

# Physics & Astronomy Department Newsletter

## Vol. 4, No. 1 (Fall 2016-Summer 2017)



ST. CLOUD STATE  
UNIVERSITY

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Mission: Apply theoretical, computational, observational, and experimental methods to explore and understand the natural world.

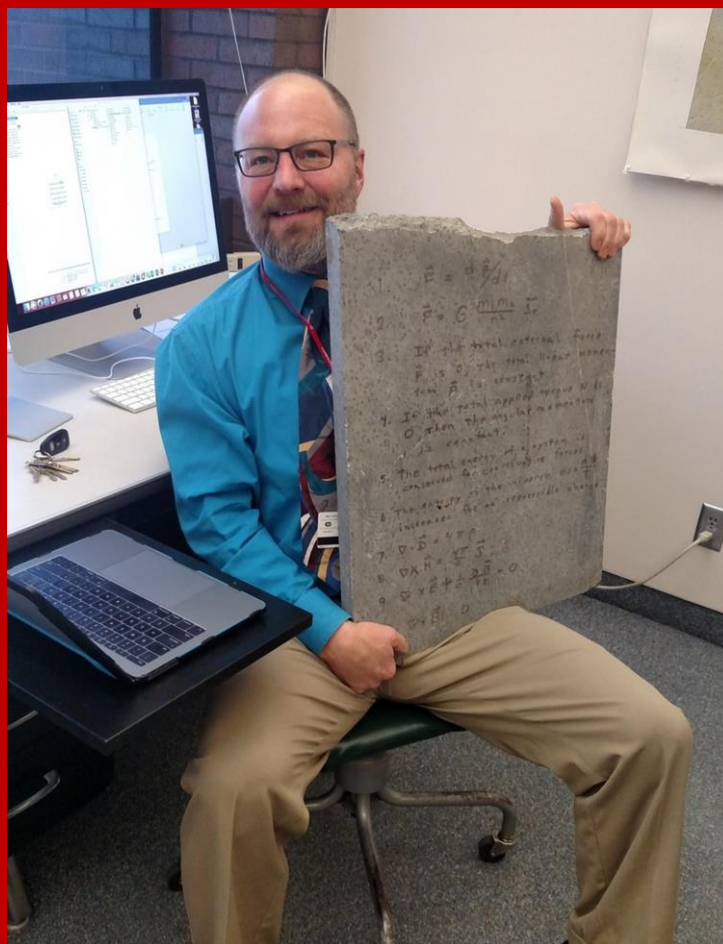
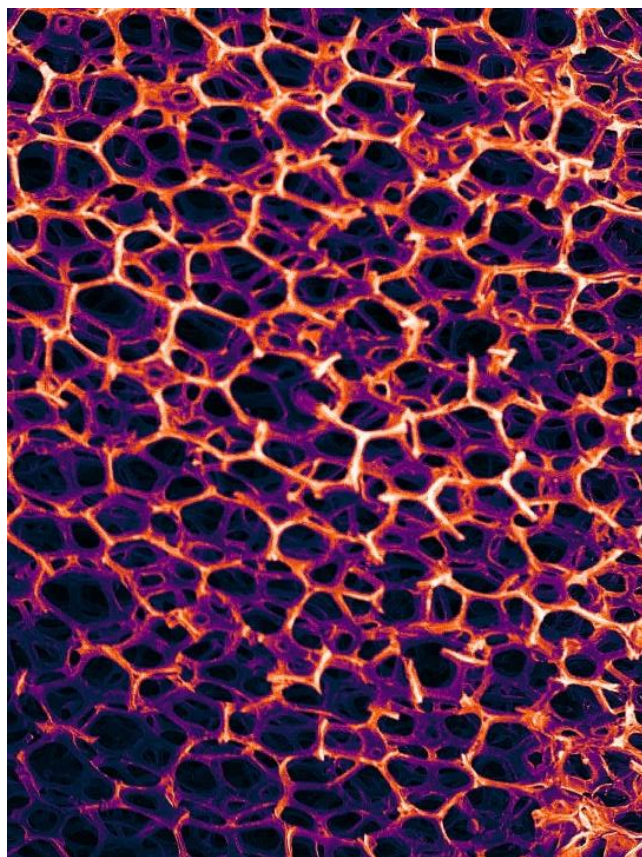
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### Message from the Chair:

It is a privilege and an honor to serve as the chairperson of the department of Physics and Astronomy. While it might seem unusual to have a Biologist as chair, I recognize the pivotal role physics has in the education and disciplines of Chemistry, Biology, and Engineering students. I know how professionally the faculty in this department approach their job, and it is my job to be sure that they can do their jobs. If I can do this, the Physics club and the Physics majors will remain healthy and strong. There are challenges facing all of higher education across the nation, and we are no different. But again, Physics is at the core of science, and by remembering this, Physics and Astronomy, our Department will continue to thrive.

