Faculty-student matchmaking session: summer research in chemistry, the physical sciences and engineering

January 15, 2019
SSS 114

Sandy Chang, MD/PhD
Associate Dean of STEM Education and Undergraduate Research

Performing cutting-edge research is an integral component of Yale's undergraduate education

Yale Summer Fellowships

Yale College First Year Summer Research Fellowships

- Supports10-12 weeks of natural science research in Yale labs. Fellowships pay $430/week., max 10 weeks funded.
- Last year, 83% first years received funding.
- As part of their research experience, students participate in a weekly class called “Entering Research”
- Fellowships due March 7.

Yale Summer Fellowships

STARS Summer Research fellowship

- Supports 30 rising sophomores doing 10 weeks of research in Yale labs. All expenses paid, plus $2,500 stipend.
- Last year 20% of students who applied received this fellowship.
- Students must first identify a mentor (Jan 28th). Selected students have to submit a proposal (Feb 27).

Yale Summer Fellowships

Yale College Dean's and Rosenfeld Research Fellowships

- Supports sophomores and juniors doing research in Yale labs. Fellowships pay $430-450/week, max 10 weeks funded.
- Last year, 60% sophomores and juniors received funding.
- Fellowships due Feb. 21.

Student-Faculty Matchmaking

- Students pick two potential mentors for further interactions.
- Faculties choose the students they want to mentor, and work with them to craft a good research proposal.
- Students who do not match with mentors, and faculties who do not get students should contact me for an additional round of matching (electronically).
- For students on financial aid, you can use your domestic summer award (DSA) to help fund your summer research. Check "yes" on the DSA box in the fellowship application.
- Much more info at:

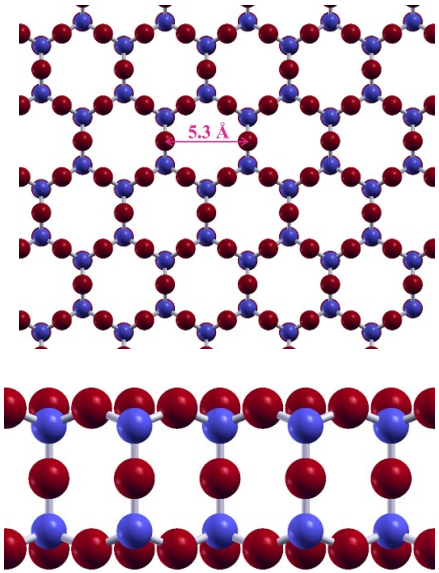
https://science.yalecollege.yale.edu/

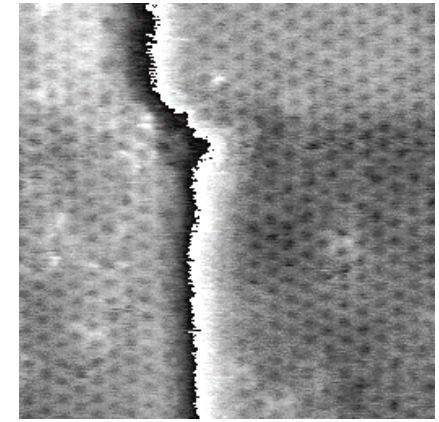
Faculty sciences

Novel 2D Materials as Switchable Ultimate Permeation Membranes

Eric I. Altman, Department of Chemical & Environmental Engineering

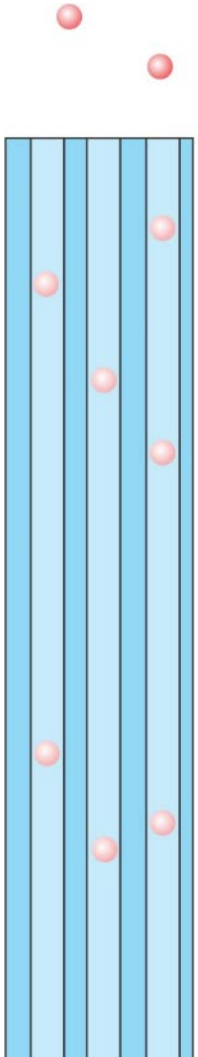
2D SiO_2



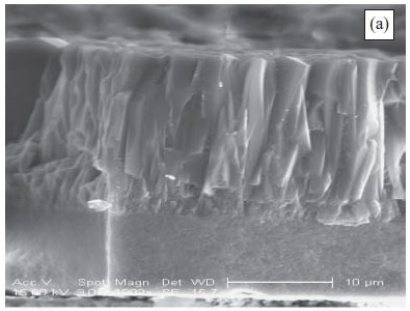


Diffusion rate goes as ℓ/d

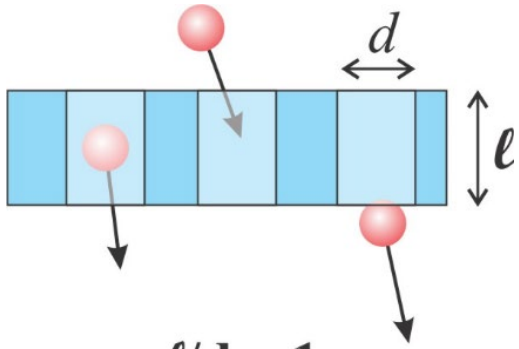
Conventional Membrane



ℓ/d ~ 10,000



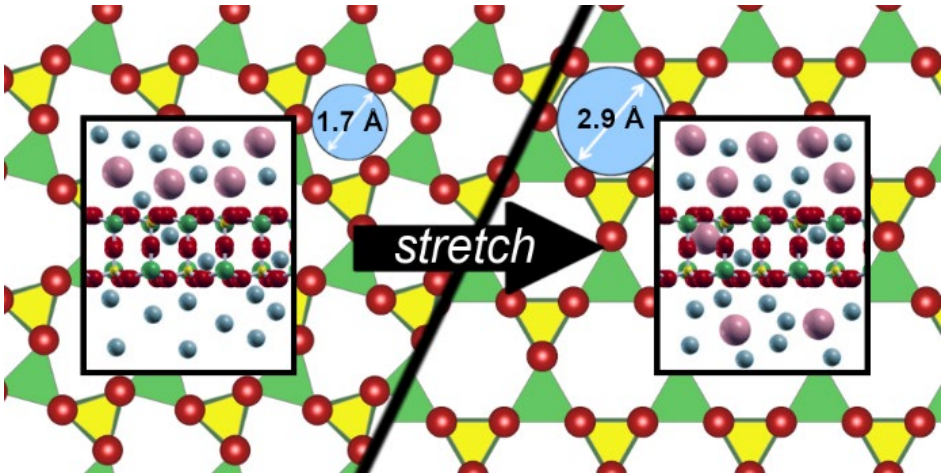
2D SiO_2

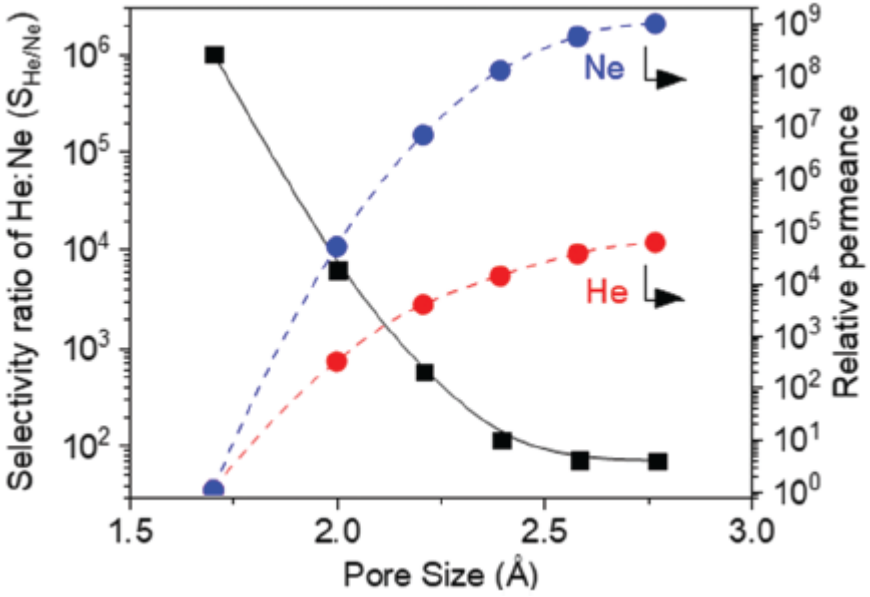


ℓ/d ~ 1

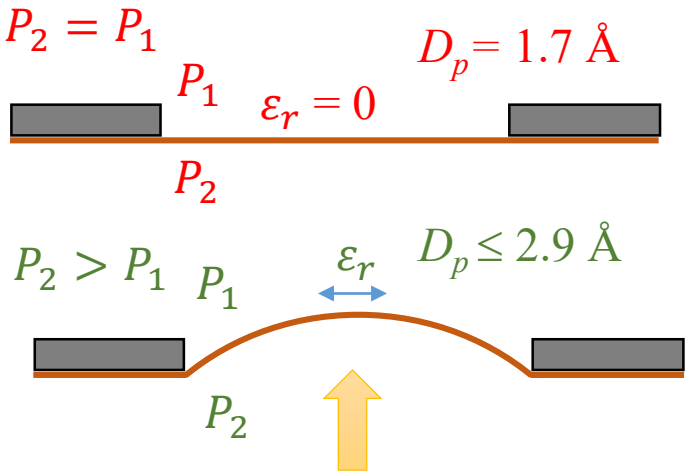
New Materials Discovery: 2D $GaPO_4$ as a Switchable, Atomically Thin Size Exclusion Membrane

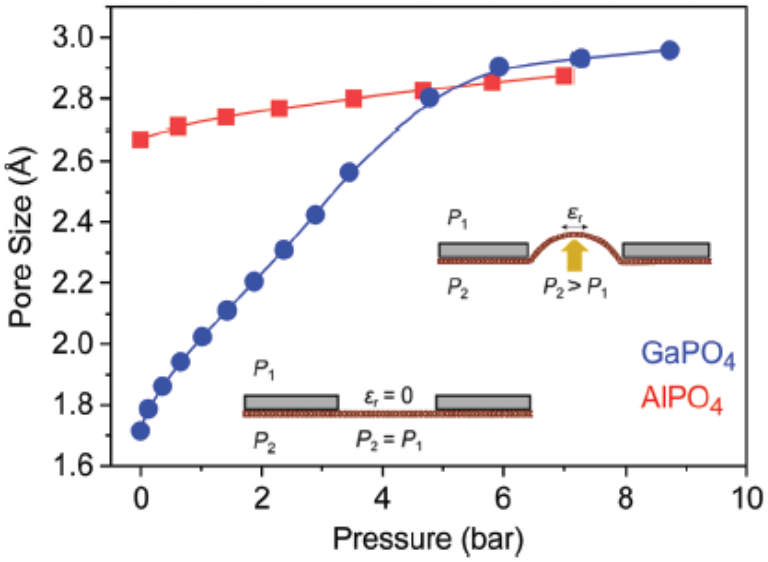
2D $GaPO_4$ – a new material predicted to include "molecular hinges."





