Slight Revision of OSSC eNewsletter - Nov 2019

1 message

Donn M Silberman(OpticsAge@gmail.com) <mailer@mail2.clubexpress.com> Sat, Nov 9, 2019 at 1:40 PM
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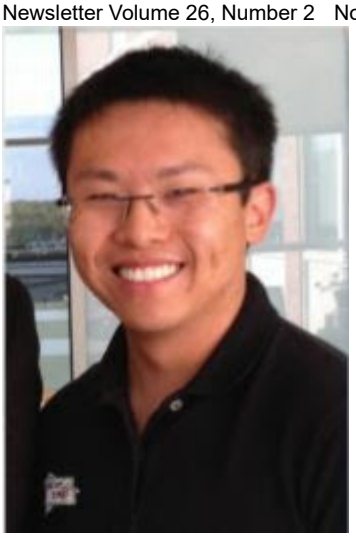
OSSC Optical Society of Southern California

IMAGES Newsletter

Newsletter Volume 26, Number 2 November 2019



In This Issue:

From the President:

Dear OSSC Members,

It's hard to believe, but we are already getting close to the end of the calendar year, with the holidays just around the corner. This also means that the OSSC is starting to gear up into our program year! I want to give a big thanks to Dr. Jon Arenberg of Northrop Grumman for his fantastic talk about the James Webb Space Telescope. By the number of total registrations, it was the second most attended meeting of the decade, only surpassed by our LaserFest Celebration in November of 2010. I especially want to give special thanks to two members, Dr. Martin Hagenbuchle and Martin Seilonen of Northrop Grumman for all of their help organizing the tours. Getting to see the JWST, especially the opportunity to see the foils at tension, is something I will remember for a lifetime, as soon it will be in L2* orbit doing some of the most amazing astronomical observations in the history of mankind.

In addition to such a great opening meeting, the OSSC is proud to once again co-host SPIE Mirror Tech Days, held again at the APC at Northrop Grumman. Over the past three years, Mirror Tech Days has become a year staple for the Southern California optics community. This is our third consecutive year hosting this conference (fourth overall), and I want to express how proud I am of all of the OSSC volunteers that makes it all possible. In the future, I envision the OSSC will be cohosting more conferences and events such as these by partnering with national partners such as SPIE, OSA, and IEEE.

In addition, we will soon release our long awaited OSSC Membership Survey. This will be your opportunity as members to make your voice heard to what you would like to see from our organization. The Survey will be open through the beginning of the calendar year, at that point it will be evaluated by the Board of Directors, and will contribute to a Project 2025 report that will be used as a guide by the organization to ensure the OSSC stays strong and on an upward trajectory in the year to come!

Finally, I want to thank Kevin Romero of Northrop Grumman for being our speaker for the November meeting at CalPoly Pomona. His talk on Optical Payload is going to be fascinating, and one that I know no one should miss! I also want to put out a call to all of the membership to recommend speakers to our Speakers Bureau. Often many of our best talks came from suggestions from our members, or from the membership themselves. We always on the lookout for events at company facilities that will allow our members to go on a tour!

Once again, it is you the membership that makes our organization so special! Wishing everyone a wonderful Thanksgiving!

Sincerely,

Bo Wang

OSSC President 2019-2020

P.S. Please remember to follow the OSSC on our social media platforms! Instagram: **OSSC_1951**, Twitter: **OSSC_1951**, Facebook: **OSSC1951**, LinkedIn: **The Optical Society of Southern California**

*** slight revision -** JWST is going to L2 not L3. L3 is on the far side of the sun – opposite from earth. We wouldn't want to put anything there because a) it is far away and b) you would need a relay to talk to it since you can't transmit thru the sun. (Thanks Martin H.)

Wednesday 13 November

Optical Payloads for Telescopes & Instruments: Innovation & Creativity

by

Kevin Romero, OPIR Systems Architecture,
Northrop Grumman

Abstract: Key parts of this presentation are from Kevin's "Fundamental Principles of Creativity". The talk will focus on methods to break psychological inertia created by our societal norms, history and our own engineering experience. The tools presented can be applied to any problem, to help develop unique

solutions. Although Kevin will focus on Creativity in Engineering, the principles are general and apply to diverse subjects like science and art. Several examples of the use of these principles to break technological roadblocks in optical instrument design will be reviewed.

About our Speaker: Kevin J. Romero is Advanced Programs Principal Systems Architect and Performance Lead for the Proto-type Infrared Payload Project, with Northrop Grumman Aerospace Systems in Azusa, California. He is a recognized expert in the system engineering of space-based imaging and remote sensing systems and has led the Los Angeles Chapter of IEEE Geo-Science Remote Sensing Society for the last four years. His 33 years of experience is broadly based and includes infrared and visible optical space systems test, test systems development, EO system design and orbital operations and anomaly resolution for space-based systems. Kevin has developed over 20 space based EO payload concepts throughout his career.

Networking & Social Hour: 6:00pm
Dinner: 7:00pm
OSSC Business: 7:30pm
Members: $35 by 8 November, $45 after
Non-Members: $40 by 8 November, $50 after
OSSC Student Members: $10 by 8 November, $20 after
Presentation: 8:00pm
Venue: Kellogg West Conference Center at
Cal Poly Pomona
3801 Temple, Pomona
Register Now!
Download the flyer to share with friends and colleagues!