With Best Regards,

Christopher Kvaal  
Professor  
St. Cloud State University



Editor: Dr. John E. Sinko

Send news to [jesinko@stcloudstate.edu](mailto:jesinko@stcloudstate.edu)

or

Physics Department Newsletter  
309 Wick Science Building, SCSU  
720 4<sup>th</sup> Ave. South, St. Cloud, MN 56301

## Physics & Astronomy Facilities Updates (2016-2017)

### Computational Physics Room

WSB 343

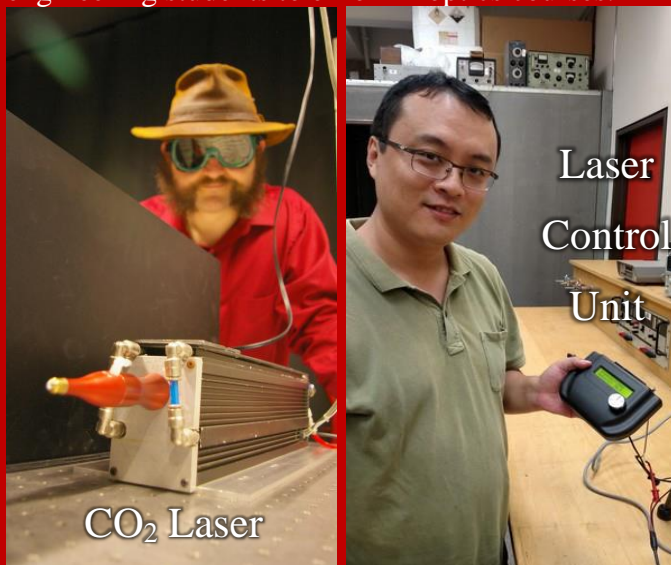
Dr. Haglin renovated Wick 343 to establish a new computational physics research space, addressing strong student interest in theoretical and computational physics. Contact Dr. Haglin to learn about computational physics research opportunities.



### Synrad 10 Watt CO<sub>2</sub> Laser

ISELF 20

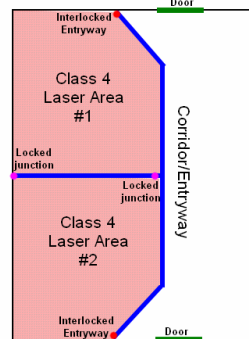
This year, through his participation with the Minnesota Optical Society, Dr. Sinko arranged for SCSU to acquire a ~10 Watt CO<sub>2</sub> laser. This several-thousand dollar-value instrument was donated by 3M, arranged by SCSU physics alumnus Bernie Koch, now an employee at 3M. The laser head did not have a cooling module or controller on arrival, and requires a kHz “tickler” PWM pulse train to operate. Dr. Liu came to the rescue and quickly built an easy-to-use control module that allows power adjustment by the user. Although the laser still needs a chiller, Dr. Sinko plans to use the laser in student projects for the 2017-2018 school year, encouraging engineering students to enroll in optics courses.



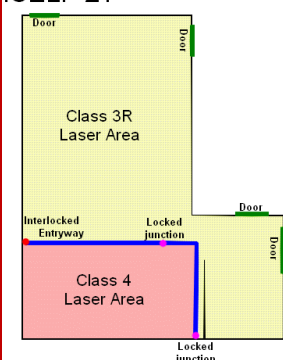
### Laser Safety Infrastructure in ISELF 21

ISELF 20 and 21

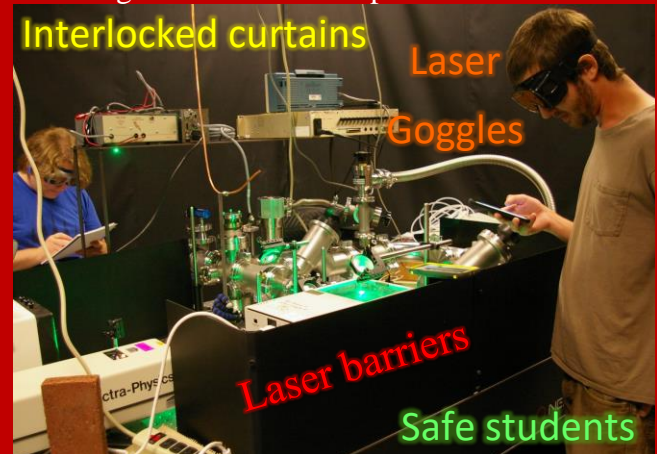
ISELF 20



ISELF 21



Dr. Sinko oversaw safety upgrades to the high power laser spaces in ISELF 20 and 21 including designating safe and hazardous laser areas, Jeff Yurczyk's installation of optical interlocks on laser curtains, and - with Russ Lidberg's help - installing laser barriers on optical tables.