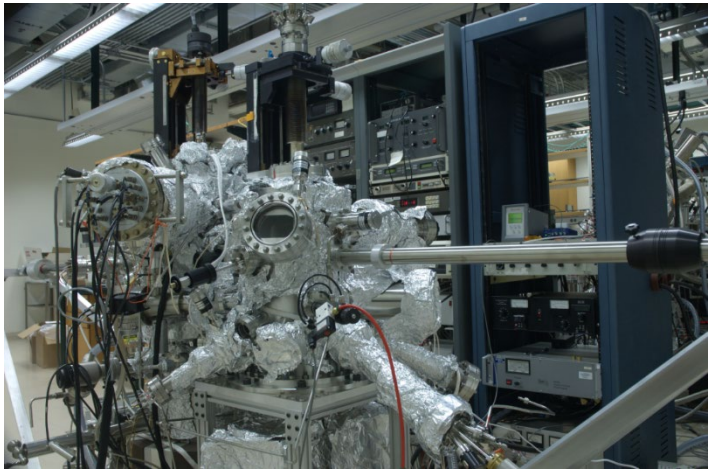
Enables a pressure driven "molecular switch."





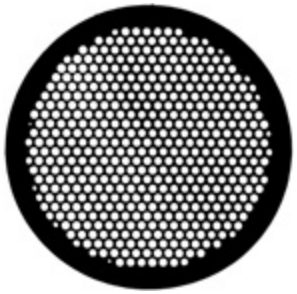
Undergraduate Projects

Materials growth and transfer



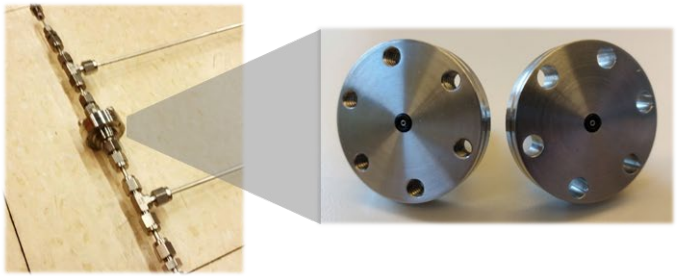
Transition Metal

Fine mesh grid

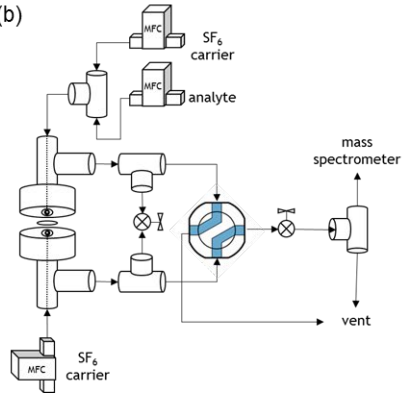


Testing

(a)



(b)



Modeling

Experimental Neutrino and Particle Physics at Wright Lab

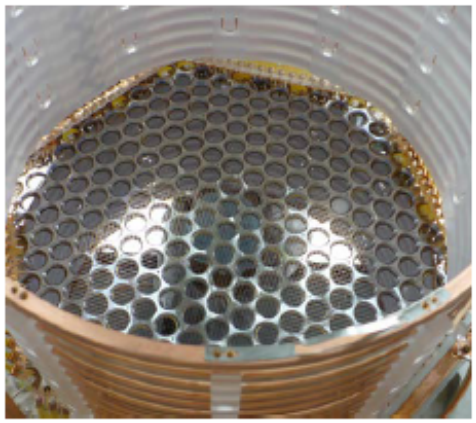
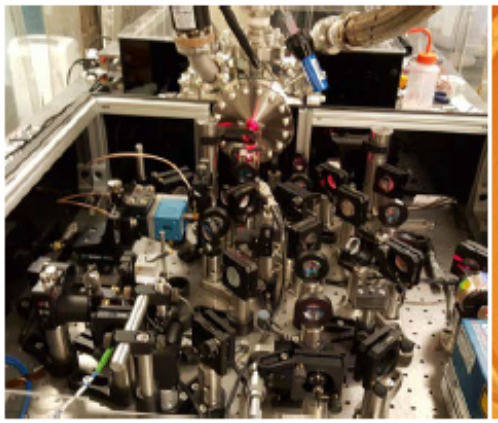
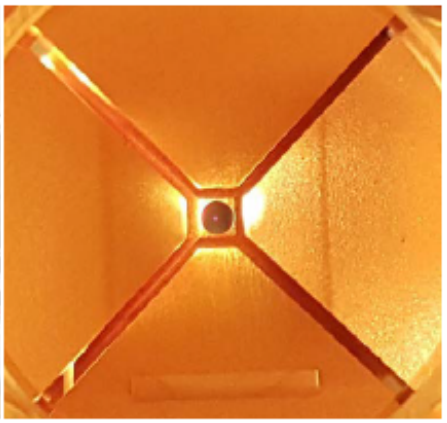
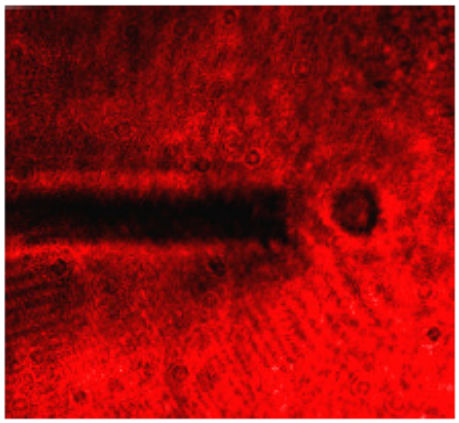
Prof. David Moore, *david.c.moore@yale.edu*

Our group is developing new technologies aimed at answering some of the major outstanding questions in nuclear and particle physics:

- What are the fundamental properties of neutrinos?
- What is the nature of dark matter and dark energy?
- Are there deviations from gravity that can be observed at microscopic distances?

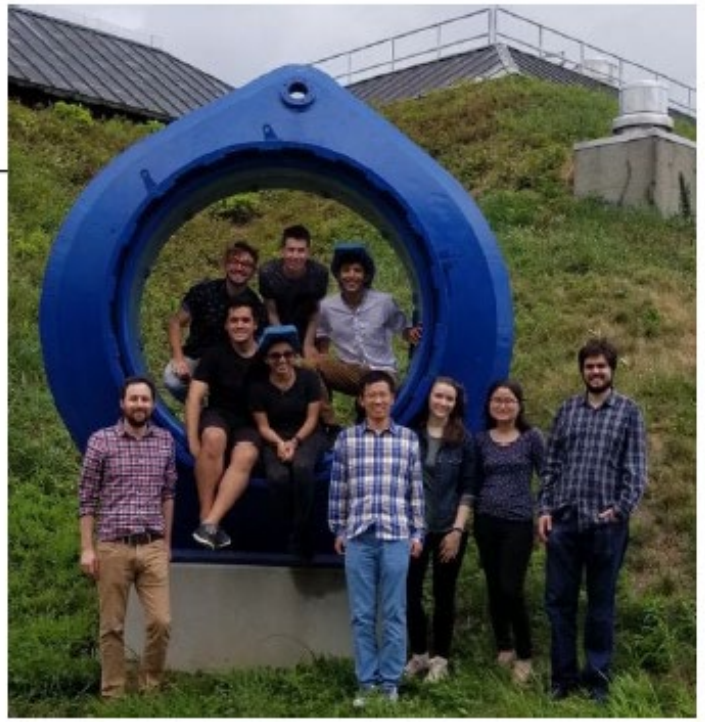
Answering these questions requires applying cutting-edge techniques from particle, nuclear, atomic, and optical physics.

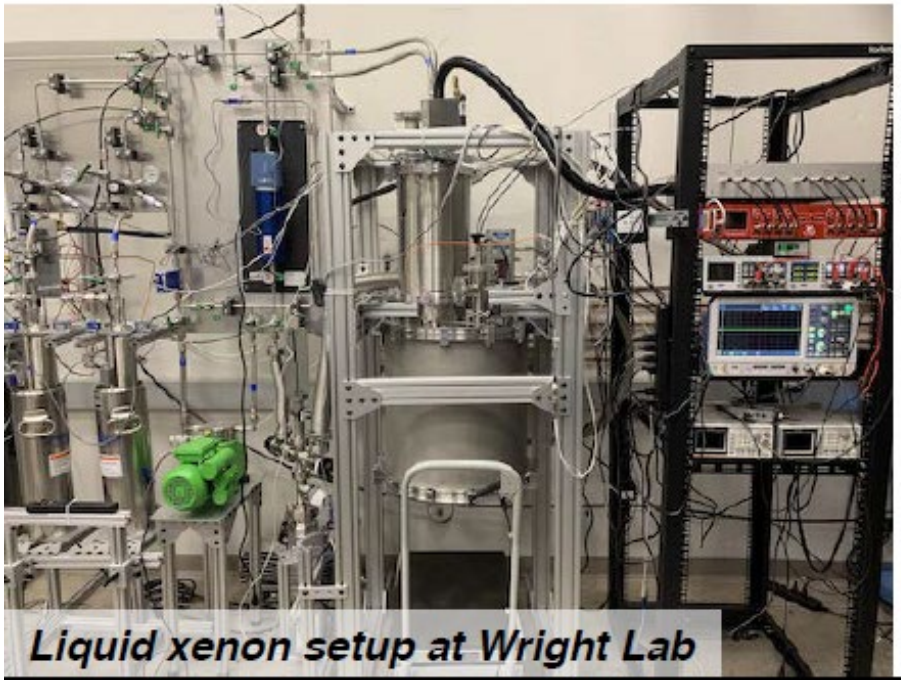
See http://campuspress.yale.edu/moorelab/ for more details

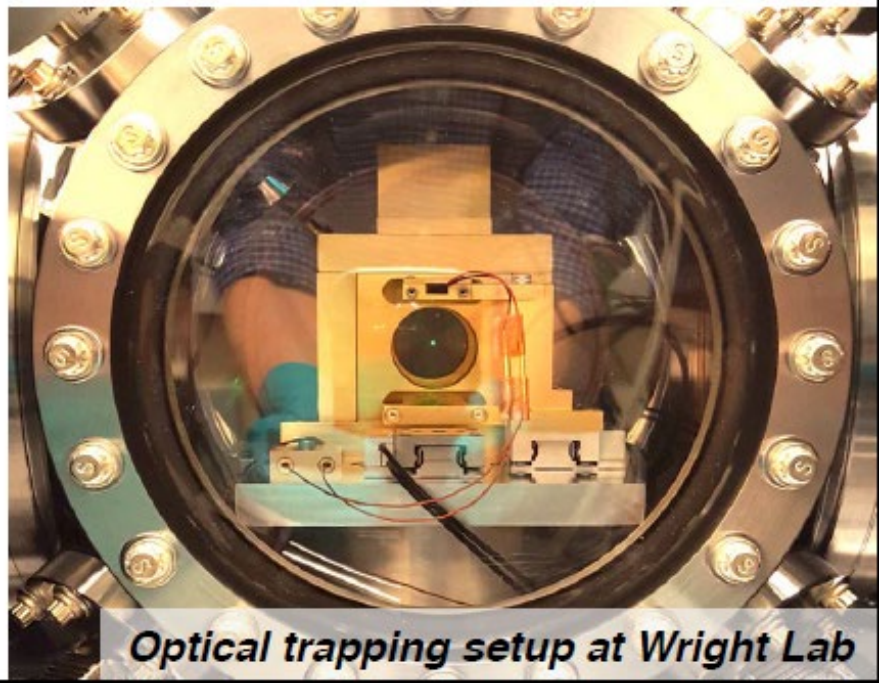
Join us!

