Dept. of Physics & Astronomy Summer Research Opportunities

(Approx 20 students will be hired depending on availability of funding)

1. Dr. Dobbins
2. Dr. Flores
3. Dr. Hettinger
4. Dr. Klassen
5. Dr. Ling
6. Dr. Nucci
7. Dr. Smith
8. Dr. Whiting

Rowan University

Important Dates & Times

- Applications Due: Monday, March 9th @ 5:pm
  - Fill out google form. URL will be in the next newsletter
- Notifications Sent: Monday, March 27th
  - Notifications will continue until ALL positions are filled
- Start Date (for *most* projects): 5/14
  - Some projects will begin on different dates (see offer letter)
- End Date (for *most* projects): 7/27 *tentative*
  - Some projects will end on different dates (see offer letter)
- Work Week (for *most* projects): Mon-Thur (30 hours/week)
- Vacation Week: 7/4 to 7/7
  - Some projects will have no vacation or a different vacation week (consult advisor)

ALL WORK SCHEDULES ARE DETERMINED BY YOUR ADVISOR; CONSULT YOUR OFFER LETTER

Rowan University

Other Important Information

- Applications Due: Monday, March 9th @ 5:pm
  - Fill out google form. URL will be in the next newsletter
- Pay is $3750 for 10 weeks and $1875 for 5 weeks (based on a 30 hour work week)
- Housing is available at a discounted rate for student workers
  - Last year, it was $11/day for Triad non-air conditioned

ALL PAY RATES AND PROJECT DURATIONS ARE SUBJECT TO AVAILABILITY OF FUNDING.

CONSULT YOUR OFFER LETTER.

Rowan University

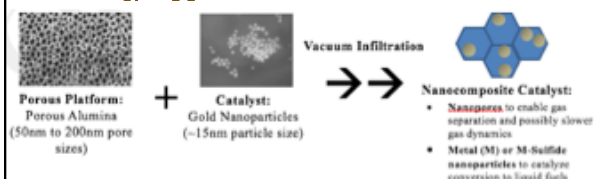
Dr. Dobbins

- NanoCatalysts for Methane-to-Gasoline Conversion
- 1 student
- Start Date: May 14 – July 26 (Mon– Thurs)

Rowan University

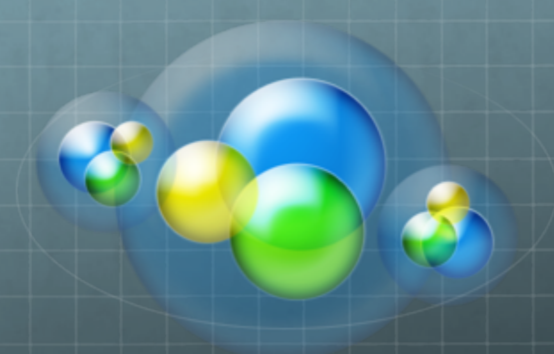
Materials for Energy Biomedical Applications --T. Dobbins

- Travel to Synchrotron and Neutron Facilities at National Laboratories to measure samples that you made here at Rowan.
- Travel to Baton Rouge, Louisiana to use the LSU Synchrotron
- Samples related Nanomaterials for Energy Applications



Rowan University

Travel is required to participate in this project!



I. Discrete Space-time
II. Cosmological Fermion Atom

Dr. Eduardo Flores

Why Discrete Space-time?

PROJECT 1

- At Planck's level space and time are expected to be discrete as opposed to continuous
- Discrete space-time solves most of the infinity problems that plague the Standard Model of Particles
- On discrete space-time one may easily build random walks. Results obtained from random walks are similar to quantum wave effects. Found. Phys. (2018) 48:60–91
- If our space-time is discrete we might be able to understand the mysterious relation between gravity and quantum mechanics

Cosmological Fermion Atom

PROJECT 2

- When the primordial blacks hole were formed they were small; the smallest vanished right away but the larger survived and grew
- Black holes that survived attracted neutral spin ½ fermions and formed the equivalent of hydrogen atom
- The atom quickly build up filling up empty states. With many fermions the mass distribution changed producing a net potential that affected the dynamics of the system
- We want to see if the final mass distribution of this atom is similar to the one we observe now for dark matter

What to expect?