## **Physics & Astronomy Club News (1/2)**

### **MainStreet**

Physics majors and faculty recruited new club members for the 2016-2017 year during the SCSU MainStreet event.

(Below: physics majors Sutapa Biswas and Christopher Crawford at Mainstreet with various physics demonstrations)



### **Halloween Pumpkin Drop!**

The Physics & Astronomy Club's annual test of gravity commenced October 31<sup>st</sup>, 2016. According to a student spokesperson, gravity is still operational and several pumpkins were reliably accelerated under its influence.

(Below: pumpkin acceleration under 1g load)



### **Purdue Trip**

SCSU physics majors Alexis Corbett, Chris Crawford, Travis Hislop, William Julius, and Meredith Rupp traveled to Purdue University in West Lafayette, Indiana on September 25-26, 2016 for the Big Ten+ Graduate School Exposition. This professional development opportunity is designed for STEM students to learn about how to successfully prepare for graduate school. After returning to SCSU, the students presented an overview of the trip to their fellow students.

(Below: Students present about the Graduate School Expo)



### **Club Game Nights**

Physics & Astronomy Club members met several times during the 2016-2017 academic year for board game nights. Competitive and cooperative games are both popular, including some physics-themed games like Schrödinger's Cats, The Manhattan Project, and Nuclear War. These are great opportunities to connect with other physics students.

(Below: students pose for a photo after playing board games)

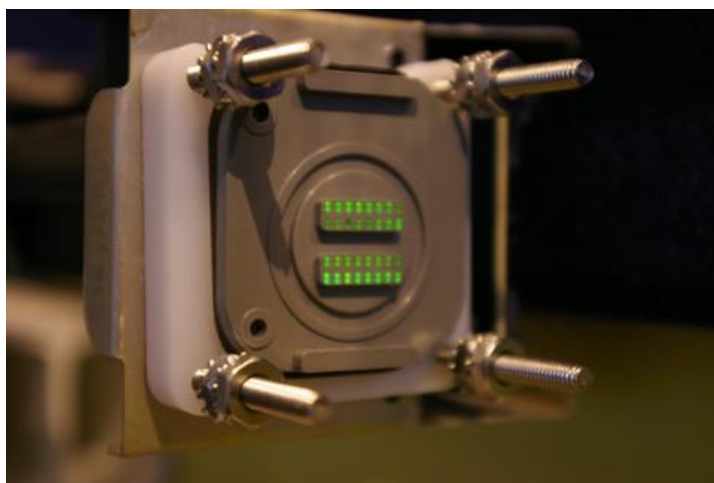




## Physics & Astronomy Club News (2/2)

### NOvA Far Detector Trip

On 4-5 March 2017, undergraduate students Chris Crawford, William Julius, Travis Mathwig, and Meredith Rupp, with Dr. Sinko, visited the NOvA detector in Ash River, Minnesota. This student-organized trip included a full walking tour of the particle detector facilities and some question and answer time with one of the monitoring technicians. The NOvA experiment is an effort to better understand the underlying mechanics behind neutrino oscillations, a process by which one kind of neutrino (in this case, a muon neutrino) turns into a different kind of neutrino (in this case, an electron neutrino). The number of each kind of neutrinos created at Fermi Lab (near Chicago) is measured once at the on-site Near Detector. The neutrino beam then passes through 810 km of dirt and rock to the Far Detector at Ash River, MN. Along the way, a fraction of the muon neutrinos turn into electron neutrinos. The particle numbers are measured a second time at the Far Detector. The results of the experiment may shed light on the neutrino mass hierarchy, and on why our universe appears to have more matter than antimatter.



## Community Engagement and Active Learning

### Arduino!

In Fall 2016, Prof. Liu developed and ran open workshops to teach use of Arduino for interested SCSU student, faculty and staff. Arduino is a type of open-source prototyping platform for electronics that can be used to support engaged learning, physics demonstrations, and research. Workshop dates were 9/28/2016, 10/11/2016, 10/27/2016, 11/16/2016, and 11/17/2016.



