

CROSS POLARIZATION

THE ACOUSTICAL SOCIETY OF AMERICA (ASA)

The Acoustical Society of America is dedicated to increasing and advancing the knowledge of acoustics – the science of sound. ASA includes physicists, engineers, biologists, psychologists, geophysicists and scientists who work in music, speech, architecture, medicine, bioacoustics, noise control and oceanography. This diversity of topics, along with the opportunities provided for the exchange of knowledge and points of view, is one of the Society's strongest assets. Whether it is the study of humpback whale songs, the design of concert halls, the study of music and musical instruments or a wide range of sound-related studies, they will be investigated by ASA members.

THE OPTICAL SOCIETY (OSA)

Founded in 1916, OSA brings together optics and photonics scientists, engineers, educators and business leaders. OSA is dedicated to providing its members and the scientific community with educational resources that support technical and professional development. OSA's publications, events and services help to advance the science of light by addressing the ongoing need for shared knowledge and innovation. The Society's commitment to excellence and continuing education is the driving force behind all its initiatives.

THE OSA FOUNDATION

Inspiring the next generation of scientists and engineers

The future's great scientists are among the children of today and tomorrow. These children live and study around the world. Some have the resources and support needed to succeed, but many others do not. The OSA Foundation believes all students should have access to quality education resources and everyone should have the opportunity to explore scientific studies and career paths.

The Foundation focuses on advancing youth science education by providing students with access to science educators and learning materials through interactive classroom and extracurricular activities. To learn more about the Foundation and its funded programs or to request support for your program, please visit www.OSA-Foundation.org, e-mail foundation@osa.org or call +1.202.416.1421.



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www.op-tec.org



On the Move

LIGHT WAVES, BELIEVE IT OR NOT, LOVE TO WIGGLE. Certainly the picture on the cover doesn't appear to move or wobble, but the light allowing you to see the picture does wiggle and vibrate. The light bouncing off the poster and going to your eyes vibrates randomly in all directions: up and down, or left and right, or other directions. This is called **unpolarized** light. **Polarized light** vibrates in only a single direction. Some filters, called polarizers, only pass one polarization of light and block all others. After passing through a polarizer, light becomes polarized. Some, but not all, sunglasses are made out of polarizers.

Some materials have a property known as **birefringence**. Birefringent objects can rotate or change the polarization of light passing through them without absorbing the light.

For example, up-down polarized light hitting a birefringent object may come out left-right polarized. How much the polarization changes depends on lots of things, like the thickness of the birefringent material, the orientation of material relative to the polarization of the light, and even the color of the light passing through the material.

So, how do we get rainbows from plastic cutlery? If you have two polarizers arranged so that the second polarizer exactly blocks all the polarized light passing through the first, then no light gets through, and we call the pair of filters crossed polarizers. However, when you put a birefringent object (such as a piece of clear, plastic cutlery) in between the crossed polarizers, the birefringent object can change the polarization of light so some light can get through the second polarizer. In the picture, the background is black because no light gets through the crossed polarizers, but where there is plastic, you see colors. Different colors indicate different amounts of polarization change caused by the plastic.

If you have a set of crossed polarizers and some clear objects to test, try rotating the objects between the polarizers or even bending them a little. Stress, from bending, is a great way to change the birefringence in an object and change the polarization of the light passing through it.

Definitions

LIGHT

Light is an electromagnetic wave that is visible to the eye. The elementary particle that defines light is the photon.

POLARIZED LIGHT

Light in which the electric and magnetic fields each vibrate in a single plane.

UNPOLARIZED LIGHT

Light in which the electric vector is oriented in a random, unpredictable fashion.

BIREFRINGENCE

The property or capacity of splitting a beam of light into two beams, each refracted at a different angle, and each polarized at a right angle to the other. Certain crystals such as calcite and quartz have this property.

Analyzing Everyday Polarization

ACTIVITY 1

Honeybee Eyes

1. Stir a few drops of milk into the water so that is slightly cloudy.
2. Shine the flashlight into the tank of water. You should be able to see the beam from the side.
3. Put on the sunglasses and look at the beam of light in the tank from the side. Turn your head from side to side as if you are trying to touch your ears to your shoulders while looking at the beam of light. Does the beam grow brighter and dimmer as you move your head? What does this tell you about the polarization of the light scattered toward you from the beam?
4. Remove the sunglasses and look at the color of the light beam from the side. Look at the color of the beam from the end (looking back toward the flashlight.) Can you use this result to explain why the sky is blue and sunsets are red?
5. Go outside wearing the sunglasses and look at different directions of the blue sky on a sunny day. (Don't look at the sun!) Do parts of the sky appear brighter? Is the blue sky polarized?