- Student will learn how special relativity works in a physical structure
- Student will learn how Dirac equation works
- Student will calculate using Mathematica
- Requirement: Quantum Mech. or permission of Dr. Flores

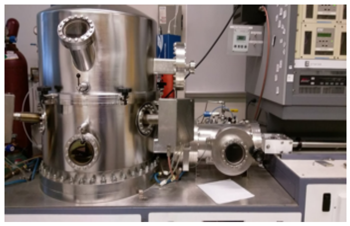
Thin Film Research

Hettinger Lab

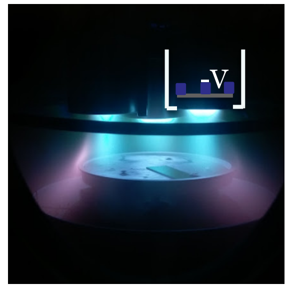
- Synthesis and characterization of thin films for electronic, catalytic, and biomedical applications.
- 3 students if funding is sufficient

Rowan University

Sputtering Thin Films



The deposition system



A deposition in progress from three targets.

Primary Current Projects:

- Neurostimulation Electrode Coatings-Maximize electrochemical performance and add bactericidal capability.
- Carbide-derived carbon coatings for "on-chip" electrochemical electronic devices.

Reactive Sputtering/Substrate Dependence/Deposition Parameter Dependence/Coatings for neurostimulation electrodes.

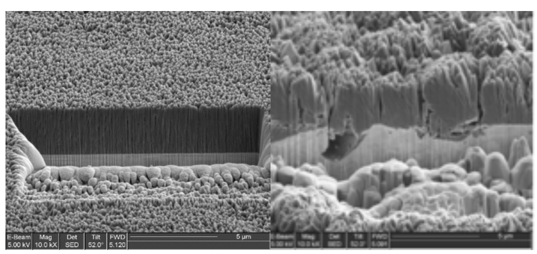


Fig. 1—SEM images of focused-ion-beam milled cross-sections of TiN deposited on smooth substrates (left) and grit blasted substrates (right).

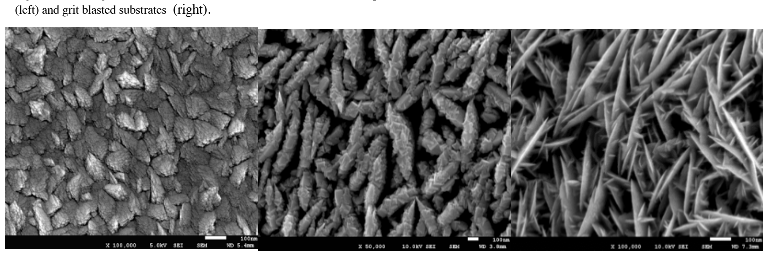


Fig. 2—SEM images of the microstructures of three IrO_2 coating synthesized on stainless steel with various deposition parameters. Electrochemical charge storage capacity improves from left to right while the coating resistivity decreases from right to left.

NASA IRTF NSFCAM 23 Aug 2003

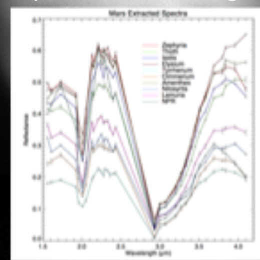
David Klassen

3 students depending on funding availability

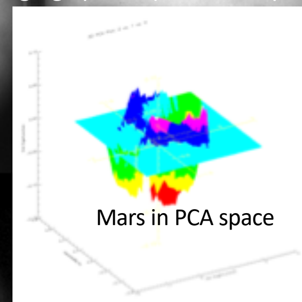
Computational/observational Planetary Science:
Measure NIR cloud optical depths on Mars using Imaging Spectrophotometry

- Analyze martian spectral image cubes using PCA
- Recover spectral surface endmembers
- Use endmembers to model surface reflectance in radiative transfer model
- Recover ice-cloud optical depth and thus amount of water in clouds

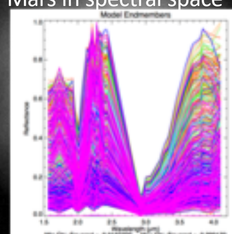
Gain proficiency with a Unix-like, command-line computer environment, computational techniques, and as much programming experience as you'd like to attempt!