### Class Trip to See the Stars

In Fall 2016, Prof. Polomski took her ASTR 323 class (Observational Astronomy) on a field trip to Eagle Lake Observatory, a site run by the Minnesota Astronomical Society (<http://www.mnastro.org/>). Students stayed into the evening observing stars using the many large telescopes available at the observatory. (Photos at right).



Image Credits: NASA  
(<https://www.nasa.gov/modernfigures/images>)

### Special Showing: 'Hidden Figures'

In her role as co-chair of the St. Cloud State University WE-STEM (Women Engaged in Science, Technology, Engineering, and Mathematics) group, Dr. Elisha Polomski and the Physics & Astronomy Club were awarded grant funding from the American Association of University Women and from the St. Cloud State University Student Government to host a special showing of the movie "Hidden Figures". The movie depicts the true story of the key roles women of color played in the early space program.

(At Left: Several of the women profiled in the movie: (from left to right) NASA computer scientist Dorothy Vaughan, mathematician Katherine Johnson, and aerospace engineer Mary Jackson)



## Physics & Astronomy in the 2017 Student Research Colloquium

### AWARDS AT THE 2017 SRC

2017 SCSU SRC 1st Place Graduate Poster

Anthony Kunkel

Faculty Sponsor: Dr. Kevin Haglin

"Light from Freezing Quarks"

2017 SCSU SRC Finalist

Michael Rogers

Faculty Sponsor: Russ Lidberg

"Photophysics of Organic Materials by Pump Probe Spectroscopy"



### CREATIVE WORKS

Student	Faculty Sponsor(s)	Title of Project
Eu Sheng Chung, Amila DeSilva, & Dareck Tamariz	John Sinko	Vision System for Factory

### ORAL PRESENTATIONS

Student	Faculty Sponsor(s)	Title of Project
Benjamin Boe	Kevin Haglin	Dirac's Inferno: Quantum Mechanics in a Tight Hot Hell

### POSTERS

Student	Faculty Sponsor(s)	Title of Project
Tyler Baxter	John Sinko	Laser-Induced Carbon-Doped Carbonate Propellant Decomposition for Beamed Energy Propulsion
Benjamin Boe	Kevin Haglin	Dirac's Inferno
Alexis Corbett, Travis Hislop, & Meredith Rupp	John Sinko	Diffuse Reflectance Study of Thermochromic Materials for Sustainable Energy Coatings
Chris Crawford	Elisha Polomski, John Sinko	Supernova Shockwaves through a Nebula-like Plasma
Sam Hartman	John Sinko	Torsion Pendulum for Laser Thrust Detection
Seth Hennagir	Russ Lidberg	Charge Carrier Mobility Studies in Polyacenes
Travis Hislop	Zengqiang Liu	Development of a Random Number Generator for Modeling
Anthony Kunkel	Kevin Haglin	Light from Freezing Quarks
Michael Rogers	Russ Lidberg	Photophysics of Organic Materials by Pump-Probe Spectroscopy
Yesenia Vega	John Sinko	Smart Materials

## Physics & Astronomy Student Awards, Fa 2016-Sp 2017

St. Cloud State University – College of Science & Engineering – Dean's List

### SCSU COSE Dean's List Fall 2016

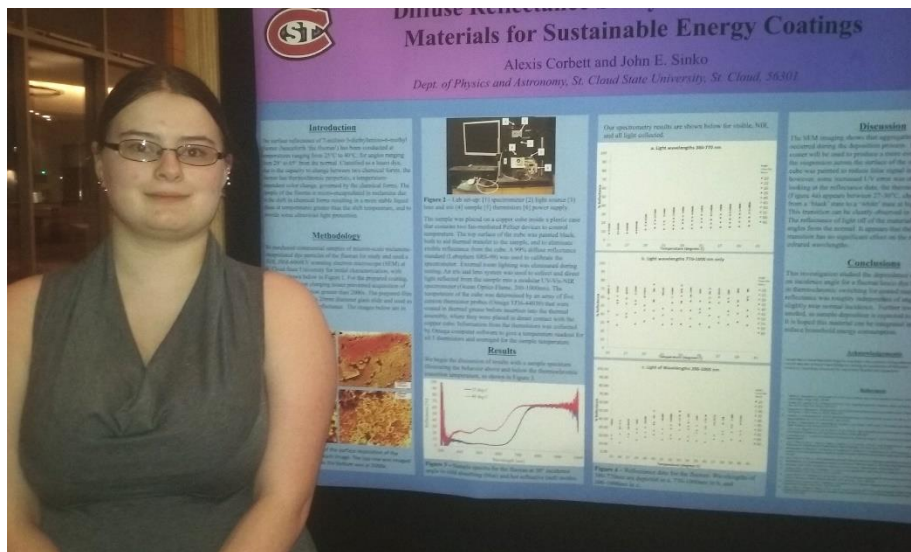
Chase Negen  
Joshua Wallin

### SCSU COSE Dean's List Spring 2017

Donovan Bassett  
Michael Free  
William Julius  
Chase Negen  
Yasmine Rajkarnicar  
Meredith Rupp

