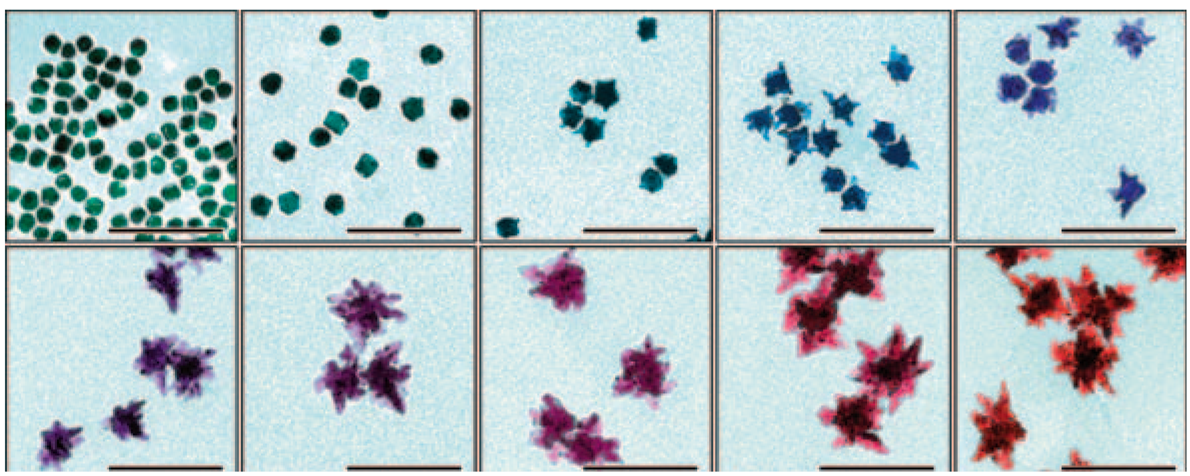
DukeBroadband

FITZPATRICK INSTITUTE FOR PHOTONICS • DUKE UNIVERSITY

FIP PIONEER AWARD

Dr. John Hall, Nobel Laureate in Physics

Gold Nanostar
Shape of The Future



Tiny gold stars, smaller than a billionth of a meter, may hold promise for new approaches to medical diagnoses or monitoring for environmental contaminants.

While nanoparticles have been the rage across a wide spectrum of sciences, a new study by Duke University bioengineers indicates that of all the shapes studied to date, stars may outshine for certain applications.

... Story continued on page 3

2008 VOLUME 3 . ISSUE 1

Tuan Vo-Dinh

It is my great pleasure to welcome you to the third issue of BROADBAND, the newsletter of the Fitzpatrick Institute of Photonics (FIP).

As education is an important focus of our Institute's mission, we have recently completed the curriculum expansion of the Graduate Certificate Program in Photonics. The Photonics Graduate Certificate enables students to broaden the scope of the typical disciplinary graduate student-training program. Students are encouraged to develop interdisciplinary and transferable sets of skills in their course work and research activities. We have established a partnership between the FIP and the Master of Engineering Management (MEM) program at Duke so that students can earn a Photonics Certificate in conjunction with their Doctoral (PhD), Masters of Science (MS), or Master of Engineering Management (MEM) degree. Further information, including approved course listings and the application process, is available at www.fitzpatrick.duke.edu/; (select Education from the menu).

We recently organized the 8th Annual Meeting of the FIP, a Symposium entitled "Frontiers in Photonics Science and Technology", which was designed to bring together scientists from multiple disciplines, and provide a forum for presentation and discussion of research, application and development of state-of-the-art instrumentation in photonics. The Symposium Keynote Lecture was presented by Dr. John L. Hall, 2005 Nobel Laureate in Physics. The 2008 meeting program included lectures from distinguished speakers, contributed papers, and posters by investigators from Duke University and other academic institutions. As we strongly believe that interdisciplinary research is the key to future advances in science and technology, the Symposium included a Special Panel Session entitled "What Physicians Request from Biophotonics Engineers", where physicians from Duke Medical School were invited to discuss what MDs need from engineers in order to address important challenges in disease diagnostics and therapy.

The dedication and achievements of our faculty, students, and staff are key to the continuing growth of our Institute. I greatly appreciate their important contribution to the wide variety of our Institute's activities. Please visit our website at www. fitzpatrick.duke.edu to learn more about our faculty, research programs, and activities.

My best wishes for a successful 2008 Fall Semester and enjoyable Holidays Season.