From the Editor:

Hello OSSC members and other readers,

Hello OSSC Members and other Readers,

Now that we are into our OSSC 2019-2002 Academic Year, I want to share two topics with you that are important to all the OSSC Leaders and many more.

1. How to begin volunteering with the OSSC without over committing (and why you should)
2. Educational programs – both formal and informal

Volunteering for the OSSC

The OSSC offers many opportunities for members to learn about participating in running the organization. These learning experiences can be helpful to both the volunteers and the members they serve. As a volunteer, you will learn skills that may be transferable to your daytime job and potentially help you get a promotion or perhaps move to another job if your growth opportunities are not available.

Currently, there are several OPEN volunteer positions on the OSSC Board of Volunteer Leaders. They are: Arrangements Chair, Corporate Memberships, Grant Chair, Jobs Board Coordinator, Newsletter Assistant and Treasurer's Assistant. Any OSSC Member can volunteer for these positions by simply contacting one of the current OSSC Leaders and inquiring. The OSSC Leaders offer one-on-one mentoring for each of these positions so that the new volunteer is completely supported in their time learning how to be successful in their volunteer role. For example; the Assistant Treasurer will work closely with the Treasurer learning how he does the required tasks; the same with the Assistant Newsletter Editor. The new Grants Chair will be mentored by the previous holder of that position and the new Arrangements Chair and Jobs Board Coordinator will be mentored by other OSSC Leaders who know how those tasks need to be completed.

Also, if you would like to volunteer to serve on a committee; each of the "Chairs" has other volunteer members on their respective committees to help complete tasks associated with each committee. Serving on a committee that interests you is a very good way to get a sense of how the OSSC functions.

So check it out and contact any OSSC Board Member to see how you can get involved…..without over-committing.

Educational Programs

The OSSC has supported both formal and informal educational programs for many years. Some of the more senior OSSC Leaders have been advisers and instructors at the Irvine Valley College (IVC) Laser Technology

program for over 25 years. And for the past 10+ years, Dr. Brian Monacelli has been leading that program both administratively as the Principal Investigator on the NSF Grant and as the main instructor. Several years ago, Brian took a position at the Jet Propulsion Laboratory in Pasadena and next summer he will move the program to Pasadena City College. PCC is welcoming this program as they had a similar program many years ago that some OSSC members attended and remember well.

Ten years ago, after a year off from teaching and administrating at IVC, I started the Optical Engineering program at UC Irvine with Valentina Doushkina as the main instructor. Valentina had taught 1 year of lens design and optical systems design at IVC in 2007 and I had taught several other courses. Then we moved the program to UCI. Now in its 10th year there is quite a list of alumni and many students currently enrolled. You can read more about the UCI and IVC programs further down in this newsletter.

On the informal educational side of the OSSC, it was 16 years ago I started the Optics Institute of Southern California (OISC) to volunteer side by side with the OSSC and other organizations, schools and government agencies. There are many examples of Optics Educational Outreach programs we completed and there are On-Line photo albums that document the progress. Over the past few years, the OISC & OSSC outreach programs have grown fewer and now a new generation of volunteers are beginning to step up with the older leaders to learn by doing. Currently this effort is being led by Anthony Oceguera, OSSC Councilor, Outreach Chair and Cal Poly Pomona Optics & Photonics Student Club President. Participating as a volunteer in OSSC Outreach Programs is a fun and rewarding way to get involved with the OSSC without over-committing. If you would like find out more, contact Anthony directly and help him on an upcoming outreach event….. you'll be glad you did.

Hope to see you at an OSSC event soon.

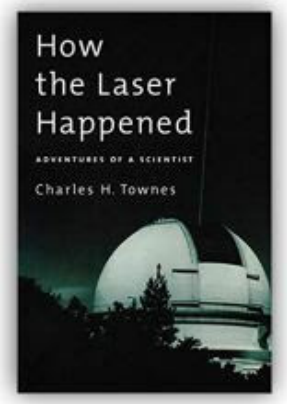
Sincerely,

Donn M. Silberman

OSSC Past President & Fellow

Current OSSC Newsletter Editor

Book Review: How the Laser Happened By Charles H. Townes - Having studied lasers and optics via the Irvine Valley College Optics program, the curiosity about where the laser came about and its multiuse today became a natural field of interest. In the thought-provoking book, How the Laser Happened, by Charles H. Townes, one the first to build a maser, delves into his personal journey. Townes acknowledges the story in how his family and community cultivated his growth as a scientist. Meanwhile, initial conversations and theories of the MASER illustrate the created sense of community and rivalry toward research for the LASER. As a result, though patenting rights becomes a focus, rather than the typical textbook format, one gets to view a personalized view of research and discovery via the mind of a scientist.
-Guadalupe Esparza, Optical Technician 11/2019



Teale Hatheway, Al's daughter, a Los Angeles based artist, has archived Al's Optomechanics newsletters in a rebuilt website at www.aehinc.com.