WHAT YOU NEED

- one pair of polarized sunglasses
- a tank of water, like a fish tank
- a few drops of milk
- a flashlight
- transparent objects to look at such as a pair of clear glasses or plastic cutlery
- a computer with a flat “liquid crystal display” computer screen

ACTIVITY 2

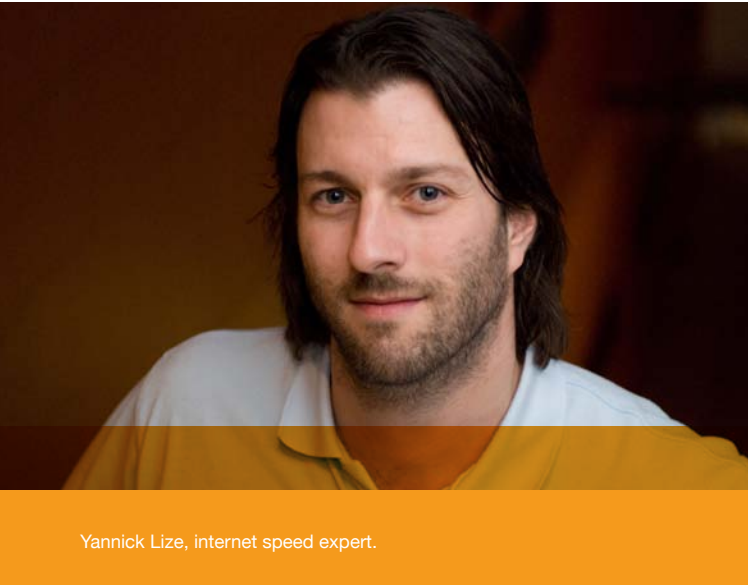
What do you see?

1. Open a blank document and maximize it so that you have a screen that is mostly white.
2. Put on your polarized sunglasses.
3. Turn your head from side to side as if you are trying to touch your ears to your shoulders while looking at your computer screen. How does the brightness of the screen change? What does this tell you about the polarization of the light coming from the screen?
4. Look through the transparent objects at the screen. How do these objects transform the polarization of the white light from the screen?
5. Try applying stress to the object, such as pinching the tines of a plastic fork. What causes the pattern to change?
6. Find a shiny surface and observe, through your polarized sunglasses, the reflected light passing through a transparent object.

FAST FACT

Bees, crickets, ants and other insects use the polarization of the blue sky for navigation!

Yannick Keith Lize



Yannick Lize, internet speed expert.

YANNICK KEITH LIZE IS AN ENGINEERING PROJECT MANAGER at Opnext Inc., in Los Gatos, CA, developing 100 Gb/s optical subsystems and transponders. In short, he's trying to make your internet faster by building high speed transmitters and receivers for long distance fiber optic links across the continent. The fiber optic revolution facilitated the hyper-connected society we have today, enabling video on demand, social networking and wireless communication by connecting cell towers together to a central office.

“My undergraduate and graduate studies helped me to understand the physics of optics and taught me the creative process of innovation. Now I am equipped to make a contribution by finding new ways of transmitting and receiving information with technological innovations. Optics is a fascinating and rich field. There have been countless ground-breaking innovations over the last 20 years and it's not slowing down.”

When Yannick decided to begin his graduate studies, his goal was always to go into industry. Thanks in part to guidance from his supervisors during his Ph.D., he figured out early on what he would need on his résumé to prepare for the job market. This career advice allowed him to make meaningful connections, so that when he graduated, he was fortunate enough to receive several job offers.

Today Yannick has a job he loves, with new challenges every day, finding creative solutions to ever more complicated problems. He realizes that he was lucky to get from where he was after earning his undergrad degree in Physics to where he is today, but also knows that luck alone is never enough.

Professional scientific societies were and continue to be an important aspect of his career development. “Despite their very successful careers,” says Yannick, “famous scientists aren’t rock stars. There aren’t constant crowds surrounding them, asking for their autographs. Scientific legends are easily approachable at society-sponsored conferences and are usually happy to offer advice. Over the years, I was the recipient of a lot of great advice.”

“Professional organizations, like OSA, also offer amazing opportunities for students. Travel grants, student chapters, awards, publications and networking, opportunities are out there for the willing! But I assure you, you miss out on 100% of the grant and scholarships you don’t apply for. 100% of the papers you don’t submit are rejected and you lose 100% of the sales on a product you don’t develop.”