Tuan Vo-Dinh, PhD
DIRECTOR, FITZPATRICK INSTITUTE OF PHOTONICS
R. EUGENE AND SUSIE E. GOODSON PROFESSOR OF BIOMEDICAL ENGINEERING
PROFESSOR OF CHEMISTRY

65 FACULTY MEMBERS
22 PARTICIPATING DEPARTMENTS & INSTITUTIONS AT DUKE UNIVERSITY:

- Anesthesiology
- Biomedical Engineering (BME)
- Cell Biology
- Chemical Biology
- Chemistry
- Computer Science (CS)
- Duke Comprehensive Cancer Center
- Duke Human Vaccine Institute
- Electrical and Computer Engineering (ECE)
- Institute for Genome Science and Policy
- Mechanical Engineering and Material Science (MEMS)
- Mathematics
- Neurosurgery
- Oncology
- Ophthalmology
- Orthopedic Bioengineering
- Pathology
- Pediatrics
- Physics
- Radiation Oncology
- Radiology
- Surgery

CORE RESEARCH THEMES

- **biophotonics:** Izatt, director
- **nano & micro systems:** Jokerst, director
- **quantum information:** Gauthier, director
- **systems modeling:** Yang, director
- **advanced photonics systems:** Reichert, director
- **nanophotonics:** Leong, director
- **metamaterials:** Smith, director
- **novel spectroscopes:** Warren, director

FIP FACULTY

ANESTHESIOLOGY
Allan Shang, M.D. Assist. Prof.

BIOMEDICAL ENGINEERING
Ashutosh Chilkoti, Prof.
Barry Myers, M.D., Prof.
Nimmi Ramanujam, Assoc. Prof.
Jingdong Tian, Assist. Prof.
George Truskey, Prof.
Adam Wax, Assoc. Prof.
Fan Yuan, Assoc. Prof.
Tuan Vo-Dinh, Prof.
Joseph Izatt, Prof.
Kam Leong, Prof.
William (Monty) Reichert, Prof. Dir.
Daniel Gauthier, Prof.
Hisham Massoud, Prof.
Farshid Guilak, Assist. Prof.
G. Allan Johnson, Prof.
Lingchong You, Assist. Prof.

CHEMISTRY
Tuan Vo-Dinh, Prof.
William (Monty) Reichert, Prof.
Jo Rae Wright, Prof.
David Beratan, Prof.
Martin Fischer, Assist. Res. Prof.
Jie Liu, Assoc. Prof.
Richard A. Palmer, Prof.
John Simon, Prof.
Warren Warren, Prof.
Weitao Yang, Prof.
Michael Therein, Prof.
Eric Toone, Prof.

CELL BIOLOGY
Jo Rae Wright, Prof.

CHEMICAL BIOLOGY
William (Monty) Reichert, Prof.

COMPUTER SCIENCE
Thomas LaBean, Assoc. Prof.
John Reif, Prof.
Xiaobai Sun, Assoc. Prof.
Nikos Pitsianis, Assoc. Res. Prof.

DUKE COMPREHENSIVE CANCER CENTER
Victoria Seewaldt, Assoc. Prof.
Neil L. Spector, M.D. Faculty

DUKE HUMAN VACCINE INSTITUTE
Nathan Thielman, Prof.

ELECTRICAL AND COMPUTER ENGINEERING
David Brady, Prof.
Rachael Brady, Res. Sci.
Martin Brooke, Assoc. Prof.
April Brown, Prof.
Krishnendu Chakrabarty, Prof.
Leslie Collins, Prof.
Steve Cummer, Assoc. Prof.
Chris Dwyer, Assist. Prof.
Richard Fair, Prof.
Jeff Glass, Prof.
Nan Jokerst, Prof.
Jungsang Kim, Assist. Prof.
Jeffrey Krolik, Prof.
Qing Liu, Prof.
David R. Smith, Prof.
Adrienne Stiff-Roberts, Assist. Prof.
Tomoyuki Yoshie, Assist. Prof.
Hisham Massoud, Prof.
Nikos Pitsianis, Assoc. Res. Prof.

INSTITUTE FOR GENOME SCIENCE & POLICY
Geoffrey Ginsburg, M.D. Prof.
Lingchong You, Assist. Prof.

MATHEMATICS
Stephanos Venakides, Prof.

MECHANICAL ENGINEERING AND MATERIALS SCIENCE
Anne Lazarides, Assist. Prof.

NEUROSURGERY
Gerald Grant, M.D. Assist. Prof.

ONCOLOGY
Victoria Seewaldt, Assoc. Prof.
Neil L. Spector, M.D. Faculty

ORTHOPAEDIC BIOENGINEERING
Farshid Guilak, Assist. Prof.

OPHTHALMOLOGY
Joseph Izatt, Prof.