Mars in spectral space



Mars in PCA space



Potential martian surface spectral endmemembers

Need to figure out which are the "real" endmembers…

1.610 3.330 4.100

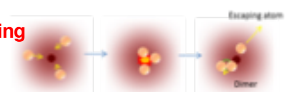
Hong Ling

2 Students – depending on availability of funding

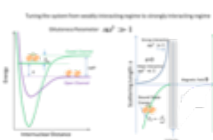
Fields of Theoretical Physics

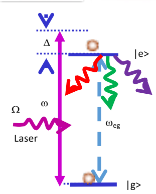
1. Atomic, Molecular, and Optical Physics: it studies
   - light-matter (atoms and molecules) interaction,
   - how the quantum nature of matter affects the properties of electromagnetic radiation
   - how the quantum nature of light affects the matter properties.
2. Condensed Matter Physics: it studies
   - the phases and phase transitions in many-body systems (gas, liquids or solids) at such a low temperature that quantum statistics of particles becomes important (e.g. bosons and fermions).
   - Of particular interest are the phenomena of Bose-Einstein condensation, superfluidity, and topological phases in the ultra-cold atom system and multi-component quantum gases.

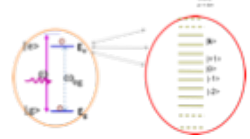
Three-Body Recombination

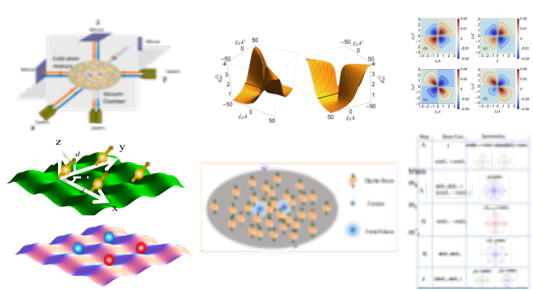


Feshbach Resonance







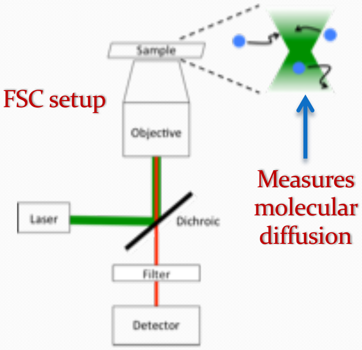


Atomic and Molecular Physics, Quantum Optics, Solid State Physics, Statistical Physics, Group Theory, Many-Body Quantum Field Theory

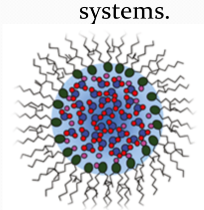
Nucci Lab: Dynamics of nanobubbles.

- Project goals:
  - Couple fluorescence correlation spectrometer to microfluidics apparatus
  - Measure dynamics (diffusion and exchange) of nanobubbles (reverse micelles) with varying compositions.
- Why?
  - This instrument and the measurements of nanobubble dynamics will form the foundation for understanding how confined space effects molecular processes in living systems.

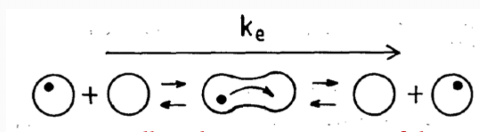
FSC setup



Measures molecular diffusion



Nanobubble (reverse micelle)



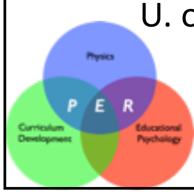
We will see how composition of the nanobubbles affects their collisions and exchange of contents.

2 students – depending on funding availability

Physics Education Research (PER)