In the process, she discovered a final completed missive that Al had not sent out. She shares it with us now in the section below. It is also available at: https://aehinc.com/optomechanics-jade-brittle-fracture-analysis-tool/. Teale can be reached at:

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Precision Optomechanical Tools
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Optomechanics* – Jade Brittle Fracture Analysis Tool

A note from Teale Hatheway:* ***As I pored over Dad's emails to organize and archive AEH's Optomechanics Newsletter, I came across this gem which, dated 7-18-18, was never shared. I also discovered an abundance of conversations sparked by these communications. It's no wonder Dad enjoyed his work well past "retirement age": your camaraderie combined with his intellectual pursuits gave him great joy. He would've called it "sport." With well over 100 Optomechanics Newsletters published since 2006, the experience of compiling these brought me renewed clarity on Al's life work. From AEH product announcements, to carefully worded client stories, to occasionally revealing his trade secrets, I hope you will continue to enjoy his wit and his wisdom here… So here we go! The last Optomechanics. I sure hope he finished editing it. Enjoy!———*

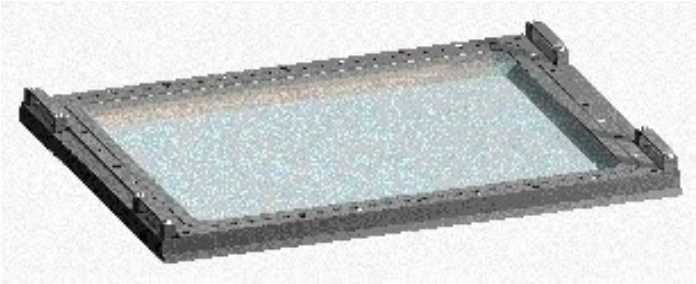
Colleagues:
Put fracture mechanics to work for you!
Fracture mechanics says that glass is sensitive to static stress corrosion fatigue effects. Glass parts have finite fatigue lives when operated in a normal moist environment. If the fatigue life, *T*, is defined as the time to fracture under the conditions of service, that life may be calculated from

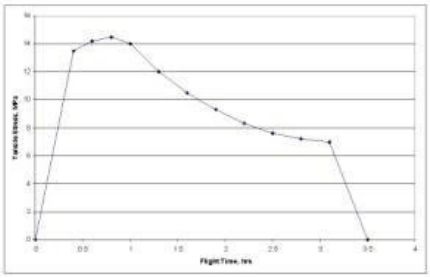
$$T=(2/1.259\pi)\int_{K_{Ii}}^{K_{IC}}(K_I/v\sigma^2)\mathrm{d}K_I$$

noting that *K*Ii is the initial stress intensity, *K*I is the instantaneous stress intensity, KIc is the fracture toughness, *v* is the instantaneous crack growth rate and the local stress, *s*, is time-variable and it is *inside* the integral.

AEH recruits our ***Jade Brittle Fracture Analysis Tool****,* to perform the numerical integration and determine *T*, the fatigue life. For ***Jade*** it's a piece of cake!

For instance, take this thermal-structural stress transient for an aircraft's window requiring 10,000 flight hours of service life:





FULL STRESS CYCLES AT FRACTURE= 3563
TIME TO FRACTURE= 44896587.75
SECONDS= 12471.274375 HOURS
CRITICAL INITIAL TENSILE STRESS= 55002270.5466022
INITIAL CRACK DEPTH= .000149

If the engineer applies a reasonable factor of safety, say 1.5, to the critical initial tensile stress (the ultimate load) it will provide a proof test load (82.5 MPa in this case) that will assure the safety of the window throughout its service life.

There's no way to get there with closed-form solutions and it's way too big for an Excel spreadsheet. ***Jade*** goes through the complete calculation in just seconds, allowing the engineer to try various combinations of design variables to optimize a safe concept.

Jade Brittle Fracture Analysis Tool
Now available from AEH.

Al H.
7-18-18

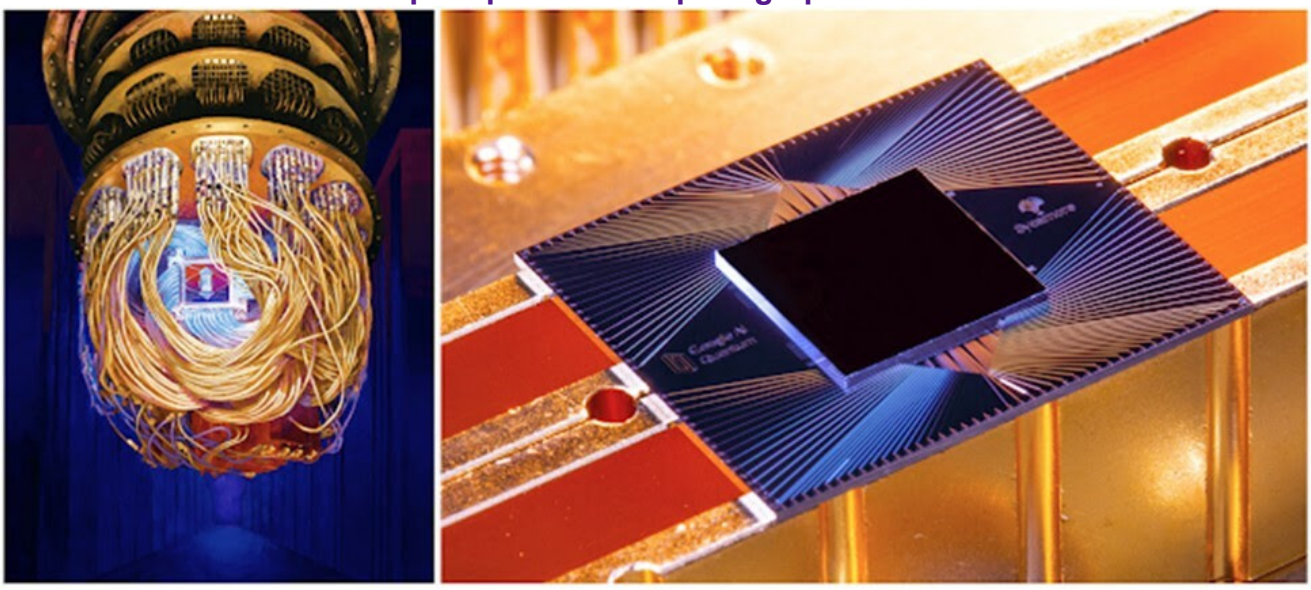
This entry was posted in **Analysis**, **Glass and Lenses**, **Jade**, **Process**, **Social** by **Al**. Bookmark the **permalink**.