PATHOLOGY
Gayathri Devi, Assist. Prof.

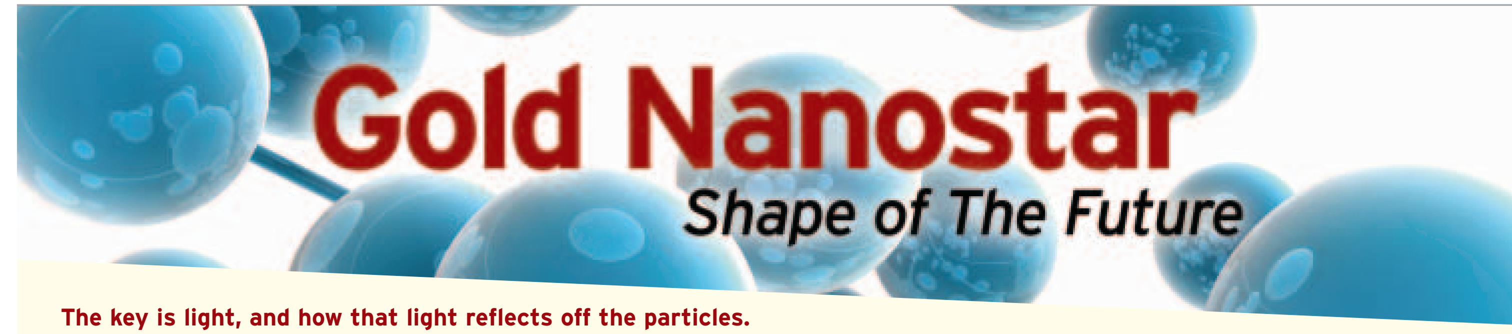
PEDIATRICS
Judith Voynow, M.D. Assoc. Prof.

PHYSICS
Harold Baranger, Prof.
Glenn Edwards, Prof.
Daniel Gauthier, Prof.
Bob Guenther, Res. Sr. Sci.
John Thomas, Prof.

RADIATION ONCOLOGY
Mark Dewhirst, D.V.M. Prof.

RADIOLOGY
G. Allan Johnson, Prof.
James Provenzale, M.D. Prof.
Terry Yoshizumi, Prof.

SURGERY
Gayathri Devi, Assist. Prof.
Kam Leong, Prof.



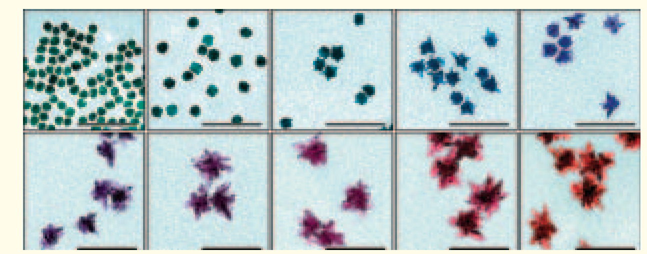
Gold Nanostar
Shape of The Future

The key is light, and how that light reflects off the particles.

Compared to other shapes, nanostars can dramatically enhance reflected light, the Duke scientists found. This increases their potential usefulness as a tracer, label, or contrast agent.

Since researchers also found that the size and shape of the nanostars affect the spectrum of reflected light, they believe that these tiny nanostars can be "tuned" to identify particular molecules or chemicals.

"To our knowledge, this is the first report of the development and use of gold nanostars as labels for molecular detection and description of controlled synthesis of gold nanostars with different sizes and shapes," said **Chris Khoury**, lead author of a paper published in the *Journal of Physical Chemistry*. Khoury is a graduate student in biomedical engineering working in the laboratory of senior researcher **Tuan Vo-Dinh**, R. Eugene and Susie E. Goodson Distinguished Professor of Biomedical Engineering and director of The Fitzpatrick Institute for Photonics at Duke.



> "We are trying to understand which type of nanostructures will give us the optimal signal so we can use them to monitor trace amounts of pollutants or detect diseases in their earliest stage." - VO-DINH

In the Duke experiments, the nanostars were used in conjunction with a phenomena first described in the 1970s known as surface-enhanced Raman scattering (SERS). When light, usually from a laser, is shined on a sample, the target molecule vibrates and scatters back its own unique light, often referred to as the Raman scatter. However, this Raman response is extremely weak. When the target molecule is coupled with a metal nanoparticle or nanostructure, the Raman response is greatly enhanced by the SERS effect – often by more than a million times, Vo-Dinh said.