### Additional Student Highlights

- Physics major **Alexis Corbett** presented a poster on her work on “Angle Dependence of Diffuse Reflectance for a Microencapsulated Thermochromic Coating”, on November 29, 2016 in Symposium BM7: Functional Nanostructured Polymers for Emerging Energy Technologies at the 2016 Fall Meeting & Exhibit of the Materials Research Society in Boston, MA.
- Physics major **Alexis Corbett** presented a poster on her work, “Diffuse Reflectance Study of Thermochromic Materials for Sustainable Energy Coatings” at the American Physical Society (APS) Conference for Undergraduate Women in Physics (CUWiP), held January 13-15 2017 at the University of Wisconsin-Madison in Madison, WI.
- Physics major **Tyler Baxter** presented his work on “Laser-Induced Carbon-Doped Carbonate Propellant Decomposition for Beamed Energy Propulsion” on July 12, 2017 at the 53<sup>rd</sup> AIAA/SAE/ASEE Joint Propulsion Conference and Exhibit in the AIAA Propulsion and Energy Forum in Atlanta, GA.
- Physics major **Sam Hartman** attended the 53<sup>rd</sup> AIAA/SAE/ASEE Joint Propulsion Conference and Exhibit in the AIAA Propulsion and Energy Forum in Atlanta, GA.
- Physics major **Christopher Crawford** earned an internship with Talon Innovations in Sauk Rapids, MN for 2017-2018. Talon makes gas delivery systems for the semiconductor industry, and aerospace components. Chris is working on improving their electropolishing and passivation procedures and is currently designing better fixtures.



Above: (left) Alexis Corbett presents her research work on thermochromic materials at the Conference for Undergraduate Women in Physics; (right), Dr. Sinko, Sam Hartman, and Tyler Baxter at the AIAA Propulsion & Energy Forum; Tyler Baxter presented his research work on laser propulsion propellants.



### Physics & Astronomy Student Research Awards, Fa 2016-Sp 2017

Physics & Astronomy was well-represented in the Fall 2016 and Spring 2017 SCSU Student Research Awards. Eleven physics students were awarded for twelve projects supervised by four Physics & Astronomy Department sponsors. The total value of these projects was \$ 9,536 out of \$ 39,849 awarded to 59 projects across the entire university. In addition to student travel funding and basic research supplies, the awards paid for electronics, pressure sensors, high vacuum components, infrared thermometers, and other instruments which will be available for our students in undergraduate research for years to come. More importantly, our students practiced valuable skills including grant proposal writing, collecting data, maintaining a laboratory notebook, and making formal research presentations.

#### Fall 2016 and Spring 2017 Student Research Awards

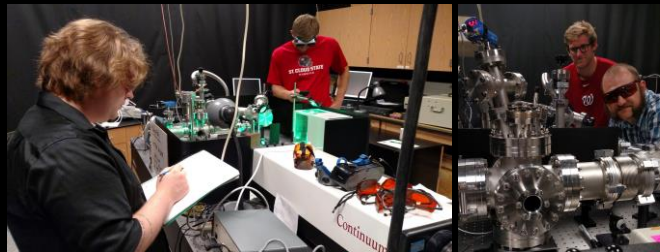
- **Tyler Baxter** Faculty Sponsor: John Sinko \$ 872  
"Laser Astronaut Retrieval"
- **Tyler Baxter** Faculty Sponsor: John Sinko \$ 1000  
"Laser Induced Carbon Doped Carbonate Propellant Decomposition for Beamed Energy Propulsion"
- **Satya Chinnamaneni** Faculty Sponsors: John Sinko and Kannan Sivaprakasam \$ 398  
"Synthesis of Iron doped TiO<sub>2</sub> for photo catalytic and optical applications"
- **Eu Sheng Chung** Faculty Mentor: John Sinko \$ 932  
"Vision system for factory"
- **Alexis Corbett** Faculty Mentor: John Sinko \$ 500  
"Diffuse Reflectance Study of Thermochromic Materials for Sustainable Energy Coatings"
- **David Corgard (Declined)** Faculty Mentor: John Sinko ~~(\$ 455)~~  
"Novel Wavelength Solid State Laser"
- **Christopher Crawford** Faculty Mentors: Elisha Polomski and John Sinko \$ 999  
"Supernova Shockwave Propagation through a Nebula like Plasma"
- **Javier Galeano (Declined)** Faculty Mentor: John Sinko ~~(\$ 700)~~  
"Identification of compounds using light absorption spectroscopy in the 405nm to 500nm wavelength range"
- **Sam Hartman** Faculty Mentor: John Sinko \$ 810  
"Torsion Pendulum for Laser Thrust Detection"
- **Seth Hennagir** Sponsor: Russ Lidberg \$ 987  
"Charge Carrier Mobility Investigations in Oligioacene Compound"
- **Travis Hislop** Faculty Sponsor: Zengqiang "John" Liu \$ 988  
"Development of a Random Number Generator for Modeling"
- **Meredith Rupp, Alexis Corbett, and Travis Hislop** Faculty Mentor: John Sinko \$ 895  
"Reaction of Thermochromic Materials to Sunlight"