Professor Roland V. Shack passed away peacefully in the early morning hours of Friday, Oct. 18, 2019. Dr. Shack was a legend in the optical engineering field and lived a full and long life of 92-years. Dean Koch reflected on Dr. Shack's impact, "Professor Shack was dedicated to teaching and the success of his students, many of whom became leaders in the field. As one of the very first faculty members hired by Aden Meinel, he was instrumental in laying the foundations of what is now the Wyant College of Optical Sciences."

See the full article at: http://www.optics.arizona.edu/news-events/news/quicknews/memoriam-roland-v-shack

Quantum Supremacy: Fact or Fiction?

Doug Fink, Managing Editor, Quantum Computing Reports
https://quantumcomputingreport.com/



I'm sure many of you have heard that news that Google has successfully completed an experiment in which they declared that their quantum computer had achieved "Quantum Supremacy" over a classical computer. Quantum Supremacy is a term coined by Professor John Preskill of Caltech to describe a case when a quantum computer can process a problem that is intractable for a classical computer.

You may also have heard of IBM's counterclaim that Google's declaration was not entirely accurate because they had found a significantly better way to performing the calculation on a classical computer. IBM's way could find the answer on a supercomputer in 2.5 days of run time versus Google's estimate of 10,000 years. For comparison, Google's quantum computer could find the answer in 200 seconds of run time.

Unless you have studied quantum computing, this all can be quite confusing and the situation is certainly not helped by the loads of popular press articles that tended to over-sensationalize the situation. So we'd like to take a few minutes to put this all in perspective and how it fits into the overall picture of quantum technology development.

I had first heard about this project in December 2017 at a quantum technology conference in a presentation by Professor John Martinis of the University of California at Santa Barbara. The specific problem he described was one where a computer (either classical or quantum) is provided an input consisting of a random circuit of quantum hardware gates and the computer is required to run a starting state through these gates multiple times and determine what the probability distribution of the output will be. The classical computer uses a quantum simulator for this calculation. The difficultly of calculating this increases very rapidly as the number of gates and depth of the circuit is increased because there is no structure in random circuits that a classical computer can exploit.

The primary motivation for using this benchmark was to select a significantly difficult problem that can be used by the engineering team to measure the performance of their technology and drive development. It is important to note that this particular problem has minimal applicability to real world problems and completing it successfully does not automatically infer that the quantum computer would beat out a classical computer on any other problem. Many researchers in the quantum community feel that the term "Quantum Supremacy" is a misnomer because it implies that a quantum computer could beat out a classical computer any type of problems, and that is certainly not the case.

Nonetheless, getting to this point is a significant achievement and the Google team should be congratulated for their hard work. They have produced a very good design which is highly competitive with other designs in terms of technical parameters such as the number of qubits, qubit connectivity, qubit quality, etc. But the development of quantum technology should be viewed as a multi-decade marathon race and this announcement should be seen as just passing the first milestone in that race. The specific artificial benchmark that Google used has minimal commercial value and the ultimate goal of developing quantum computers is to provide solutions that was not previously possible to real world, commercially valuable problems in such areas as computational chemistry, optimization, machine learning and many other areas.

There is still a lot of hard work on the road ahead as researchers improve the technology to achieve better results. The researchers are working on many different paths, including development of photonic based quantum computers, in their quest to achieve a Moore's Law like improvement in quantum computers performance.

The next major milestone will be a lot more interesting in some respects. Within the next couple of years, we expect to start seeing announcements of teams that have applied quantum computing so solve some of these real world problems we've mentioned above. Some quantum researchers use the term "Quantum Advantage" for this scenario. But Quantum Advantage will still be only shown for specific problems that are a good match for quantum algorithms and it will not be applied universally. Quantum computers will never replace classical computers but will only serve as a means to augment their capability.

So this area will be a fascinating area to watch and I expect to see many more announcements on quantum computer developments and breakthroughs in the coming years. Taken as a whole, I do expect quantum computing to have a significant impact on our world over the long term. But I do caution you to realize that progress will be the result of cumulative development over a very long period and no single breakthrough will change our world over night.

NPRO, A Very Stable Laser By Russell Rauch

Previous YAG Lasers

We are used to YAG rod lasers laser (polished and coated end facets as mirrors, or external mirrors). The two mirrors create in-phase optical feedback into the active laser medium, which receives energy optically.1) Note that a **standing wave** is formed in the laser gain medium.

NPRO YAG Laser

Lasers can also be formed by mirrors that reflect the light into a closed optical path (ring laser). In this case the light circulates within the laser as **a traveling wave**. In fact the light normally circulates around the closed loop or the laser in both the clockwise and counterclockwise directions.