In the early 1980s, while at the Oak Ridge National Laboratory, Tenn., Vo-Dinh and colleagues were among the first to demonstrate that SERS could be put into practical use to detect chemicals including carcinogens, environmental pollutants, and early markers of disease. Now at Duke, Vo-Dinh is pushing the boundaries of the SERS technology by designing a variety of unique types and shapes of metal nanoparticles that can be used as SERS labels for chemical and biomedical detection.

"We are trying to understand which type of nanostructures will give us the optimal signal so we can use them to monitor trace amounts of pollutants or detect diseases in their earliest stage" Vo-Dinh said. "This study is the first demonstration that these nanostars can enhance the effect of SERS to produce strong and unique signatures, like 'optical fingerprints.'"

Khoury "grew" the nanostars by mixing miniscule gold particle seeds in a growth solution. As more gold was added to the solution, protrusions began to sprout from the central core. Additional gold increased the size of the entire particle.

"These experiments demonstrate that it is possible to vary the size and shape of the nanostars in a controlled fashion by adjusting the volume of gold seeds added to the growth solution," Khoury said. "We found that variations in star size changed the reflected light, which hints toward the tuning capabilities that can be exploited by SERS technology."

For such studies, or those involving environmental contaminants, a dye would be attached to the nanostars and mixed with the sample to be tested. The sample would then be placed under a microscope and hit with a burst of laser energy. Sensors would pick up the Raman scattering and interpret the unique optical fingerprint.

Khoury said that nanostars are small enough to pass through cell walls into the interior of the cell, which would make them an effective method for molecular diagnostics. Nanostars could be attached to an antibody to search for antigens, or coupled with a dye to improve the effectiveness of different imaging tests.

The research was supported by the National Institutes of Health.

AT LEFT:
Tuan Vo-Dinh and Chris Khoury

A Great View

New Technique Sees Into Tissue At Greater Depth, Resolution

LEFT TO RIGHT: *Joseph Izatt, Melissa Skala, Mathew Crow, and Adam Wax*

By coupling a kicked-up version of microscopy with miniscule particles of gold, Duke University scientists are now able to peer so deep into living tissue that they can see molecules interacting.

If future studies in animal models prove fruitful, the researchers believe that their new approach can have a wide spectrum of clinical applications, from studying the margins of a tumor as it is removed from the body to assessing the effects of anti-cancer agents on the blood vessels that nourish tumors.

The Duke bioengineers combined tightly focused heat with optical coherence tomography (OCT), which has often been called the optical equivalent of ultrasound. OCT is commonly used in medical clinics where imaging at the highest resolution is critical, such as in the retina. These experiments represent the first time the technique has been extended to the functional imaging of cells expressing particular molecular receptors.

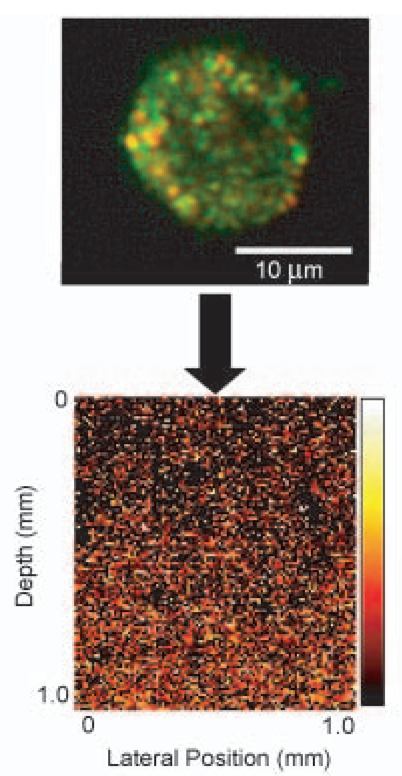
"Not only were we able to get **better images**, we were able to specifically target the types of cells we were looking for."

"This technique could possibly augment traditional methods of deep-tissue molecular imaging with a relatively high resolution," said **Melissa Skala**, a postdoctoral fellow working in the laboratory of **Joseph Izatt**, professor of biomedical engineering in Duke's Pratt School of Engineering. "Not only were we able to get better images, we were able to specifically target the types of cells we were looking for."

The results of the Duke research were posted on line by *Nano Letters*, a journal published by the American Chemical Society. The research was supported by the National Institutes of Health.

For their experiments, the Duke team attached nanospheres of gold to a targeting molecule known as a monoclonal antibody. Gold is a metal that not only is an efficient conductor of heat, but whose effects in the body are well known. The antibody they used targets epidermal growth factor receptor (EGFR), a cell-surface receptor implicated in cancer.