- We typically have projects available for 1-2 students per summer to work in our labs
- Recent undergraduate researchers: Ilana Kaufman (YC17), Adam Fine (YC19), Cady van Assendelft (YC19), Alec Emser (YC19), Michael Mossman (YC19), Sam Day-Weiss (YC20), Shoumik Chowdhury (YC21), Charlotte Kavaler (YC21)

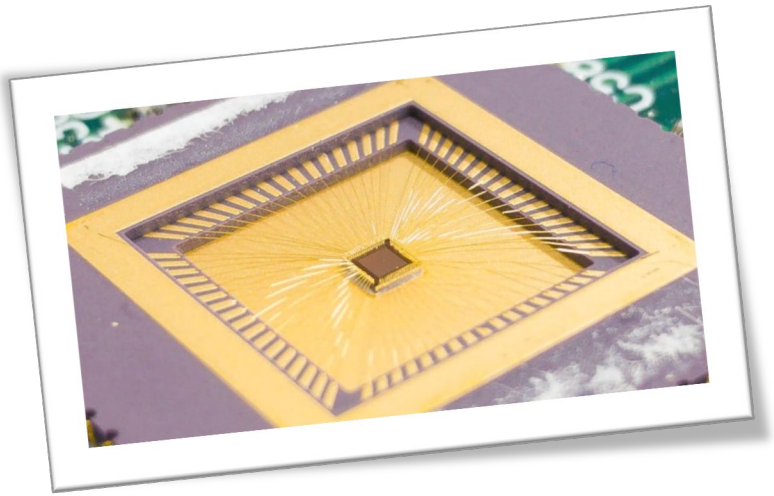


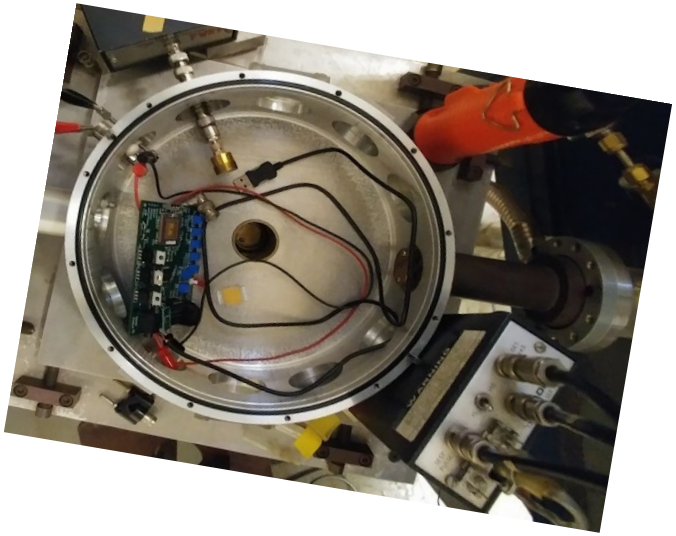


Liquid xenon setup at Wright Lab



Optical trapping setup at Wright Lab

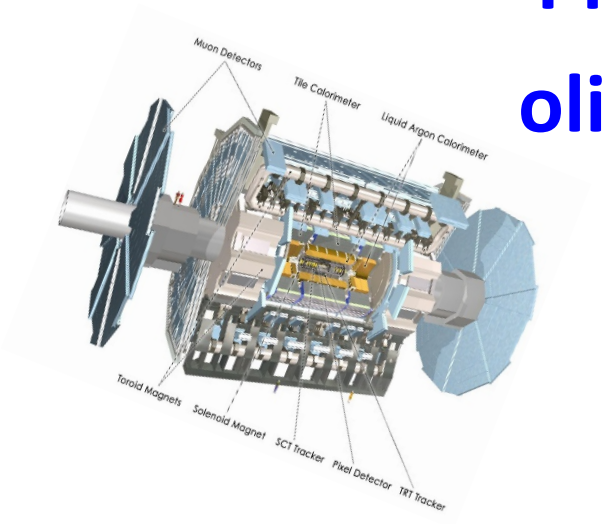


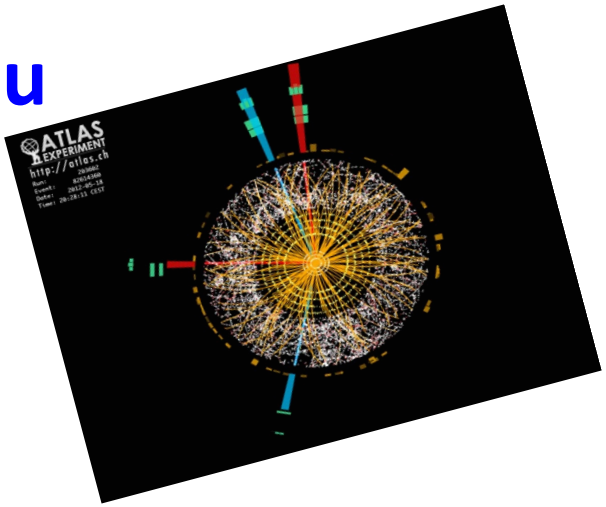


Experimental High Energy Physics

Professor Keith Baker

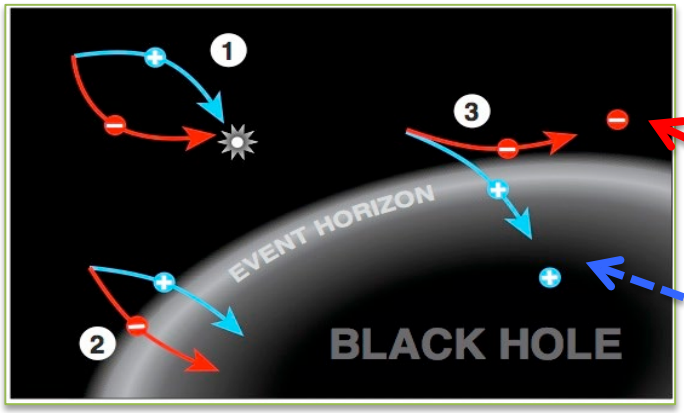
oliver.baker@yale.edu



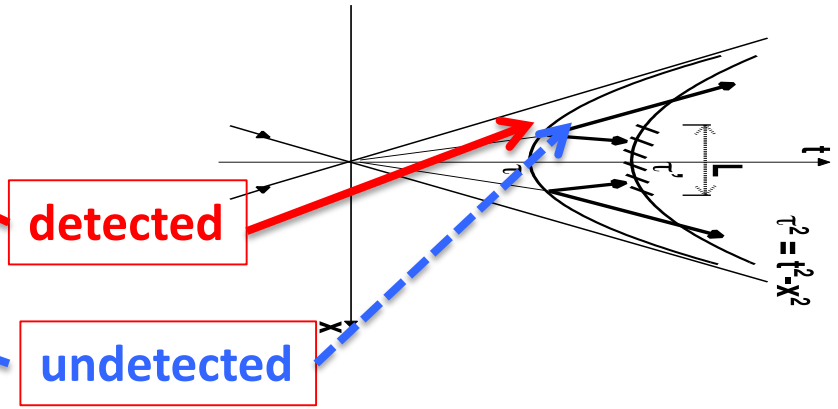


- quantum computing
  - begin with classical simulator of quantum algorithm
  - implement on IBM QC using QISKIT

black hole event horizon



proton-proton collision



detected

undetected

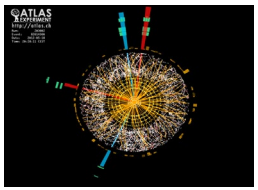
at BH, one particle escapes and one particle is trapped inside the BH event horizon

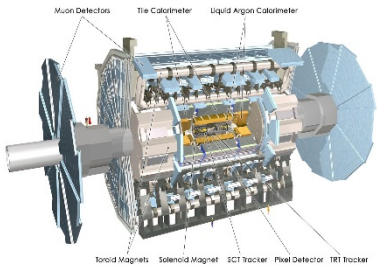
in pp collision, one region is probed and the complimentary region is not probed

- FPGA programming
  - monolithic cmos silicon pixel research and development
  - VHDL language, for detector readout and control

student mentoring

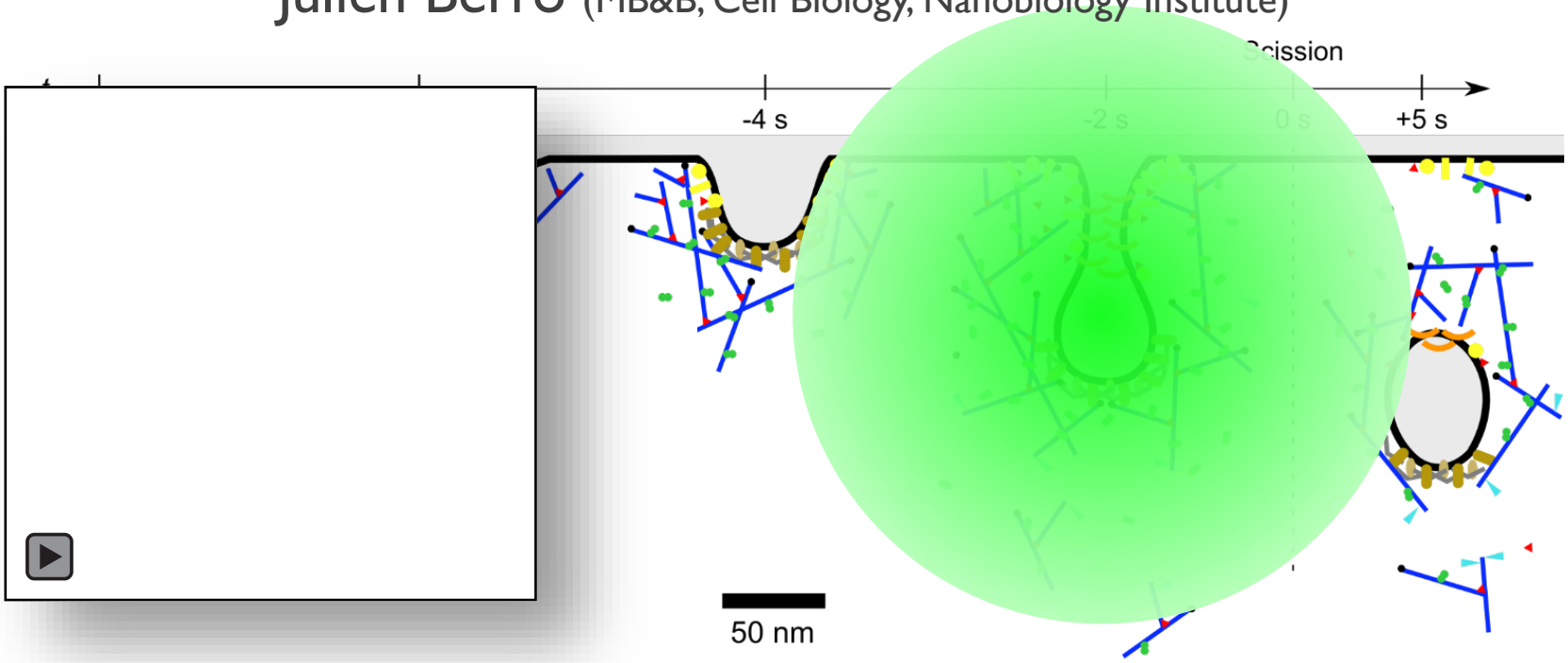
- on-campus laboratory (Wright Laboratory)
- professor present daily (except when traveling)
- graduate student expert in all projects; present daily (except when traveling)
- postdoctoral researcher (search underway); present daily (except when traveling)
- single funded student for this summer
- experience mentoring > 6 undergraduate students during summer