A device called the **NPRO (Non-Planar Ring Oscillator)** was disclosed in patent US4578793 by Kane and Byer. A schematic diagram of the device is illustrated in figure 1, which illustrates how a piece of Nd-doped YAG crystal is used to create a ring laser in a monolithic laser chip:

a) Light is reflected in a ring path by using total internal reflections at three points, namely B, C, D, and one non-TIR reflection at point A.

b. The surface that contains point A is curved so that the resonator is stable. Moreover this surface acts as an output coupler of the NPRO laser by applying a partially transmissive coating, which also acts a partial polarizer. Pump light from a diode laser also enters this surface.

c. A magnetic field is applied along the direction AF in figure 1. This field is used to produce lasing in only one circulation direction (More about this magnetic field later).

Operation and Characteristics of NPRO Laser

The NPRO Nd:YAG chip, a small permanent magnet, the pump diode, and lens can all be bonded to the same substrate to produce a compact, rugged device as in figure 2. This Nd:YAG chip is small (less than one centimeter in longest dimension).

A comprehensive discussion of the NPRO laser and of optimizing the NPRO design is given in the paper by Nilsson, Gustafson, and Byer 2). Let's look further into the laser chip. The YAG crystal is cubic, so it

optically isotropic,, and the lasing occurs from electronic transitions by the Nd dopant (The output wavelength is 1.064 um for Nd:YAG). The traveling wave in the ring eliminates "spatial hole burning," which could cause higher order modes to resonate.3) Moreover, with proper diode pump laser focusing,

this laser resonates in TEM00 mode. How does this laser achieve a single direction of propagation around the ring? First we have to understand the polarization rotation during travel around the ring—namely how a rotation of 360 degrees can be produced for beam traversal once around the ring.

a. Without Magnetic Field Applied.

Rotation of the laser light polarization occurs, when light is incident on TIR reflecting surfaces B, C, D and also the output coupler surface at A. Note that the reflections at points B and D are symmetrical and opposite; so we are left with net rotation from points A and C. The rotation at point C is due to the non-planar geometry of the device However, without an applied magnetic field, the net rotation due to a clockwise traverse around the ring would be equal and opposite to that of a counterclockwise traverse. Without a magnetic field the NPRO would resonate with both CW and CCW travel around the ring. See reference 2.

b. With a Magnetic Field

Suppose a magnetic field is applied and polarization is rotated during propagation in the laser crystal by the **Faraday Effect** (see appendix). **This effect is non-reciprocal**: it rotates the polarization with same handedness regardless of whether is traveling along ABC or CBA (optical and Faraday rotations add in one direction around the ring and subtract in the other). The NPRO is designed so that in one direction the net combination of optical polarization rotation and of magnetically-induced rotation is 360 degrees, while the other direction the net rotation is not 360 degrees. **Thus the NPRO only resonates for circulation in one direction around the ring.** The analysis is covered in detail (see reference 2, which uses Jones calculus and an optical equivalence theorem.

Summary of NPRO Design Advantages

1**. A single YAG chip is used to provide the mirrors of the ring laser.** Mounting of the magnet, pump laser, and focusing lens in close proximity reduce sensitivity to vibrations and temperature change.

2. **Output beam is single mode TEM00 that resonates in one direction around the ring.**

3**. Reduced sensitivity to extra-optical cavity feedback** (feedback is in wrong direction around ring)

4. N**PRO laser frequency of 1.064 um has a very narrow linewidth**, <3kHz originally, and now down to 1 kHz for 200mS). 4)

5. **Vernier tuning of the laser output wavelength** can be accomplished by changing the temperature of a TEC cooler for slow tuning, or by applying a mechanical stress to the crystal via piezo-electric material, attached to the NPRO.4).

6. **Diode pumping utilized for good NPRO power stability.**

Applications of NPRO

A very notable application is: **master laser oscillator for LIGO and VIRGO Gravitational Wave Antennas.** Possible additional applications include LIDAR, communications, spectroscopy, atom cooling.4)

Foot Notes and References

1. Nd:YAG Rod Laser: The pump light produces a population inversion of an upper electronic level of Nd in the YAG (this inversion is an excess of electrons in an upper levels of the Nd, compared to thermal equilibrium). Spontaneous emission starts the process. Further transitions within the rod are caused by the newly created in-phase photons by stimulated emission, and these transitions create a buildup of in-phase laser light, until energy losses are in balance with the pump energy. One crystal facet is coated with a high reflector; the other facet is coated to be partially transmitting to allow the laser light to exit the rod. *Standing optical waves are created between the facets.*

2. A. C. Nilsson, E. K. Gustafson, R. L. Byer, " Eigenpolarization of Monolithic Nonplanar Ring Oscillators", IEEE J. Quantum Electronics**, 25**,no 4, pp 76779,1989.

3. NPRO eliminates spatial hole burning defined as "A period population inversion is due to the standing wave in the laser medium. This leads to higher order axial modes." For more details on this quote see the section "Spatial Hole Burning", in the book **Lasers**, A. E. Siegman, p. 465, 1986. Since there are traveling waves in the NPRO, the higher order axial modes are suppressed.

4. Product Information for "Mephisto" and "Lumentum" laser systems, from Coherent, Inc. Other vendors are listed in rp-photonics.com.