These "tagged" antibodies were then applied to the surface of a three-dimensional tissue model composed of human cells – both cancerous and non-cancerous. Skala hoped that these antibodies would home in on cells that were overproducing EGFR on their surfaces, an indicator of cancerous activity. Then the photothermal OCT would be able to detect them by showing where the gold spheres were concentrated.



In this manner, Skala explained, they were not only able to "see" cells within the tissue, but they were able to capture the molecular function of an antibody attaching to a receptor.

Skala plans to expand the use of this approach in animal models to better understand the role of different cancer therapies. Tumors with elevated levels of EGFR are known to have a poor prognosis, and she plans to use photothermal OCT to measure how these tumor types react to different therapies.

Mark Dewhirst

Other members of the Duke team were **Adam Wax**, Associate Professor of biomedical engineering and his graduate student **Matthew Crow**. Skala also worked with **Mark Dewhirst**, a cancer researcher at Duke University Medical Center, and plans further collaborations with the Dewhirst laboratory to apply this technique to better understand the fundamentals of cancer.

GoldenPotential

Gold, DNA combination may lead to 'nano' sensor

The ability to use genetic material to assemble nanoscopic particles of gold could be an important step toward creating tiny "spies" that will be able to infiltrate individual cells and report back in real time on the cell's inner workings.

A team of Duke University materials engineers and chemists has developed tiny gold nanostructures that can create signals from subtle changes in light reflecting off their nanoscale surfaces. The sub-cellular size of the nanostructures and their ability to absorb or scatter light as their structure changes makes them appealing as biological sensors, the researchers said.

By measuring color changes, researchers can tell what is happening at the molecular level, said lead researcher **Anne Lazarides**, assistant professor of mechanical engineering and materials science at Duke's Pratt School of Engineering. But while these light-reporting particles are relatively easy to see, it is a challenge to get things that small organized.

"When dealing in such small realms, it is important that any nanostructure be able to assemble itself in a reliable and predictable fashion," she said. "We engineered a structure whose organization and response to light are both reproducible and well-controlled."

The results of Lazarides' experiments were published online in Nano Letters, a journal published by the American Chemical Society. The research was supported by the National Science Foundation and the Army Research Office.

The current line of research represents another step in plasmonics research, a field in which researchers use light to control the high frequency motions of electrons in materials. Because of the strength of interactions between light and electrons, the response of metallic particles or combinations of particles to light of particular colors is easy for the human eye to detect, researchers said.

Anne Lazarides

The Duke construct is known as a "core-satellite" structure, resembling a planet with numerous smaller moons tethered to it by tiny strands of DNA. Gold core particles and smaller satellite particles are mixed together in solution with strands of DNA and under controlled circumstances assemble themselves into the desired core-satellite structure.

Following assembly, the structures are ready to be used to detect new strands of DNA, Lazarides explained. If presented with the right DNA molecules, the DNA tethers between the planet and its moons contract or expand. As the satellites move in relation to the core, the optical properties of the structure change.

Theoretically, nanostructures that report on the presence of specific molecules could give scientists or medical researchers key information about processes within the cell, such as cell differentiation or the triggering of protein synthesis from RNA.

"We believe that our findings are important because they demonstrate that these nanoparticle-DNA structures can be engineered to assemble on their own in a controllable manner and that they can be used to measure biological processes in real time," Lazarides said.

According to Lazarides, refinements of the methods will unfold rapidly because "within the team at Duke, we have the unique capability to both self-assemble many structures and monitor the behavior of individual ones."

"We engineered a structure whose organization and response to light are both reproducible and well-controlled."

Other members of the Duke research team were **David Sebba**, mechanical engineering and materials science; **Jack Mock** and **David Smith**, electrical and computer engineering; and **Thomas LaBean**, chemistry and computer science.