Yannick is a member of the professional organizations OSA, IEEE Photonics Society and IEEE Communications Society. He also serves on the OSA Membership and Education Services (MES) Council and has published several papers on fiber optic communications over the years.

“How was I able to attending school for so long? Simple: If I didn’t like what I was doing during my Ph.D. (bringing new ideas, analyzing problems, providing creative solutions, demonstrating results), I would hate my job today because this is what I do! A Ph.D. program is like a training camp before the regular season begins.”

“My childhood idol, Wayne Gretzky, once said, ‘You miss 100% of the shots you don’t take.’ It is clearly a sports concept, but it can easily be applied to anything you do: If you don’t even try, you have already failed. It is with that very mindset that I went through graduate school.”

—YANNICK KEITH LIZE, ENGINEERING PROJECT MANAGER,
OPNEXT SUBSYSTEMS INC., USA



Yannick in the lab at Opnext.

Michael Bass

MICHAEL BASS ISN'T VERY OLD. He was born in 1983. Yet he already wants to mentor young technical school students. “Outreach and mentoring is probably one of the most valuable things we (as technical school alumni) can do.” Michael has good reason to reach out to future laser optics technicians: If not for *his* mentor, he wouldn't even have been a photonics student.

Michael began an electronics engineering technology degree at Central Carolina Community College (CCCC) after high school. But Gary Beasley, head instructor for laser and photonics technology at CCCC, saw potential in Michael and spent two years recruiting him. “Gary recruited me to the photonics curriculum right after my electronics curriculum. He's an extremely passionate person for photonics and education in general. It was fascinating to see the demonstrations he did. He understood the photonics industry, how huge the growth and market are. If it wasn't for Gary's passion and

dedication to the student, then I would not be where I am today.”

That Michael inherited Gary Beasley's passion is obvious when he is asked about his career field. “Photonics is such a young industry. Most photonics jobs are on the cutting edge of technology. That's one of the things I find most interesting, working with technology and taking it from the research and development stage to a practical application stage, whether it is manufacturing, medical, or telecommunications. The applications of photonics are almost endless, which means the opportunities that can be opened for you are very broad.”

But other aspects of Michael's education at CCCC play major roles in his job every day. “The associate degree wasn't just about learning one type of math or very specific physics laws. It was really building the technical foundation and learning how to be a good employee, how to work in a team, and how to solve normal everyday challenges that face technicians in the field.” The greatest assets he acquired while at CCCC, Michael says, are “having a foundation of technical knowledge and learning to be a self-motivated person who has the desire to be successful.”

And “successful” can easily describe Michael's career to date. He works for Bright-View Technologies, a start-up company that manufactures optical films for the management of light distribution. “These optical films consist of billions of microstructures or micro-lenses that manage light, making them more

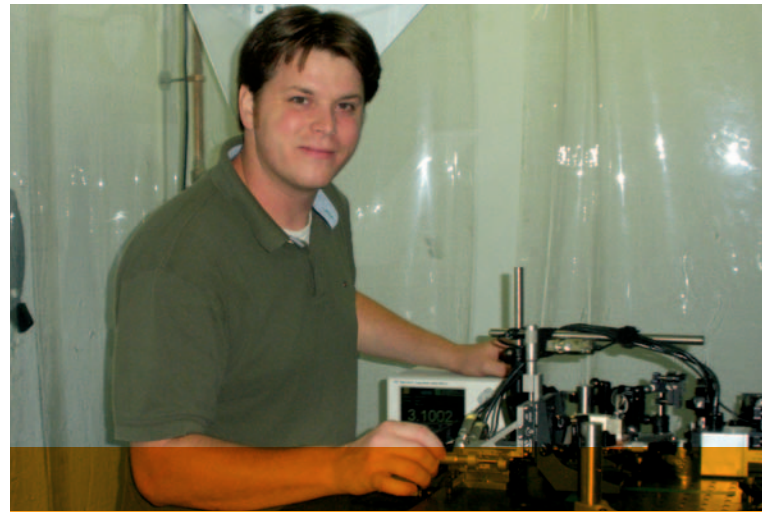


Michael Bass, Central Carolina Community College graduate.

aesthetically pleasing or adjusting the viewing angle for light distribution.” Michael started as a technician three years ago for BrightView’s main technology platform, called E-lamps. “Today, I am responsible for the well-being of this whole system: everything from the optics alignment and calibrations of the system all the way to manufacturing, logistics and process controls. It’s very interesting; I’m in a world between research/development and manufacturing.”