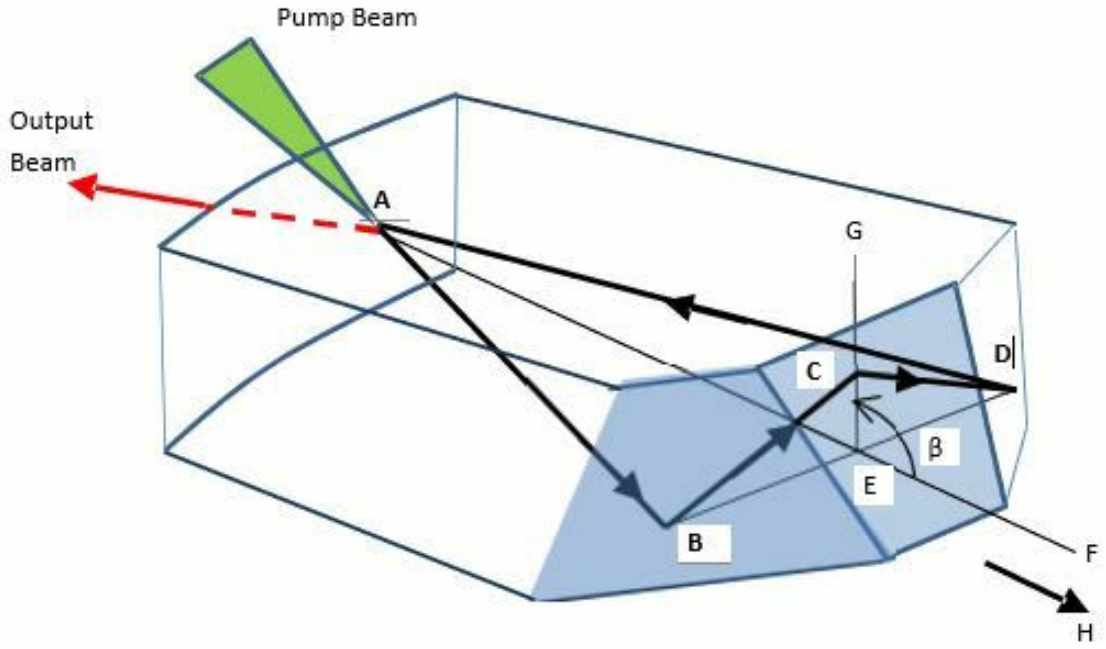


Figure 1. Sketch of NPRO Optical Path and Facets

The internal optical path ring is A->B->C->D->A. The reflections at points B, C, D are total internal reflections. At point A the facet is the output coupler (partially transmissive, partially polarized, and curved to make the resonator ring stable. All other optical facets are planar.

Plane at point B tilts toward the reader

Plane at Point C tilts away from line EG toward point A

There is a magnetic field H along direction AF.

The angle GEF is called β. In the original paper by Kane and Byer, β was 90 degrees. In reference 2, angle β was decreased to 1.049 degrees.

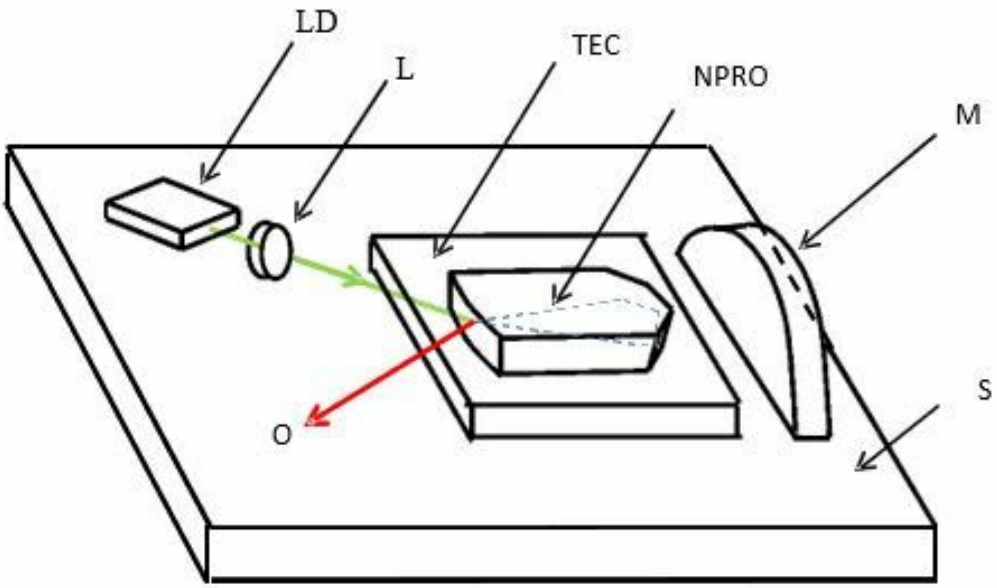


Figure 2. NPRO Assembly (After Reference 2)

S = substrate, LD = laser diode TEC cooler for laser not shown),
L =focusing lens for pump beam, NPRO = Nd:YAG (see figure 1 above),
TEC = cooler for NPRO crystal, M = permanent magnet, O= output beam

Appendix. Faraday Effect

This discussion is based on the Wikipedia article "Faraday Effect" (https://en.wikipedia.org/wiki/Faraday_effect) and reference 2.

Faraday Effect Description

Applying a magnetic field to an isotropic, magneto-optic material such as Nd:YAG causes a linear polarization rotation about the light propagation vector; the rotation is proportional to the distance traveled and to the strength of the magnetic field component (along the propagation vector), as described in equation (1) and figure 1.