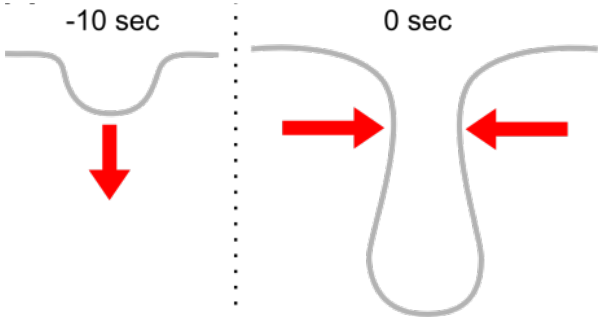
Understanding force production mechanisms in cells at the nanometer scale

Julien Berro (MB&B, Cell Biology, Nanobiology Institute)



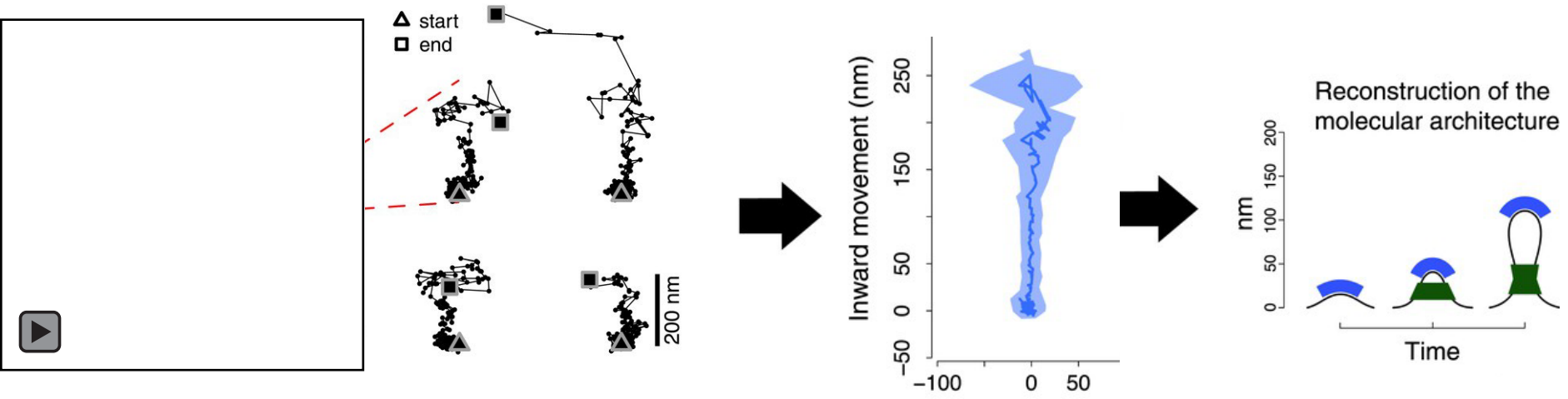
Mike Lacy

Clathrin-mediated endocytosis



Too small and too fast to observe or measure directly
=> develop computational & mathematical tools to infer molecular mechanisms

Your summer project:
Develop machine learning algorithms
to align noisy datasets and infer mechanisms of endocytosis



Adapted from Picco et al 2015

Get in touch if you want to know more!

julien.berro@yale.edu
campuspress.yale.edu/berrolab/
@BerroLab

Lab meetings every Monday 12 – 1 pm
Journal clubs every Friday 9 – 10:30 am

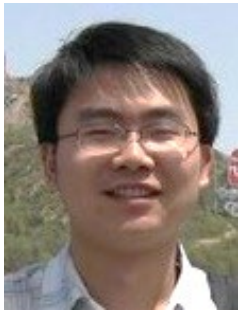
Ruchira Ray
TC '21

Mimi Kostoska
BF '21

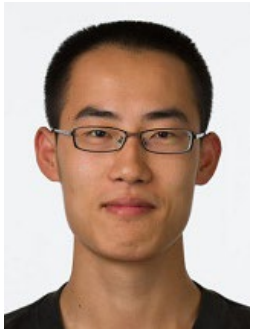
Neal Ravindra

Xiaobai Li

Dr Ronan Fernandez



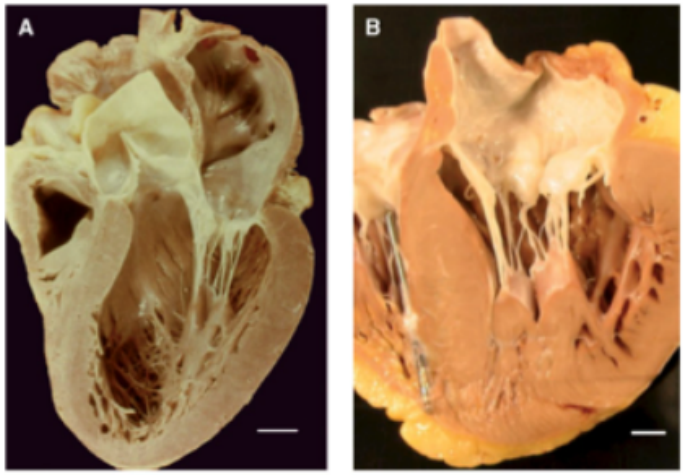
Dr Rui Ma



Dr Yuan Ren

YOU !!

Inherited Cardiomyopathies



- Dominant pattern of inheritance
- Often caused by sarcomeric mutations
- High risk of sudden death
- Delayed onset (15-35 years of age)
- Long term: Heart failure

MANY UNANSWERED QUESTIONS: MECHANISMS? DIAGNOSIS? CURE?

1. STUDY PATIENT CARDIAC MUSCLE UNDER CONTROLLED CONDITIONS

ENGINEERED HEART TISSUE

2. INTEGRATE OBSERVATIONS INTO DETAILED DISEASE MECHANISMS

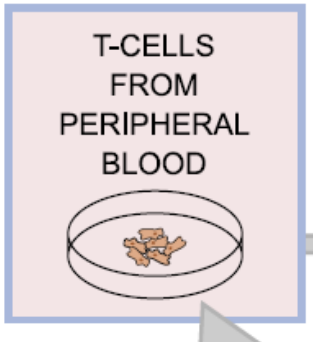
COMPUTATIONAL MODELING

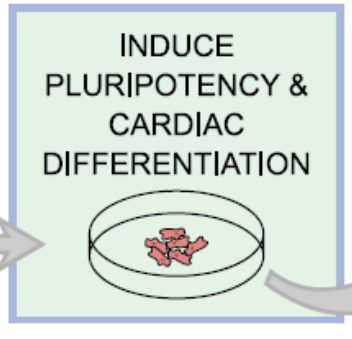
Teekakirikul, P., Padera, R. F., Seidman, J. G. & Seidman, C. E. Hypertrophic cardiomyopathy: translating cellular cross talk into therapeutics. *J Cell Biol* 199, 417–421 (2012).

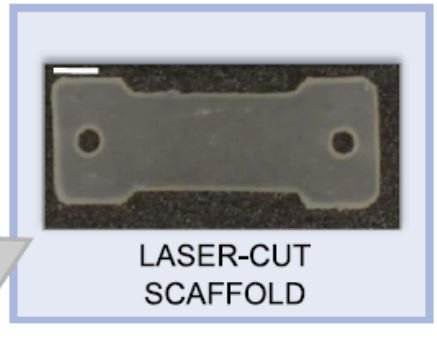
Engineered Heart Tissue from Specific Patients

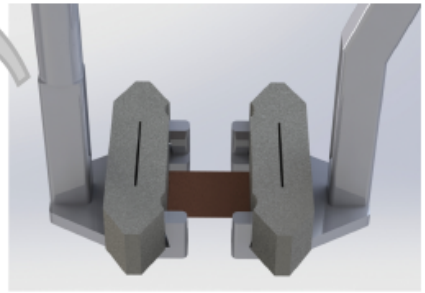
Dr. Yibing Qyang

Dr. Daniel Jacoby

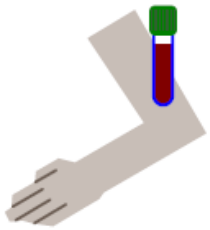




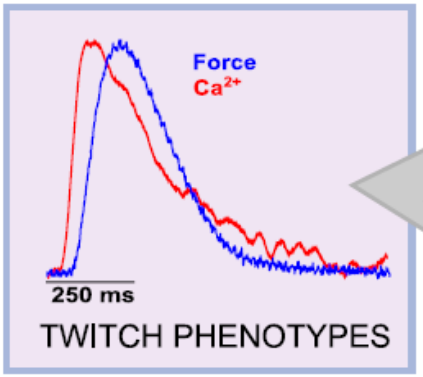




MECHANICAL TEST
APPARATUS



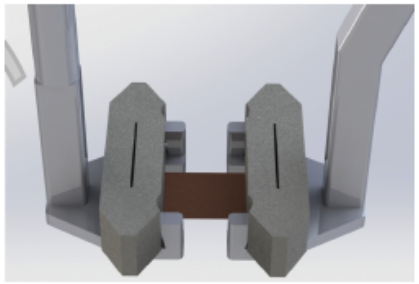
CARDIOMYOPATHY
PATIENT



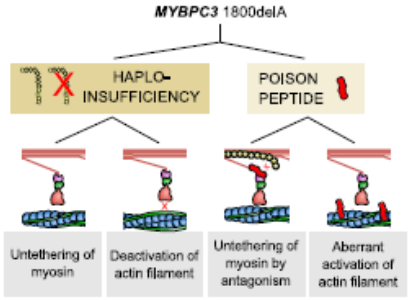
TWITCH PHENOTYPES

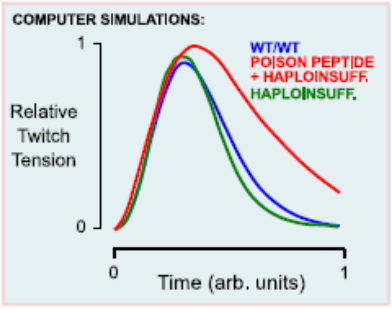
What would STARS students do in my lab?