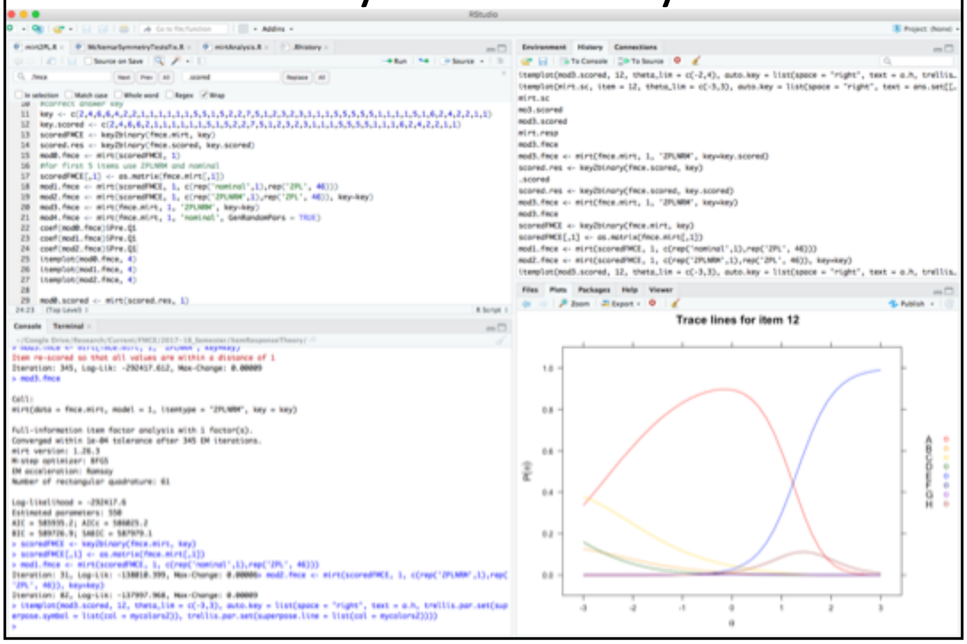
Dr. Trevor I. Smith (smithtr@rowan.edu x4848)

- Projects
  - How much physics do students actually learn?
  - How do students' math abilities develop in physics classes? (Collaboration with U. of Washington)
- Skills you'll develop
  - Analyses of large data sets
  - Programming in R
  - Data-based interpretations of students' test answers



RU PERt

What you'll actually do

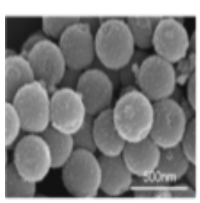


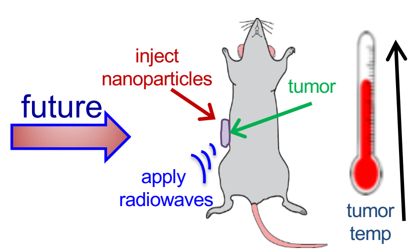
Magnetic Field-Cycling Hyperthermia in Nanoparticles

Synopsis: exposure of oscillating electromagnetic fields to nanoparticles can induce a heating response ("hyperthermia"); this can be leveraged for cancer therapy

Short-Term Goal: characterize the heating response for different nanomaterials under various hyperthermia conditions to maximize this effect

Long-Term Goal: perform hyperthermia in mice afflicted with different cancer systems using biomarker-targeted nanoparticles





Silicon nanoparticles + **Hyperthermia** **Cancer Therapy**

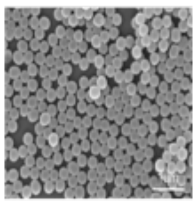
Prof. Nicholas Whiting Dept. of Physics & Astronomy and Dept. of Molecular & Cellular Biosciences whitingn@rowan.edu **1-2 Students**

Nanoparticle-Induced ^{1}H Relaxation Effects at Different Magnetic Fields

Synopsis: T_1 relaxation in ^{1}H is an important MRI contrast mechanism; this study aims to determine the changes in ^{1}H T_1 due to interactions with various nanoparticles at different magnetic field strengths

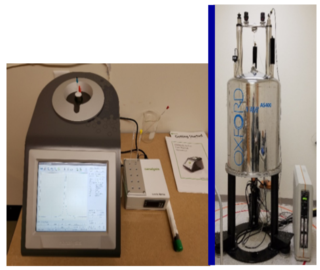
Short-Term Goal: characterize the change in ^{1}H T_1 at 1.5 T and 9.4 T for samples comprising of liquid saline and silicon nanoparticles of varying sizes and surface morphologies

Long-Term Goal: develop this contrast mechanism for use in MRI scanners



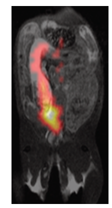
Silicon nanoparticles

+



Low-field NMR/ High-field NMR

future →



MRI Contrast

Prof. Nicholas Whiting Dept. of Physics & Astronomy and Dept. of Molecular & Cellular Biosciences whitingn@rowan.edu **1-2 students**

Dept. of Physics & Astronomy Summer Research Opportunities

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Remember to check the next newsletter for the URL to sign up!

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