Department	Biology	Physics	Information Systems	Electrical & Computing Engineering	Chemistry & Biochemistry	Community Psychology, Counseling and	Medical Laboratory Science	Comp. Science & Information Technology	Anthropology	Communication Sciences and Disorders	Geography & Planning	Psychology	Social Work
Total \$	\$ 11677	\$ 9536	\$ 2475	\$ 2422	\$ 2285	\$ 2278	\$ 1879	\$ 1809	\$ 1601	\$ 1500	\$ 1000	\$ 890	\$ 497
# Projects	14	12	5	4	3	6	2	3	2	3	2	2	1
# Students	17	11	5	12	4	7	4	7	2	4	2	4	1
# Faculty	8	4	1	4	3	4	1	2	1	2	1	1	2



## **Student Research in Physics & Astronomy 2016-2017**

### **Building a Laser Tractor Beam**



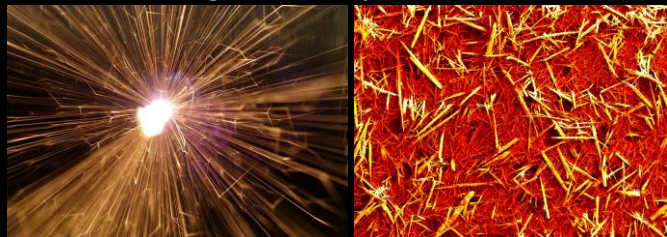
Students Tyler Baxter and Sam Hartman worked with Dr. Sinko in ISELF 21, using high power lasers, optical sensors, and vacuum chambers to research tractor beams to rescue astronauts or deorbit space debris.

### **Analyzing Color Changing Solar Materials**



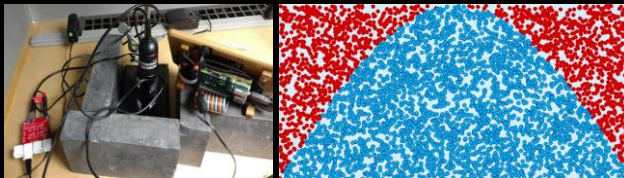
SCSU students Alexis Corbett, Meredith Rupp, Travis Hislop, and Yesenia Vega worked with Dr. Sinko using a UV-visible spectrometer and scanning electron microscopy to characterize the optical behavior of color-changing materials for application to solar thermal coatings for energy savings.

### **Characterizing Dust for Supernova Shock Waves**



SCSU student Christopher Crawford worked with Dr. Polomski and Dr. Sinko on characterizing micron-scale granular materials by scanning electron microscopy. Samples will be used in laser experiments to simulate supernova shock waves in a stellar nebula.

### **Generating Random Numbers**



True random numbers are hard to generate for applications like encryption. One option is use of a random process like nuclear decay. SCSU student Travis Hislop worked with Dr. Liu and built a working random number generator seeded by radiation counts, using an Arduino Uno and Raspberry Pi 3+. The data was tested in a Monte Carlo simulation.

### **Radiation Physics and Medical Physics**

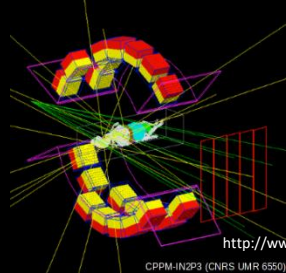


Image source:  
<http://www.opengatecollaboration.org/>  
CPPM-IN2P3 (CNRS UMR 6550)

Past SCSU student research projects have included projects in radiation-induced thermoluminescence, retrospective dosimetry, radiation measurements, and radiation transport calculations. Please contact Dr. Ratliff for more information if you are interested in doing research with him.