Design and Build Stuff



Muscle Physiology Simulations





Make Engineered Heart Tissue

UNDERGRADUATE SUMMER RESEARCH OPPORTUNITIES

The research group of Juan Fernandez de la Mora (Yale Mechanical Engineering) uses **fluid flow** phenomena such as **electrospray** and **high speed flows** in a variety of scientific and technological problems such as

Electrical propulsion

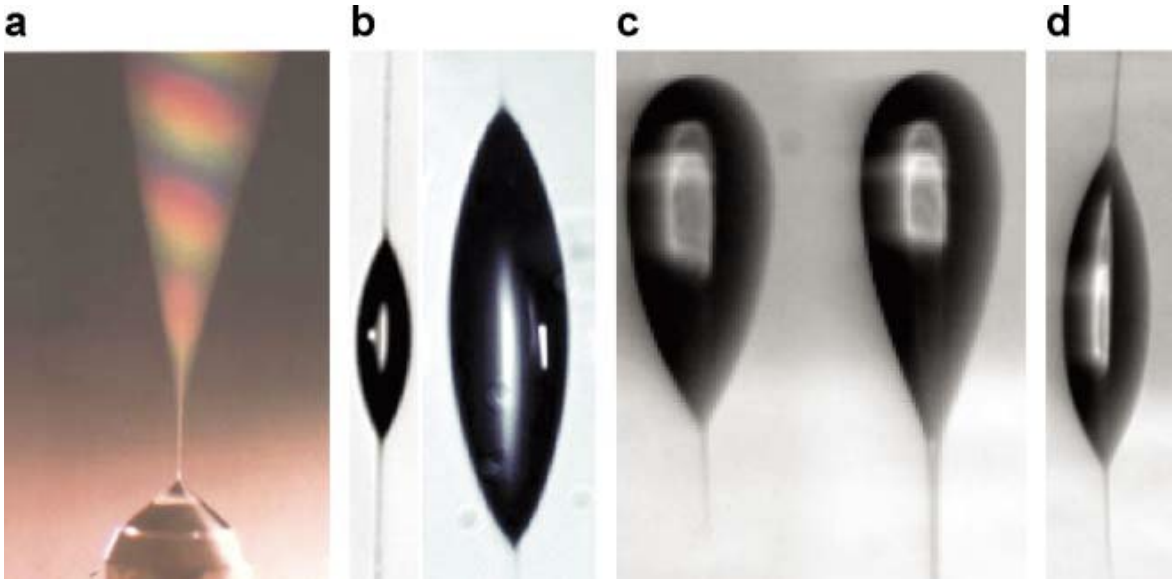
Size-Analysis of viral particles for disease diagnostics

Studies of very small clusters in the gas phase.

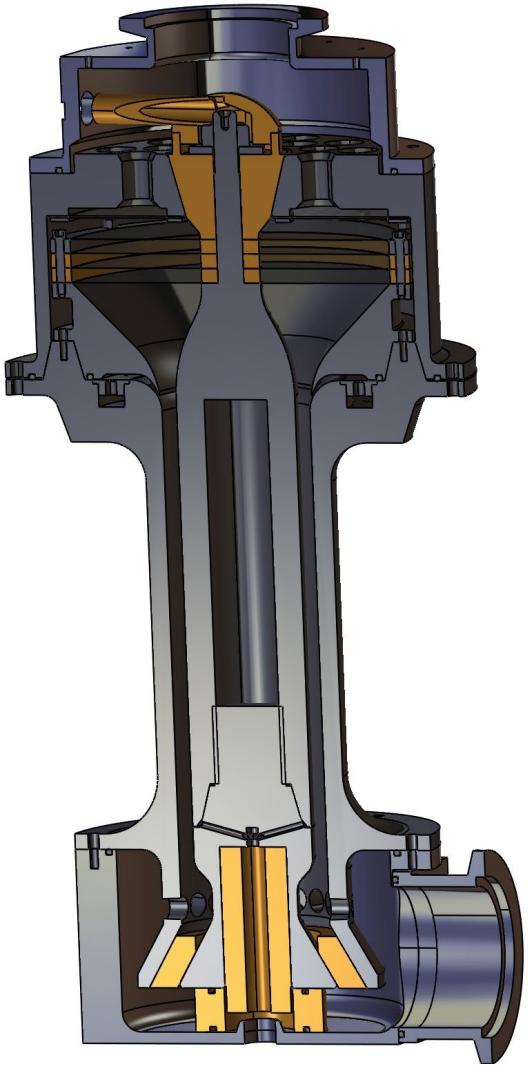
Development of flow instruments operating LAMINARLY at high speed

Juan de la Mora juan.delamora@yale.edu

electrosprays



- Beautiful fluid flow problem
- Applications in biochemical analysis, Propulsion, cluster studies
- Various research projects are available depending on the student's interests



The differential mobility analyzer (DMA) as a high speed flow device for analysis pf clusters biomolecules and viral particles

- Special features of this instrument over other ion mobility devices are its high speed of analysis at atmospheric pressure, preservingmaximally the structure of biomolecuels.
- From the fluid dynamics point of view it achieves Reynolds number ~300,000 while keeping the flow laminar.
- Various research projects are available depending on the student's interests

Juan de la Mora juan.delamora@yale.edu

Yale University

Undergraduate Student Research Presentation

- 22 undergraduates have worked in the group
- 10 are in graduate school in chemistry, 3 are in medical school
- 5 received NSF Fellowships
- 8 were in the STARS program
- We would love to have more!

Hazari Group (nilay.hazari@yale.edu)

Inorganic Chemistry

Catalysts

A *catalyst* is a substance that alters the rate of a reaction without being consumed in the reaction

$$A + B \xrightarrow{\text{slow or no reaction}} C + D$$

$$A + B \xrightarrow[\textit{catalyst}]{\text{fast reaction}} C + D$$

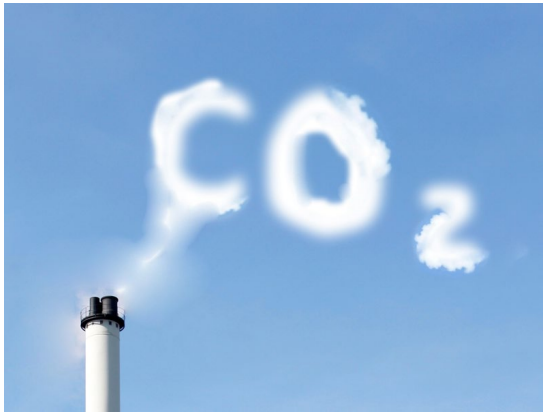
- **Almost 90% of chemicals that are produced commercially utilize a catalyst at some point in their synthesis**

We develop transition metal based catalysts for a variety of different applications

The Hazari Group

- **Research in synthetic inorganic and organometallic chemistry**
  - Applications and links to organic chemistry
  - Synthesis of both fine and commodity chemicals
  - Energy related problems

- **Research areas and techniques**
  - Inorganic synthesis
  - Organic synthesis
  - Catalysis
  - Materials
  - NMR, UV-Vis, IR spectroscopy
  - X-ray crystallography
  - Mass spectrometry
  - Electrochemistry



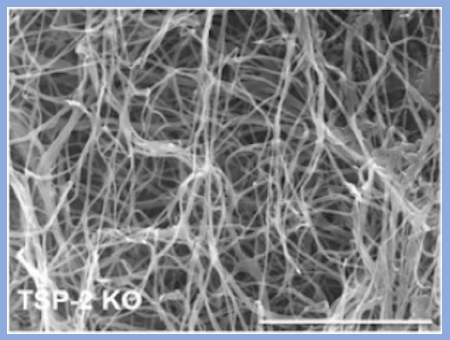
Please feel free to contact me for more information

Contact: hao.xing@yale.edu

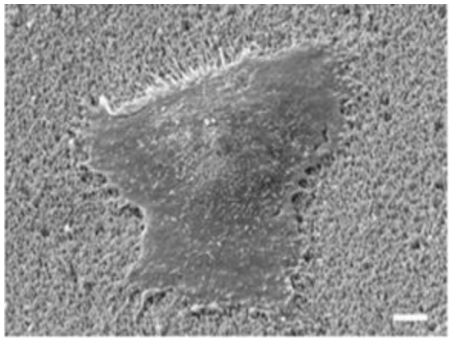
Kyriakides Lab

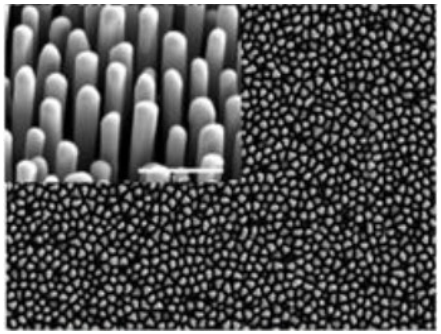
Where discovery meets application

TISSUE ENGINEERING

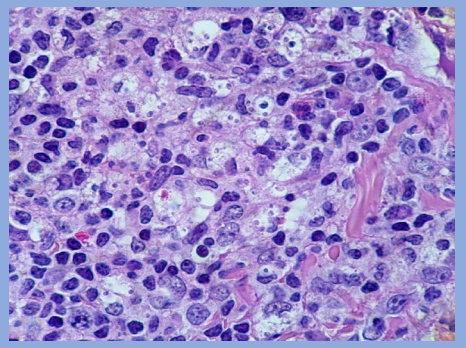


BULK METALLIC GLASS





TOPICAL TREATMENT



Contact: hao.xing@yale.edu

Potential Summer/Semester Project

- Diabetic Kidney Fibrosis and Treatment
- Growth-factor imbedded biomaterials
- Nano-patterned BMG Implant in Rodents
- Mechanical Characterization of Cell-derived Matrix

How can you get involved?

- Graduate students as day-to-day mentors
- Bimonthly project meetings followed by journal club
- 2 funded students
- 4 BME students completed their senior thesis with us past year