(1) $\beta = VBL\cos(\theta)$, where

β = polarization rotation angle, L = distance traveled, V = Verdet constant for YAG, θ = angle between magnetic field **B**, and light propagation vector **k**; thus $\cos(\theta)$ =(normalized **B** and **k**)

The polarization rotation by the Faraday Effect is illustrated in figure 3.

Non-Reciprocal Rotation by Faraday Effect

Will the polarization rotate back to the original vertical position upon reflection? No, in fact the Faraday rotation is insensitive to the direction of propagation in figure 3, so the net rotation for the reflected beam will end up at angle 2β from the input polarization. Thus the Faraday rotation is called **non-reciprocal.** The NPRO crystal without an applied magnetic field is an **example of reciprocal** polarization rotation (see reference 2, p. 775).

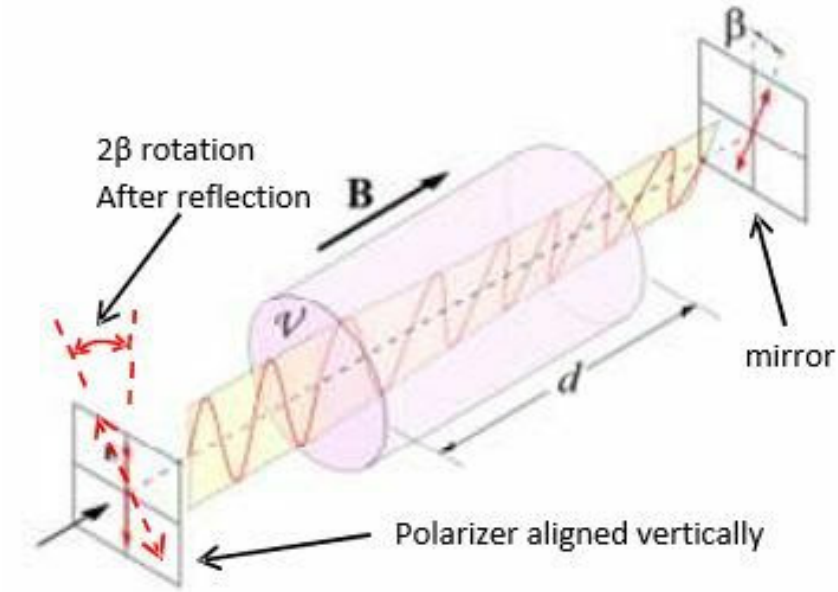


Figure 3. Faraday Rotation Illustration from https://en.wikipedia.org/wiki/Faraday_effect

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UCI Division of Continuing Education

Celebrating 10 Years of Course offerings in OPTICS

UCI Optical Engineering 10 yrs - Photonics Spectra from Sept 2019 Photonics Spectra Magazine

The following courses are part of **Certificate Programs** in:
Optical Engineering and **Optical Instrument Design**
There was an Information Session - Monday 19 August
OSSC Fellow Donn Silberman was the guest speaker.
Recorded Session Here
Winter 2020 courses will begin in early January:
Advanced Lens Design
Optical Instrument Design
Optomechanical Systems Engineering
Past UCI Optical Engineering Webinars

UCI DCE Financial Aid for Optics Programs
Go to the links above to learn more about the courses and programs.
*15% discount for **OSSC** Members on courses Required for a Certificate.*
Email: **Jennifer Mortensen**
with confirmed **OSSC** Membership
to receive discount code.
Instructors Wanted to Teach:
Optical Engineering and Optical Instrument Design!

IRVINE VALLEY COLLEGE
PHOTONICS TECHNOLOGY

Laser and Photonics Technology instructors lead hands-on, laboratory-driven classes, utilizing state-of-the-art industrial equipment, based on the industry-guided photonics curricula written by industry professionals. In addition to laboratory skills, students are offered one-on-one support and career advice, including résumé and LinkedIn profile building.

Program Website
***IVC Laser Technology** is located on the*
IDEA at **ATEP** campus in Tustin, CA
For Information Contact:
Prof. Brian Monacelli, Ph.D.
949-824-2704
IVCphotonics@ivc.edu

WEBSITE SPONSORS

AEROTECH

AMP Optics

Website Sponsors are *Corporate Members* that make an additional donation to support the **OSSC.ORG** website. They enjoy all the benefits of *Corporate Membership* AND have their company logo and link prominently displayed along the left side of our website. Website Sponsorship dues are $200 per year.
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All Website Sponsors may contact the Website Team to add or update their company link or logo or to resolve other website issues.
For general membership questions, please contact the Membership Chair.
Become a **Corporate Member or Website Sponsor!**

Corporate Members

OSSC Corporate Members display their products at the December 2012 Corporate Member Appreciation Meeting.

Corporate Members benefit the **Optical Society of Southern California** through their generous donations of time, talent and financial resources. Corporate Membership dues are $100 per year.

