse Measurements
Neil Troy

As laser pulses enter the ultra-short regime (<100fs) it becomes increasingly important to measure pulse width and pulse shape. The rise-time of CCD's and even of photodiodes can no longer be used to model these on their own and as such we have a need to introduce correlation techniques in a non-linear crystal so as to properly model pulse behavior in this temporal bandwidth.

Bragg Gratings
Chris White

Bragg gratings are periodic structures which can be imposed upon optical fiber cores in order to achieve highly tuned reflection and filtering. As such, they are useful in the manufacture of fiber lasers, telecommunications devices, and sensors. This presentation will cover the optical principles involved in grating operation and design. Additionally some history, manufacturing techniques, the various types of gratings which have been developed, and some key applications will be discussed. In particular, the use of Bragg gratings to form optical cavities in fibers will be explored as well as the potential to produce tunable devices by taking advantage of changes due to thermal or mechanical strain. A brief overview of contemporary developments will also be presented.

Micro-Resonators for Add-Drop Filtering
Pradeep Senanayake

Micro-resonators have found applications in optical communications as add-drop filters. An add-drop filter is used in Wavelength Division Multiplexing (WDM) optical networks to multiplex or de-multiplex a selected channel from a multi-channel input. A channel to be dropped propagates along one waveguide couples into the resonator and couples into the drop waveguide, where the channel is re-routed. The add-drop filter is implemented using a racetrack resonator design as shown in Figure 1 below. The presentation will detail the design, fabrication, and characterization of racetrack resonator based add-drop filter. This work was done in fulfillment of Senior Design at the Electrical Engineering department at SJSU.

Methods for Generating Cylindrically Polarized Light
Reid Greenberg

A light beam which is linearly polarized at any given point, but whose direction of polarization has a spatial dependence which is symmetric with respect to the optical axis is referred to as being "cylindrically" polarized. There are two varieties of cylindrical polarization: radial polarization and azimuthal (tangential) polarization. Research has shown that cylindrical polarization is superior to uniform linear or circular polarization for laser cutting and drilling applications. In this presentation we introduce several methods for generating cylindrically polarized light. One method uses an intracavity resonant grating mirror to generate radially polarized light. In another method, sections of $\lambda/2$ waveplates are attached together to form a novel device called a "spatially varying retarder". A third method generates radially polarized light by exploiting thermally induced birefringence in an Nd:YAG laser crystal.

Driving stimulated Raman transitions using an Electro-optic Modulator
Dan Rose

Trapped atomic ions were first proposed as a viable quantum computing candidate by Cirac and Zoller in 1995. Qubits are stored in stable electronic states of each ion, and quantum information can be processed and transferred through the collective quantized motion of the Coulomb coupled ion crystal. I will briefly report on a technique for driving high-fidelity stimulated Raman transitions in trapped ion qubits. An electro-optic modulator induces sidebands on an optical source, and interference between the sidebands allows coherent Rabi transitions to be efficiently driven between hyperfine ground states separated by 14.53 GHz in a single trapped 111Cd+ ion.

Liquid Crystal Display (LCD) Technology
Peter Relich

The purpose of this discussion is to discuss LCD technology from its roots to its current placement in the consumer industry. From its initial discovery in 1888 to the first watch display in 1972, Liquid Crystals have expanded from the realm of observable phenomena to an industry changing technology. The three types of Liquid Crystals: Nematic, Smectic and Chiral, have unique properties. However, it is the yield to a larger range of environmental conditions that make Nematic crystals the most prevalent liquid crystal used in modern displays. Through a helical alignment of silica based liquid crystal substrates, light can be transmitted through two perpendicularly aligned polarizers. By applying an electric voltage at one end of the liquid crystal substrate layer, the polarization of that side can be altered to prevent different light from propagating through the medium. This simple mechanism is the driving force behind light modulation through LCD pixels in the electronic devices used today. By using a technique employed in older CRTs (Cathode Ray Tubes): stacked rows of alternating Red, Green and Blue pixels, a massive grid of LCD pixels can display millions of colors and contrasts. One significant limitation preventing LCD technology from completely surpassing CRT technology lies in its voltage delivery system; the rate at which specific voltage signals arrive at each LCD pixel determines the refresh rate of the LCD display. As a result, two contrasting delivery mechanisms have emerged: Passive and Active displays. Passive displays send sinusoidal voltage signals to nodes located at the beginnings of all the rows and columns of the LCD matrix. The points where a specific row and column meet denote a pixel, which is then assigned a particular voltage value. Active displays, on the other hand, have transistors assigned to every pixel; this allows a much faster refresh rate and promotes the possibility of a flexible display. It is very difficult and expensive to manufacture a large active display because it requires as many transistors as there pixels; this is why passive displays are still used in televisions and computer monitors. Samsung, a forerunner in LCD production technology, has broken the size barrier of LCDs with a 70 inch monitor. They have also made strides in improving their refresh rate to 8 milliseconds: measured in the scale from which a pixel of a specific contrast cycles from light to dark and back to its original contrast. These gains, as well as the recent shutdown of several CRT manufacturing facilities, indicate that LCD technology will soon dominate the world market as the leading display medium.