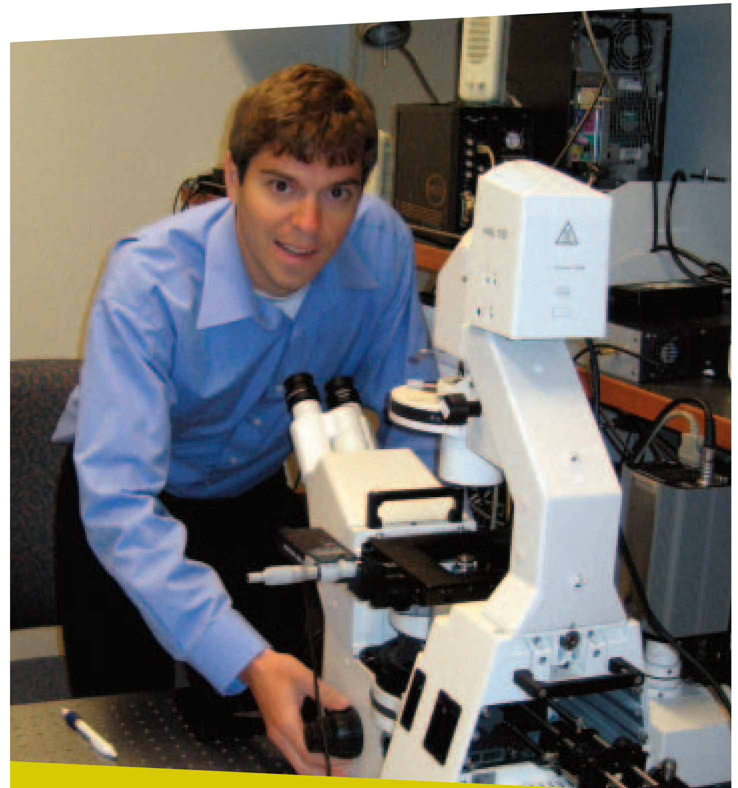
2008 - 2009
JOHN T. CHAMBERS FELLOWS

The Fitzpatrick Institute for Photonics (FIP) is pleased to announce the recipients of the John T. Chambers Fellows for the 2008-2009 academic years. We are delighted to say that with continued support and generosity of John Chambers we are able to provide thirteen (13) graduate students a one-year fellowship program.

Each candidate was nominated by a FIP Professor and judged on the criteria of research accomplishments, research potential, personal qualities and collaborative potential and the following thirteen students were chosen:

Student Fellow Awardee	Advisor	Department
Vivide Chang	Prof. Nimmi Ramanujam	BME
Shiuan-Yeh Chen	Prof. Anne Lazarides	MEMS
Molly Gregas	Prof. Tuan Vo-Dinh	BME
James Joseph	Prof. John Thomas	Physics
Chris Khoury	Prof. Tuan Vo-Dinh	BME
Caleb Knoernschild	Prof. Jungsang Kim	ECE
Kyle McKay	Prof. Jungsang Kim	ECE
Elizabeth Irish Nelson	Prof. Anne Lazarides	MEMS
Matthew Rinehart	Prof. Adam Wax	BME
Matthew Royal	Prof. Nan Marie Jokerst	ECE
Lingling Tang	Prof. Tomoyukie Yoshie	ECE
Yuankai (Kenny) Tao	Prof. Joseph Izatt	BME
Neil Terry	Prof. Adam Wax	BME

Top Row (L-R): Chris Khoury, Molly Gregas, Neil Terry, James Joseph, Kenny Tao, Matthew Rinehart, Shiuan-Yeh Chen, Vivide Chang, Caleb Knoerschild, Kyle McKay, Matthew Royal, Elizabeth Irish Nelson (Not pictured: Lingling Tang)



STUDENT SPOTLIGHT

Matthew Crow

2007 CHAMBERS FELLOW

Matthew Crow graduated from St. Louis University with a BS in Biomedical Engineering. After working in industry for three years, he entered the Biomedical Engineering Ph.D. program here at Duke University. His current research focuses on the development of optical systems for the investigation of nanoparticle biomarkers.

ABSTRACT FROM LATEST RESEARCH:

Fluorescent indicators are the current standard for molecular imaging of receptor expression in live cells. However, photobleaching and cytotoxicity limit the possibilities of long term and clinical studies. As an alternative, immunolabeled nanoparticle (NP) biomarkers can quantify receptor expression levels while avoiding these issues. In addition, NP biomarkers can be used to reveal additional intracellular refractive index information. In this study, we compare epidermal growth factor receptor (EGFR) expression of both human epidermoid carcinoma and astrocytic tumor cells using both imaging methods. To enhance contrast of the NP biomarkers, a microspectroscopy system is used that includes an epi-illumination darkfield light train. We demonstrate that molecular imaging with immunolabeled NPs can quantitatively measure EGFR expression levels with comparable sensitivity to fluorescence measurements. Because of the additional information available from NP scattering spectra, immunolabeled NPs show promise for their ability to better characterize receptor expression compared to fluorescent-tagged imaging.

Inaugural Meeting of the Carolina Photonics & Optics Investor Conference - DUKE UNIVERSITY

The Fitzpatrick Institute for Photonics hosted the inaugural meeting of the **Carolina Photonics & Optics Investor Conference** on June 3, 2008 at Duke University. This conference has evolved from the partnership and collaborative efforts of the following institutions: Carolina Photonics Consortium (CPC); Technology Entrepreneurship and Commercialization (TEC) Center at NC State University; Center for Entrepreneurship and Research Commercialization (CERC) at Duke University, and the Fitzpatrick Institute for Photonics at Duke University.