### **Theoretical Particle Physics**



Students Anthony Kunkel and Benjamin Boe worked with Dr. Haglin to study quantum systems with quarks. If you are interested in theoretical physics research or in learning more about particles, contact Dr. Haglin!

**Physics & Astronomy Faculty 2016-2017**

**Dr. Kevin Haglin**

Professor, Physics  
Department Chair



Theoretical Physics

**Dr. Sneha Kalia**

Professor, Physics



Physics

**Prof. Annette Lee**

Associate Professor, Astronomy  
SCSU Planetarium Director



Astronomy

**Dr. Zengqiang (John) Liu**

Associate Professor, Physics



Experimental Physics

**Dr. Christofer Nelson**

Assistant Professor, Physics



Structural Glass, Theoretical Materials

**Dr. Elisha Polomski**

Assistant Professor, Physics  
WE-STEM Coordinator



Astrophysics, Women Engaged in STEM

**Dr. Steven Ratliff**

Professor, Physics  
Director of Rad Tech, Nuc Med Tech Programs



Medical Physics, Radiation Transport

**Dr. John Sinko**

Assistant Professor, Physics  
SCSU Laser Safety Officer



Experimental Physics, Optics, Materials

**Dr. Todd Vaccaro**

Assistant Professor, Physics



Astrophysics, Astronomy



## Faculty Scholarly Achievements

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### Papers

- Tyler R. Baxter and **John E. Sinko**, "Laser-Induced Carbon-Doped Carbonate Propellant Thermal Decomposition for Use in Beamed Energy Propulsion," 53<sup>rd</sup> AIAA/SAE/ASEE Joint Propulsion Conference, AIAA Propulsion and Energy Forum, 10-12 July 2017, Atlanta, GA, USA, AIAA 2017-4958 (2017). <https://doi.org/10.2514/6.2017-4958>
- **A. Lee**, "Celestial Calendar-Paintings and Culture-Based Digital Storytelling: Cross-Cultural, Interdisciplinary, STEM/STEAM Resources for Authentic Astronomy Education Engagement," Proceedings of IAU International Symposium on Education in Astronomy and Astrobiology, 3-7 July 2017, Utrecht, Netherlands (In Press)
- **C. B. Nelson** and H. Fang, "Tight binding model of catalysis mechanisms in 6 nm Co-O particles," submitted to *Journal of Applied Physics* (under revision).
- **C. B. Nelson**, T. Zubkov, J. D. Adair, and M. Subir, "A Synergistic Combination of Local Tight Binding Theory and Second Harmonic Generation Elucidating Surface Properties of ZnO Nanoparticles," submitted to *The Royal Society of Chemistry: Physical Chemistry Chemical Physics* (under revision).
- **John E. Sinko**, Alexis J. Corbett, Travis L. Hislop, and Meredith E. Rupp, "Angle Dependence of Diffuse Reflectance for a Microencapsulated Thermochromic Coating," *MRS Advances* 2(6), 369-374 (2017). <https://doi.org/10.1557/adv.2017.1>
- **John E. Sinko**, Tyler R. Baxter, Mark Gill, and Clifford A. Schlecht, "Thrust Assessment for a Laser Tractor Beam Target," 53<sup>rd</sup> AIAA/SAE/ASEE Joint Propulsion Conference, AIAA Propulsion and Energy Forum, 10-12 July 2017, Atlanta, GA, USA, AIAA 2017-4960 (2017). <https://doi.org/10.2514/6.2017-4960>

### Professional Presentations

- 10/2016     **Annette Lee**     "Native Skywatchers – Earth Sky Connections": Condor SWAP program, CUNY, NY.
- 6/2017     **Annette Lee**     "Star Maps, Planispheres, and Celestial Calendars: Engaging Students, Educators, and Communities with Multicultural STEM/STEAM Visual Resources": AAS Meeting
- 7/2017     **Annette Lee**     "Native Skywatchers – Earth Sky Connections": World Indigenous Conference on Education (WICPE), Ontario, Canada
- 7/2017     **Annette Lee**     "Celestial Calendar-Paintings and Culture-Based Digital Storytelling: Cross-Cultural, Interdisciplinary STEM/STEAM Resources for Authentic Astronomy Education Engagement": IAU International Symposium on Education in Astronomy and Astrobiology, Utrecht, Netherlands.
- 9/2017     **Annette Lee**     "Interdisciplinary, Intercultural, Community-Based Education Practices at the Intersection of Art-Science-Culture": INSAP-OXFORD-SEAC, Spain
- 7/26/2017     **Zengqiang Liu**     "Engaged and Individual Learning Using a Student's Own Mistakes": American Association of Physics Teachers (AAPT) Summer Meeting, Cincinnati, OH USA
- 6/12/2017     **John Sinko**     "Thermochromic Materials": Material Technology Institute (MTI) annual meeting, 3M Innovation Center, St. Paul, MN USA
- 7/12/2017     **John Sinko**     "Thrust Assessment for a Laser Tractor Beam Target": 53<sup>rd</sup> AIAA Joint Propulsion Conference, Hyatt Regency Atlanta, Atlanta, GA USA