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Supply Chain Optics
Synopsys
Trioptics
II-VI Optical Systems
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CONFERENCES AND SEMINARS

SPIE & OSSC Join together again for:
19th Annual Mirror Technology

SBIR/STTR Workshop

Northrop Grumman Aerospace Systems
Presentation Center
Redondo Beach, California, United States
5 - 7 November 2019

SPIE. PHOTONICS WEST BIOS

1 - 2 February 2020
San Francisco, California
The Moscone Center

More Information

SPIE. PHOTONICS WEST

4 - 6 February 2020
San Francisco, California
The Moscone Center

More Information

OFC
The Optical Networking and Communication Conference & Exhibition
Technical Conference: 8 – 12 March 2020
Exhibition: 10 – 12 March 2020
San Diego Convention Center, San Diego, California, USA

SPIE. DEFENSE+ COMMERCIAL SENSING
Anaheim Convention Center
Anaheim, California, United States
26 - 30 April 2020

The Following list of OSA Student Chapters in California is a bit outdated.

The OSSC Board would like one volunteer to reach out one of these OSA / SPIE Student Chapters and become a contact that one college or university student chapter and optics community. Please contact Donn Silberman if you would like to v

- California Institute of Technology - OSA Student Chapter
- California State Polytechnic University, Pomona
- Irvine Valley College (IVC) Student Chapter
- San Francisco State University, OSA Student Chapter
- Stanford University, Stanford Optical Society
- University of California, Berkeley, "PhotoBears" (Joint OSA & SPIE Student Chapter)
- University of California, Davis, Optics Club
- University of California, Irvine, Photonics@UCS (Joint OSA & SPIE Student Chapter)
- University of California, Los Angeles (Joint OSA & SPIE Student Chapter)
- University of California, Merced
- University of California, San Diego, Photonics Society at UCSD

Outreach

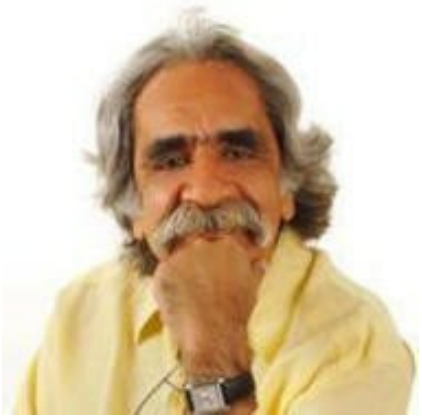
Left: Dr. Murty Mantravadi demonstrates his Optricks!

Right: Children play with home made telescopes.

The **OSSC** supports several outreach events each year. If you would like to volunteer to help on a project or event, please contact **OSSC** Outreach Chair - Nick Lambert, or any member of the Outreach Committee

The OSSC Optics Outreach Programs have had a long history of success over many years. At this time we are

looking forward to bringing on a new outreach leader, Anthony E. Oceguera, from Cal Poly Pomona's Optics & Photonics Club, who will help us continue reaching many young people around Southern California. Please welcome Anthony and volunteer to help him create successful programs for the next year and beyond.



Wednesday, December 11th, 2019

The Optical Society of Southern California invites its members and friends to our

Annual Corporate Member Appreciation Event Featuring

a presentation on:

Molecular Vibrations Imaged for the First Time:

Atomically Confined Light

Professor V. Ara Apkarian,

Director of UC Irvine's Center for Chemistry at the Space-Time Limit (CaSTL)

Wednesday, December 11th, 2019

Reception & Corporate Member exhibits: 6:00 pm

(no host bar)

Dinner: 7:00 pm; Talk: 8:00 pm

Meal: Pasta, Chicken or Meat Lasagna

Members: $35 by Dec. 7, $40 after

Non-Members: $40 by Dec. 7, $45 after

(OSSC Student Members $10 by Dec. 7, $20 after)

Attend the Talk for Free by Registering

Venue: Angelo's and Vinci's

550 N Harbor Blvd, Fullerton, CA, 92832

714-879-4022

On-line Registration: www.ossc.org

Or Contact: Sean Wilson

Events@ossc.org, (310) 933-2255

Corporate members can reserve exhibit tables during online registration.

Contact Donn Silberman for information.

Abstract: The internal vibrations of molecules drive the structural transformations that underpin chemistry and cellular function. While vibrational frequencies are measured by spectroscopy, the normal modes of motion are inferred through theory because their visualization would require microscopy with ångström-scale spatial resolution—nearly three orders of magnitude smaller than the diffraction limit in optics. Using a metallic tip to focus light and taking advantage of the surface-enhanced Raman effect to amplify the signal from individual molecules, tip-enhanced Raman spectromicroscopy (TER-SM) reaches the requisite sub-molecular spatial resolution, confirming that light can be confined in picocavities and anticipating the direct visualization of molecular vibrations. Here, by using TER-SM at the precisely controllable junction of a cryogenic ultrahigh-vacuum scanning tunneling microscope, we show that ångström-scale resolution is attained at subatomic separation between the tip atom and a molecule in the quantum tunneling regime of plasmons. We record vibrational spectra within a single molecule, obtain images of normal modes and atomically parse the intramolecular charges and currents driven by vibrations. Our analysis provides a paradigm for optics in the atomistic near-field.

About our Speaker: V. Ara Apkarian is a Professor of Chemical Physics at UCI and Director of the NSF Center for Chemical Innovation on Chemistry at the Space-Time Limit (2007-present). He holds B.S. and Ph.D. degrees in Chemistry from USC and Northwestern, respectively. Following a postdoctoral fellowship in Cornell, he joined the Chemistry faculty at UCI in 1983. He has served as Department Chair (2004-2007) and as the founding co-Director of the Chemical and Materials Physics (ChaMP) program at UCI (1997-2000).

OSSC Corporate Members are invited to sign up for exhibit space!

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