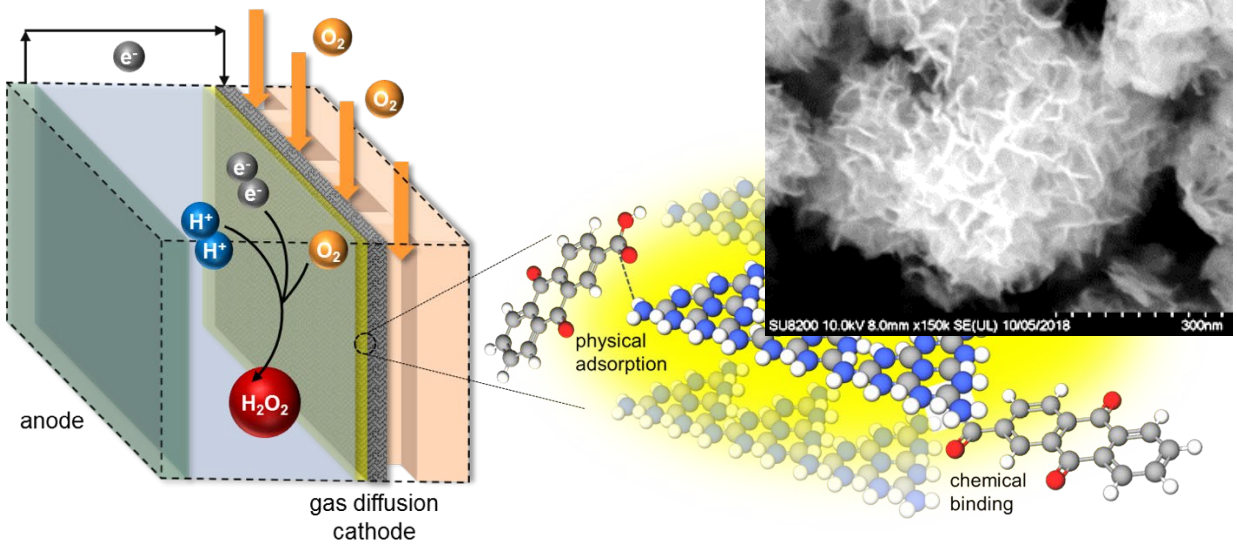
Prof. Shu Hu

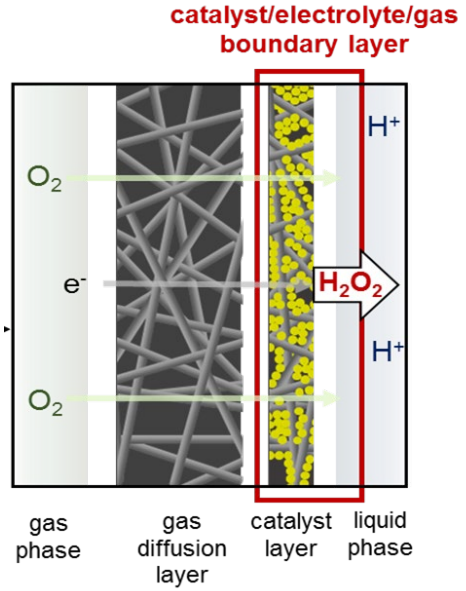
Yale *Energy Sciences Institute*

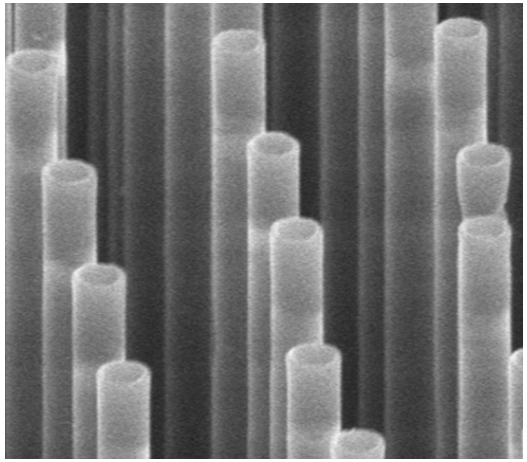
Photoelectrochemical Materials and Interface

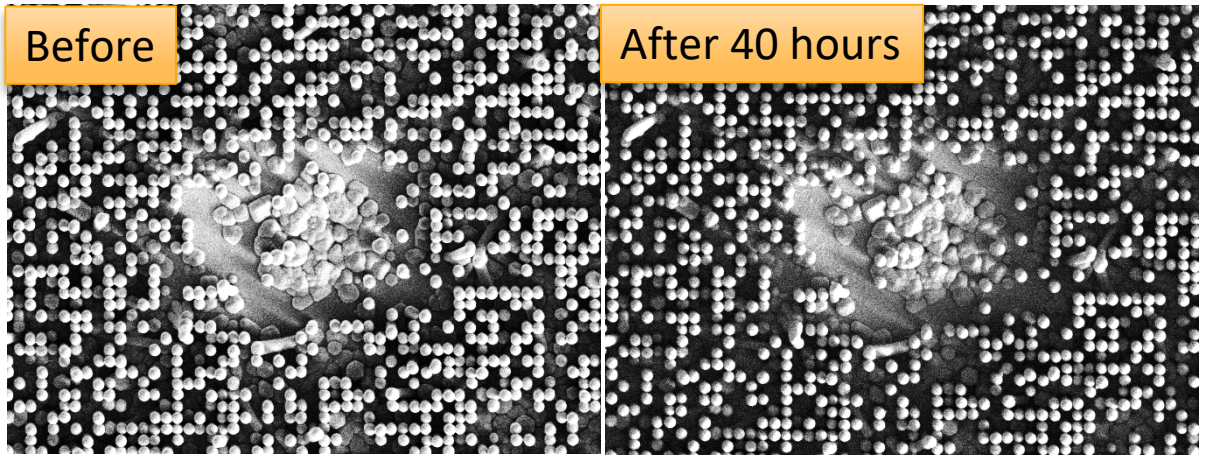
- Group Meeting at Mason Lab 321B
- Every Wed 4pm shu.hu@yale.edu

Light-Driven Chemistry and Materials Synthesis: A Living System









- Common rules for photocatalysis and materials growth

Projects & Mentorship Organization

Projects: Looking for 2-3 students

- Sunlight production of hydrogen peroxide
- Grow cheap energy conversion materials at large scale
- Converting (fracking) nature gas to liquid fuels

Previous summer students: Feel free to ask them

- Avram During (’19); Ian Billinge (‘19); Jacob Miller (‘20)

Mentorship:

- Assistance with summer research fellowship applications (STARs program, Silliman SEAS, fellowship in your R.C.
- Weekly one-on-one meeting together with student mentor
- Participate in group meeting, feedback for presentations
- Hands-on lab with professor, and *ad hoc* mentoring

Wenjun Hu, Dept of EE&CS

wenjun.hu@yale.edu

Edge, Cloud

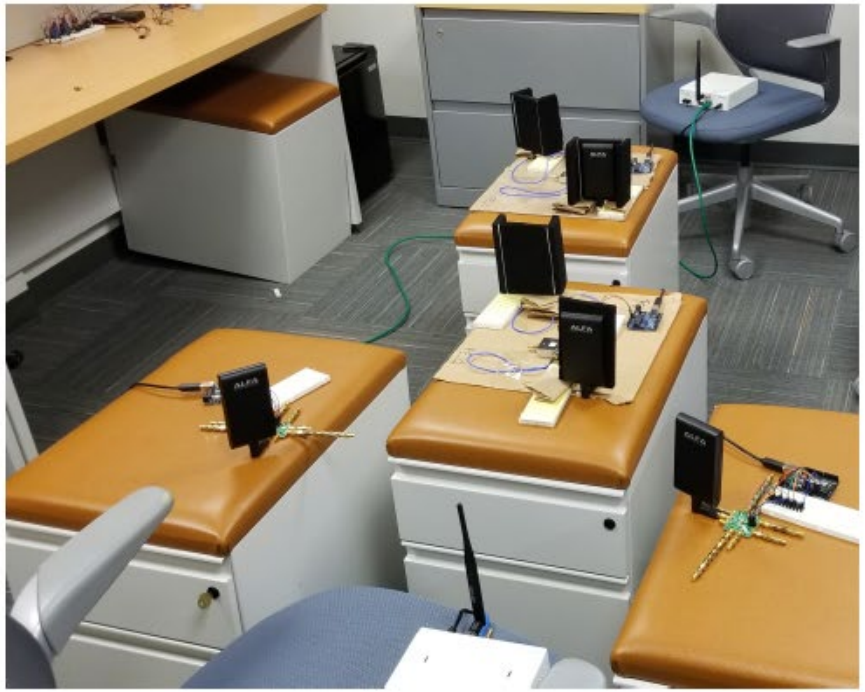
Backend system support

Wireless connectivity

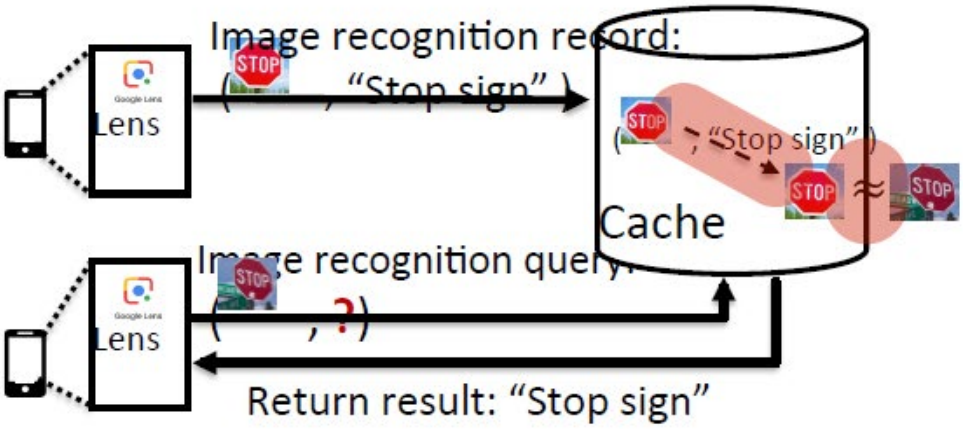
Mobile

Device-centric optimizations

Projects



(i) Programmable Radio Environment
(ii) Self-Upgrading Radios
(iii) Semantic Computation Reuse

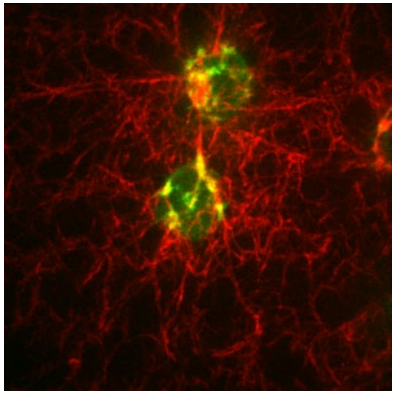


Logistics

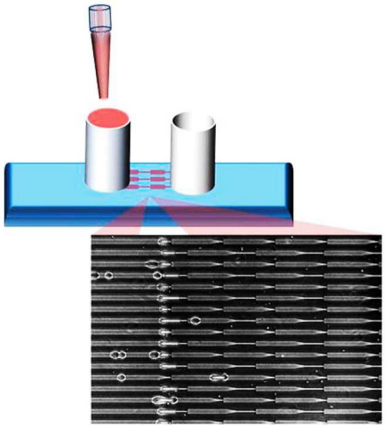
- Target: 2-3 undergrads
- Work closely with the PhD student leads
- Typically meet with me 1-2 times a week
- Previous summers: Josh Chavez (2017, 2018), Michael McNamara (2018)

Multiscale Mechanobiology Lab

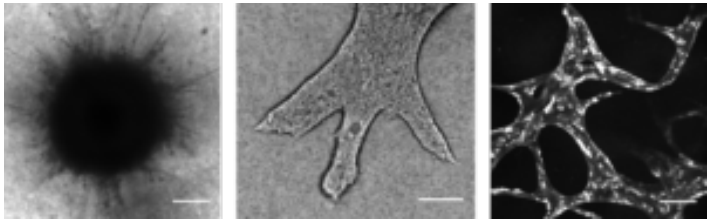
Cell-Matrix Interactions



Microfluidic Assays



Collective Cellular Systems



- Prof. Michael Mak
- Michael.Mak@Yale.edu
- MakResearchLab.com

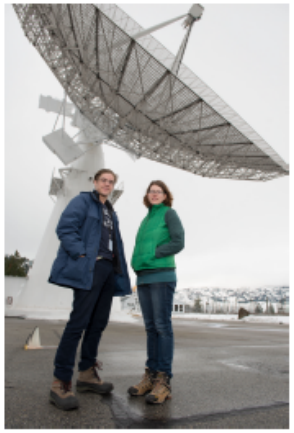
- **Mechanobiology:** intersection of mechanics and biology
- **Topics:** cell biophysics, tumor microenvironment, extracellular matrix, microscopy, image analysis, microfluidics, cancer immunotherapy, collective systems
- Computational and experimental approaches

Projects

1) Studying cell-matrix and cell-cell interactions in cancer and other diseases.
2) Microfluidic assays for measuring biophysical properties of cells.
3) Computational modeling of cell migration and tumor invasion, intracellular signaling, and cytoskeletal dynamics.
4) Additional topics can be discussed.

Activities

- Weekly individual meetings.
- Weekly group meetings.
- Regular guidance from graduate students and postdocs.
- Interactive, multifaceted, and integrative environment with opportunities for both individual and group projects.