The goal of the conference was to provide a forum where a select number of photonics-based technology companies at various stages of growth can present their products to potential investors.

"This inaugural meeting has been a great success. It has helped created many networking opportunities between companies, researchers, entrepreneurs and VCs", said **Tuan Vo-Dinh**, Director of the Fitzpatrick Institute for Photonics.

"With over 100 attendees and 12 presenting companies, the conference was a good measure of the critical mass of photonics-based companies and investor interest in the Carolinas. It was also noteworthy that this investor conference was the first "photonics only" conference in the country, which speaks volumes about photonics in the Carolinas." said **Jeff Conley**, Manager of the Carolina Photonics Consortium.

CPC Carolinas Photonics Consortium

With over 100 attendees and 12 presenting companies, the conference was a good measure of the critical mass of photonics-based companies and investor interest in the Carolinas.

The session on Growth Stage Companies included presentations from the following companies: **Semprius**, **Bioptigen**, **Southeast TechInventures**, and **Sensory Analytics**.

The session on Early Stage Companies included presentations from the following companies: **Selah Technologies**, **InnerOptic**, **M Bright**, **Oncoscope**, and **Protochips**.

The session on Seed Stage Companies included presentations from the following companies: **Blue Angel Optics**, **Endls Optics**, and **HueMetrix**.

Five companies invited to present their products are start-ups from FIP faculty: **Bioptigen**, **M Bright**, **Oncoscope**, **Blue Angel Optics**, and **Endls Optics**.

The Carolina Photonics & Optics Investor Conference also included a session highlighting several seed projects funded by the **Carolina Photonics Consortium** (CPC). The Fitzpatrick Institute for Photonics (FIP) is a founding member of the CPC, which includes Duke University, Eastern Carolina University, North Carolina State University, the University of North Carolina-Charlotte, Western Carolina University, and Clemson University. One of the primary goals of the CPC is the commercialization of photonics-based research by awarding funds to competitively submitted proposals from the member campuses.

Graduate Certificate in Photonics

"Photonics technology has the ability to change everything from communications to process control to patient care and Duke's Fitzpatrick Institute is positioned to provide the kind of market facing innovations that will drive that change."
- BARRY S. MYERS, MD, PHD, MBA

In recognition of the growing importance of photonics as an enabling multidisciplinary field, Duke University's world-class Fitzpatrick Institute for Photonics (FIP) and the Pratt School of Engineering provide Masters and Doctoral candidates with the following options in the study of photonics.

Earn a Photonics Certificate in conjunction with your Doctoral (PhD), Masters of Science (MS), or Master of Engineering Management (MEM) degree.

The Photonics Graduate Certificate enables students to broaden the scope of the typical disciplinary graduate student-training program. Students are encouraged to develop interdisciplinary and transferable sets of skills in their course work and research activities. Certificate requirements include:

- Four photonics courses from approved course listings, one of which must be a qualified "Introductory Survey Course"
- One research presentation for the Fitzpatrick Institute Student Groups
- Attend at least four FIP seminars/yr
- PhD candidates only: dissertation committee to include a FIP member

Further information, including approved course listings and the application process, is available at **www.fitzpatrick .duke.edu/**; choose Education from the menu.

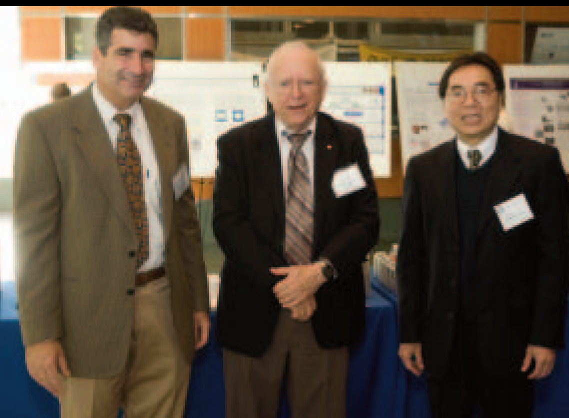
Concentrate on Photonics as part of a Master of Engineering Management (MEM) degree.

Further information on MEM technical electives and concentrations is available at **http://memp. pratt.duke.edu/**; choose Interdisciplinary Courses and Curriculum from the menu.