Working in the transitional area between research/development and manufacturing is both the most difficult and most fascinating part of Michael’s job. “Some days I love it. Some days I hate it because it’s so frustrating. But I do know it has taught me an immense amount of information I could not have learned on only one side or the other. Being stuck in between has enabled me to be extremely valuable to the company on both sides. Many other technologies that lasers are being used in have to be shifted from a research environment to a manufacturing environment. That is one of the things I identified as very fascinating and very prevalent in the photonics industry. Manufacturing and research, that’s a double-edged sword, but there’s no doubt I absolutely love it and am learning so much. I actually love my job with a passion.”

Like his mentor before him, Michael wants to pass on his passion for photonics to the newest students, with an added focus on people skills. The ability to work with and support people may not sound hard but it manages to challenge Michael regularly. “A significant portion of my job is working with people. One of the greatest challenges I have in my career



Michael in the lab.

is being able to work side by side with people, disagree on things, but still be able to support them. Being successful in any career, I believe, is not a matter of knowing more math or more physics theories than somebody else. It’s being able to work with people, being optimistic and being able to solve problems.”

On overcoming disagreements: “You have to know what your position is and then try to put yourself in other people’s shoes. Even if you can’t, you’ve got to identify that this person is still your teammate, you’re working for the same company and you’re still trying to accomplish the same goals. Remember that this person is actually trying to accomplish the same thing as you. They’re just trying to do it a different way.”

—MICHAEL BASS

Additional Resources

For Students, Teachers and Parents

OPTICS: LIGHT AT WORK

This 15 minute DVD is geared toward 12 and 13 year old students, and is a great resource for raising awareness of optical science, along with its applications and many career opportunities. In addition to introductory information about the science of optics, the video highlights real world applications of optical technology, from everyday items like remote controls, cell phones and bar code scanners, to space exploration, innovations in solar energy and new frontiers in medicine. A variety of career options are highlighted through clips from a diverse group of scientists currently working in the field. Helpful advice and encouragement to students is included throughout.

LASER TECHNOLOGY: CHANGING DAILY LIFE, FORGING NEW OPPORTUNITIES

This 42-minute video/CD-ROM traces the fast-paced history of the laser and includes exciting visual depictions of laser applications. Targeted to high school and post-secondary students, the video/CD focuses on the characteristics of diode, solid-state and gas lasers and the properties that make them useful in a variety of applications including telecommunications, entertainment, biomedicine and the military.

OPTICS DISCOVERY KIT

The Optics Discovery Kit provides educators with classroom tools and optics lessons. The Kit features 11 experiments that demonstrate basic principles of optics. Components include: lenses, color filters, polarizers, optical fibers, a mirror, a hologram, a diffraction grating and an anamorph. Also included are teacher and student guides.

OPTICS SUITCASES

The OSA Rochester Local Section developed the Optics Suitcase in 1999. The *Optics Suitcase* is an innovative, interactive presentation package designed to introduce primary school students to many of the concepts of optics as well as other sciences. The cornerstone of the *Suitcase* is the give-away theme packets which the students are encouraged to show to friends and family members, therefore reinforcing the lessons learned from the presentation. Reprints of articles about the Rochester Section's outreach and a copy of the *Optics Suitcase* guide for presenters are available at www.opticsexcellence.org/SJ_TeamSite/index.html; you can also view a video of Dr. Steven Jacobs using the *Suitcase* on the osapod.libsyn.com/.

EDUCATIONAL WEBSITES

OSA hosts award-winning educational websites for students, teachers and parents. The material is designed to spark students' interest in science. OpticsForKids.org features optics experiments, tutorials, demonstrations, games, optical illusions, career profiles, reference materials and more. The Optics and Photonics Education Directory, OpticsEducation.org, is a high-powered search engine of schools that offer advanced studies in optics and related topics.

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OPTICS DISCOVERY

KIT[®]

11

Easy Experiments

Demonstrating interesting properties of light and optics!

Experiments Include:

Magnification, Properties of Telescopes, Fresnel Lenses, Digital Cameras, Diffraction Gratings, Polarizers, Mirrors, Holograms and Fiber Optics.

For Ages 10 + Up



13 KIT CARDS IN ALL!

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(United States and Canada)

+1.856.547.3488 ext. 6006
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www.edmundoptics.com

The Optics Discovery Kit was created by volunteer members of the Optical Society of America. The kit is part of the Society's youth education outreach programming. To request more information about OSA and other educational materials, please contact the OSA Education programming staff at: opticseducation@osa.org.

OSA Educational Resources ... *Exploring the Science of Light*

—Image courtesy of Ryan Gallagher: www.kineticphotography

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