Laura Newburgh

laura.newburgh@yale.edu

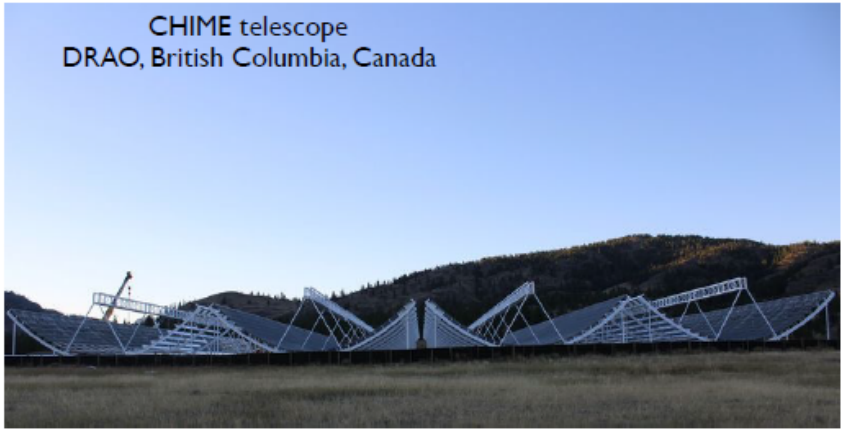
Next-generation Cosmology Instrumentation and Science with Millimeter and Radio Telescopes

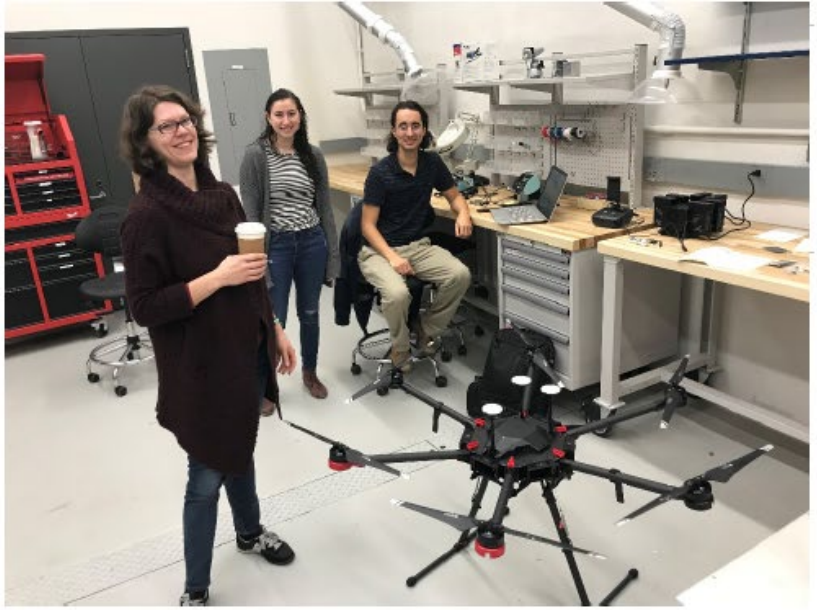
Cosmic Microwave Background Measurements with the Simons Observatory (and CMB-S4)

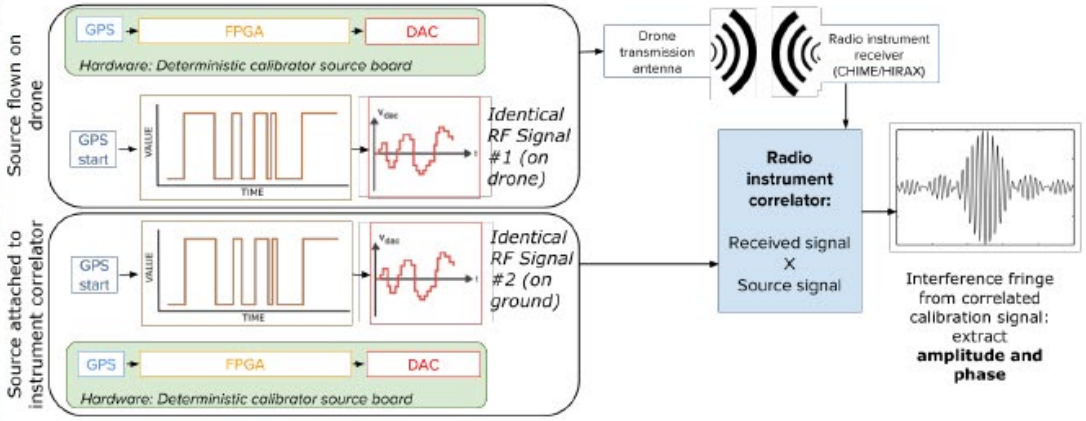
- Simons Observatory: 4 telescopes in ~2020
- Main science goals using measurements of the power spectrum, maps, and lensing: inflation, neutrino mass sum, light relics, dark energy
- I lead the group on 'data acquisition' (a group of ~15 people spread throughout the SO collaboration) focusing on software development: all acquisition and control, auxiliary readout hardware and software, timing, live monitoring

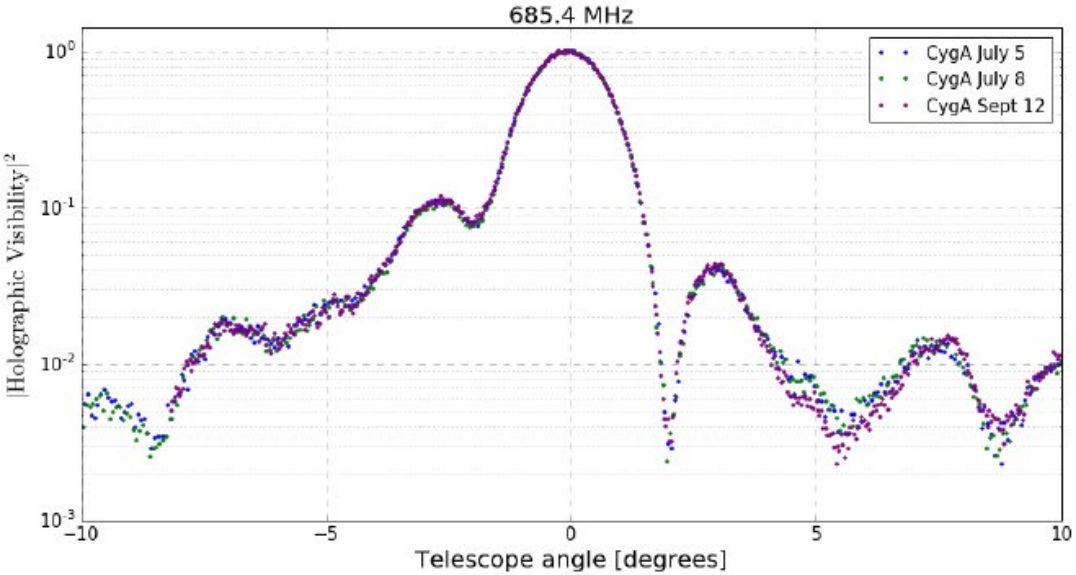
21cm Measurements of Dark Energy with CHIME and HIRAX

- CHIME is a new radio interferometer in Canada, seeking to use a new technique ('21cm intensity mapping') to expand the reach of galaxy surveys to very high redshift, critical for improving our understanding of Dark Energy
- I work on calibration: measuring the PSF of the instrument using a co-located a steerable dish and quadcopter drone measurements
- I also am a collaborator on HIRAX, a prototype instrument in South Africa which should overlap with other cosmological surveys (like SO)






Source flown on drone
GPS
FPGA
DAC
Hardware: Deterministic calibrator source board
GPS start
VALUE
TIME
Identical RF Signal #1 (on drone)
Drone transmission antenna
Radio instrument receiver (CHIME/HIRAX)
Source attached to instrument correlator
Identical RF Signal #2 (on ground)
Radio instrument correlator:
Received signal
X
Source signal
Interference fringe from correlated calibration signal: extract amplitude and phase


685.4 MHz
CygA July 5
CygA July 8
CygA Sept 12
|Holographic Visibility|²
Telescope angle [degrees]

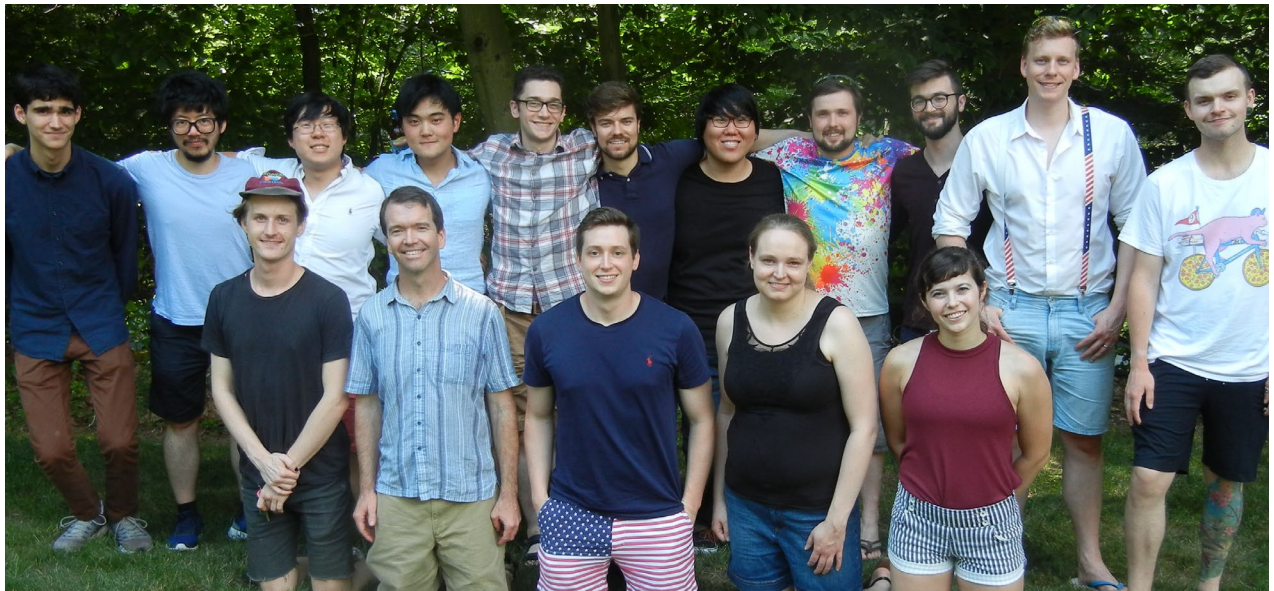
- Mentoring
  - Formal: one-on-one meeting per week
  - Experiment: typically one meeting per week
  - Informal: students feel free to drop by, I usually go through the lab at least once/day
  - Informal: its likely (depending on project) you'd be paired with either a graduate student or a postdoc as well
- Number of students: looking for one, people have already expressed interest, highly encourage you to look for funding of your own (STARs program, grants within your college, etc).
- Feel free to ask my previous/current students about their experiences:
  - Ry Walker, Sam Day-Weiss, Ava Polzin (Northwestern), Maxime Pradier (more upon request)