## Faculty Grant Proposals

### Submitted

<b>5/2017</b>	<b>Zengqiang ‘John’ Liu (PI)</b> and Jeffrey Cheng (Co-PI) Minnesota Legislative Citizen Council on Natural Resources “Digital Watershed Simulator for K-12 Education and Outreach”	\$314,489
<b>5/2017</b>	<b>John Sinko (PI)</b> , Kannan Sivaprakasam (Co-PI), and Jeffrey Cheng (Co-PI) Minnesota Legislative Citizen Council on Natural Resources “Color-Change Solar Coating for Residential Energy Savings”	\$151,306
<b>5/2017</b>	Kannan Sivaprakasam (PI), Jeffrey Cheng (Co-PI), and <b>John Sinko (Co-PI)</b> Minnesota Legislative Citizen Council on Natural Resources “Innovative Technology to Remove Nitrate from Surface Water”	\$173,847
<b>5/2017</b>	Geraldine Peters (PI), R. E. Wilson (Co-PI), and <b>Todd Vaccaro (Co-PI)</b> NASA Astrophysics Data Analysis (NNH17ZDA001N-ADAP) “Analysis of Semi-Detached Binaries with Advanced Modeling”	\$36,000
<b>1/2017</b>	<b>John Sinko (PI)</b> , Kannan Sivaprakasam (Co-PI), <b>Chris Nelson (Co-PI)</b> , and Thomas Gardner (Co-PI) National Science Foundation: Designing Materials to Revolutionize and Engineer our Future “DMREF: Thermochromic Solar Infrared Switching Coatings”	\$928,797

### Awarded

<b>4/2017</b>	<b>Annette Lee (PI)</b> SCSU Cultural Diversity Grant “Interdisciplinary STEM and Native Skywatchers – Student Research Experiences”	
<b>5/2017</b>	<b>Annette Lee (PI)</b> SCSU Short Term Faculty Improvement Grant “Digital Storytelling Workshop: Engaging Large Lecture Introductory Astronomy Students with the Creation of Short Storytelling Videos”	\$1,962
<b>2/2017</b>	<b>Elisha Polomski (PI)</b> SCSU Long Term Faculty Improvement Grant “Astrophysical Dust Evolution from Shock Waves”	\$6,359
<b>3/2017</b>	<b>Elisha Polomski (PI) and Physics Club (Co-PI)</b> Grant from American Association of University Women, and partial match by SCSU Student Government “WE-STEM Presentation of the movie <i>Hidden Figures</i> to SCSU and the general public in honor of Women’s History Month”	\$ 800
<b>5/2017</b>	<b>John Sinko (PI)</b> SCSU Short Term Faculty Improvement Grant “Successful Measurement of Dynamic Force, Pressure and Acceleration” (PCB Piezotronics)	\$1,711
<b>1/2017</b>	Kannan Sivaprakasam (PI), Sarah Petitto (co-PI), and <b>John Sinko (Co-PI)</b> MnSCU Leveraged Equipment “Initiative to transform education, research and workforce development at St. Cloud State University and partnering institutions” (Raman Imaging Microscope) with Eden Medical and Ultradurable	\$189,257 (\$98,414 match)



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**OUR STUDENTS NEED YOUR SUPPORT!**

**Supporting students is our number one goal.**

We owe it to them to provide the resources necessary to continue to be at the forefront of applied research in the state and region.

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\_\_\_\_\_ I would like to support the Physics General Fund

\_\_\_\_\_ I would like to specify a donation for \_\_\_\_\_

Please make check out to St. Cloud State Foundation (or Dept. of Physics & Astronomy, if you prefer)  
720 4<sup>th</sup> Ave. South  
St. Cloud, MN 56301-4498

**THANK YOU FOR YOUR SUPPORT!**