"The partnership between the Fitzpatrick Institute for Photonics and the Master of Engineering Management Program at Duke University allows students to study photonics science and technology AND to understand how such technology is managed in the business world. It is a rare benefit to have a world class program in photonics and engineering management within the same institution!" - JEFFREY T. GLASS, PHD, MBA

2008 FIP PHOTONICS PIONEER AWARD

The 2008 FIP Photonics Pioneer Award was presented to Dr. John L. Hall during the Banquet Ceremony at the 2008 Annual Meeting



Left to right: *Dean Tom Katsouleas, Dr. John Hall and Dr. Tuan Vo-Dinh*

About Dr. John L. Hall

Dr. Hall was awarded the 2005 Nobel Prize in Physics, sharing this honor with Theodor W. Hänsch of the Max-Planck-Institute (Garching) and Roy J. Glauber of Harvard University. This recognition was awarded "for their contributions to the development of laser-based precision spectroscopy, particularly the optical frequency comb technique." The optical frequency comb can rapidly measure the frequency of another laser with extraordinarily high precision, and has many broader applications in Science, Metrology and, most recently, in Diagnostic Medicine.

John L. Hall received his PhD.(1961) degree from Carnegie Tech (now Carnegie Mellon University). He had 44 good years of research at the National Institute of Standards and Technology (NIST), working in laser technology, opto-electronic development and precision measurement. He is now NIST Senior Fellow Emeritus, Adjunct Professor of the University of Colorado, and an Adjunct Fellow of JILA (formerly the Joint Institute for Laboratory Astrophysics), a cooperative institute of NIST and the University of Colorado-Boulder. Known as a preeminent laser experimentalist and innovator, Dr. Hall has contributed significantly to the evolution of the laser from a laboratory curiosity into one of the fundamental tools of modern science. He is known also for his training and mentoring of new generations of inspired physicists, several now star researchers themselves.

PREVIOUS FIP PHOTONICS PIONEER AWARD

- 2006, FIP Photonics Pioneer Award, Dr. Charles Townes

2008 FIP ANNUAL MEETING

Fitzpatrick Institute for Photonics Annual Meeting Recap

The 8th Annual Meeting of the Fitzpatrick Institute for Photonics was held at Duke University on October 13-14, 2008. The Symposium, entitled **"Frontiers in Photonics Science and Technology"**, was designed to bring together scientists from multiple disciplines, and provide a forum for presentation and discussion of research, application and development of state-of-the-art instrumentation in photonics.

Dr. John L. Hall, 2005 Nobel Laureate in Physics, delivered the Keynote Address. Dr. Ian Walmsley, Hooke Professor of Experimental Physics, University of Oxford, United Kingdom and Dr. John Thomas, Fritz London Professor of Physics, Duke university delivered the two Plenary Lectures.

The 2008 Annual Meeting included Special Topic Sessions on Coherence and Imaging Techniques, with invited speakers including: Professor Robert Boyd, University of Rochester, Professor John Schotland, University of Pennsylvania, and Professor Aristide Dogariu, University of Central Florida.

As interdisciplinary research is the key to future advances in science and technology, there was a Special Panel Session entitled "What Physicians Request from Biophotonics Engineers," where several physicians from Duke Medical School were invited to discuss "what MDs need from engineers." The 2008 meeting program included lectures from distinguished speakers, contributed papers, and posters by investigators from Duke University and other academic and industrial institutions.

For more information, the scientific program of our 2008 Annual Meeting is available on the following website: **http://www.fitzpatrick.duke.edu/2008fipannualsymposium.html**

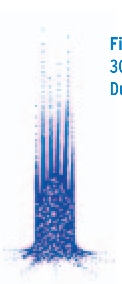
RECENT EVENTS

DUKE WORKSHOP ON ENERGY RESEARCH OPPORTUNITIES

Faculty of the Fitzpatrick Institute of Photonics participated in a Duke Workshop on Energy Research Opportunities at Beaufort, NC, Nov. 21-23, 2008. This meeting was designed to be a forum for exchange of ideas and a brainstorming session to identify promising directions for future research and research collaborations focused on energy research. Workshop participants included Duke faculty members and researchers as well as selected invited guest speakers including Prof. Mark Ratner, Northwestern University, co-chair of the 2008 DOE report "Directing Matter & Energy: Five Challenges for Science and the Imagination." Dr. Carol A. Bessel, Program Director at the National Science Foundation (NSF) presented by video conference an overview of NSF current portfolio and initiatives in energy. The workshop organizers were FIP faculty members, Professors **April Brown**, **David Beratan** and **Tuan Vo-Dinh**.

DukeBroadband

DukeBroadband is published semi-annually by the Fitzpatrick Institute for Photonics, Pratt School of Engineering, Duke University. Edited by: Adam Wax, Tuan Vo-Dinh, August Burns, and Deborah Hill. Direct comments to august.burns@duke.edu.



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