Trying to Reach the Iron Age

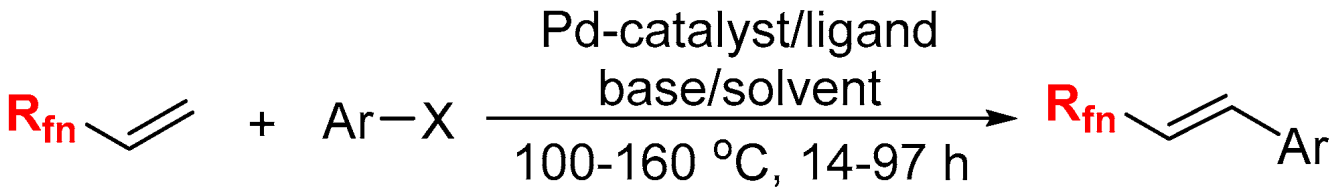
Prof. Patrick Holland

http://holland.chem.yale.edu/

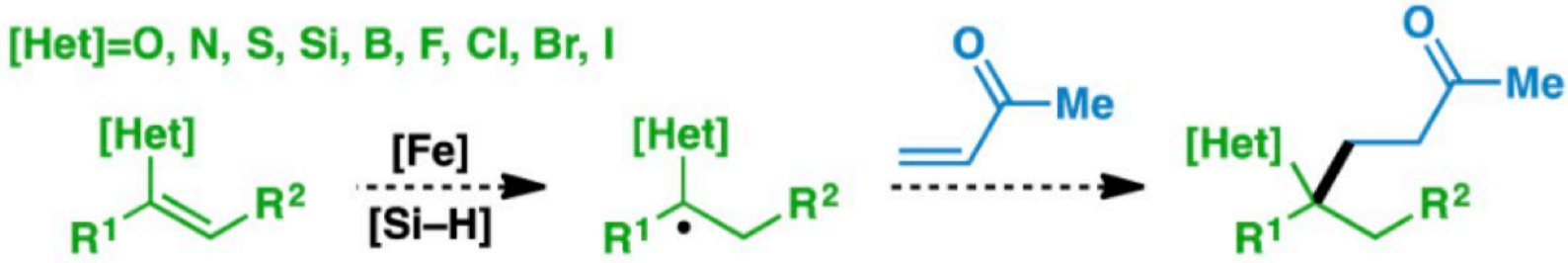
Organometallic Chemistry
Bioinorganic Chemistry
Organic Chemistry



Traditional catalysts for alkenes use precious metals



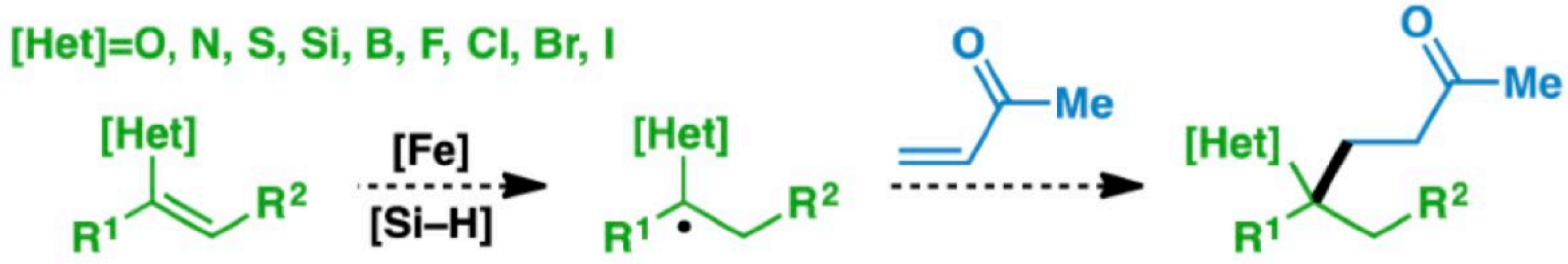
New methods using iron catalysts



Lo, Gui, Yabe, Pan, Baran *Nature* **2014**, *516*, 343.

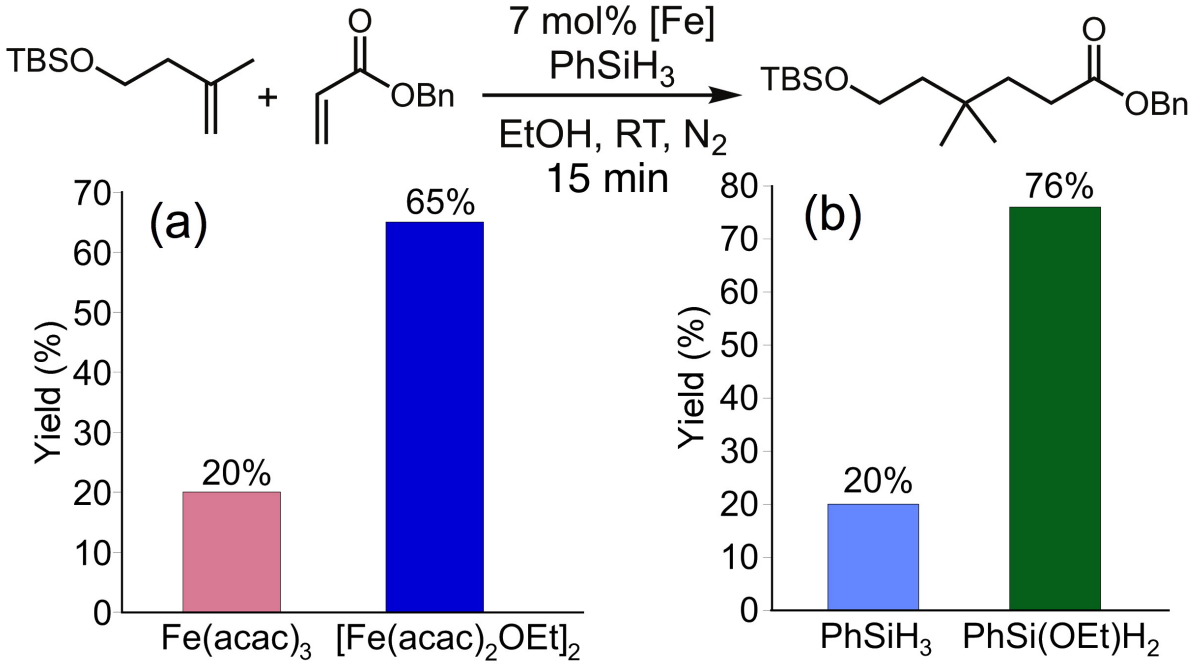
However, low yields and limited applicability

Lo, **Kim**, Pan, Edwards, Yabe, Gui, Qin, Gutierrez, Giacoboni, Smith, **Holland**, Baran *J. Am. Chem. Soc.* **2017**, *139*, 2484.



Lo, Gui, Yabe, Pan, Baran *Nature* **2014**, *516*, 343.
Lo, **Kim**, Pan, Edwards, Yabe, Gui, Qin, Gutierrez, Giacoboni, Smith, **Holland**, Baran *J. Am. Chem. Soc.* **2017**, *139*, 2484.

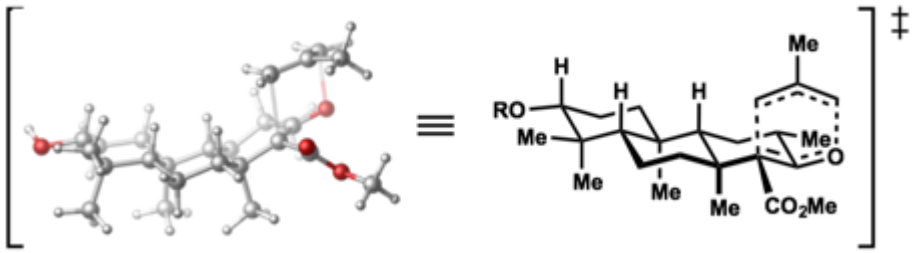
improvement:



goal: development and testing more active iron catalysts
methods: organic and inorganic synthesis, analytical testing
current undergrads: Kuan Jiang '19, Josef Lawrence '20, Dan DiPrimio '21

Newhouse Research Group

Use machine learning and quantum chemical calculations
to predict feasibility of synthetic plans



Email me to make an appointment to meet, include CV:
timothy.newhouse@yale.edu

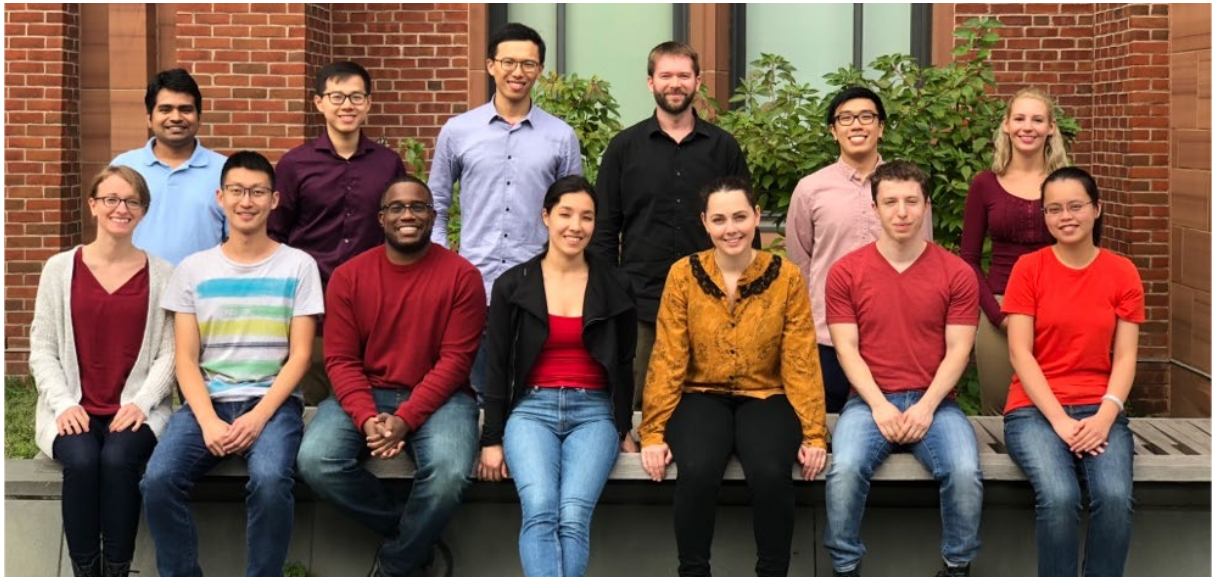
<u>We are seeking:</u> motivated, enthusiastic researchers interested in the intersection of computational chemistry and organic synthesis

(Positions also available for conducting experimental research!)

Join the team! Email me a CV: timothy.newhouse@yale.edu

Masha Elkin (graduate student mentor)

- ***Daily one-on-one meetings***
- ***Weekly team meetings***
- ***Weekly group meetings***



Prof. Corey S. O'Hern

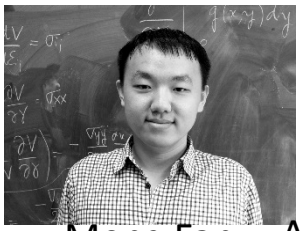
Laboratory for computational modeling of soft and biological materials

Departments of Mechanical Engineering & Materials Science, Physics, and Applied Physics

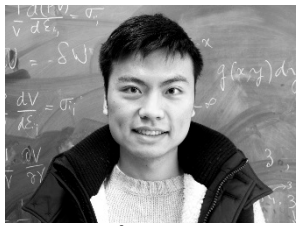
Graduate Program in Computational Biology & Bioinformatics

http://jamming.research.yale.edu

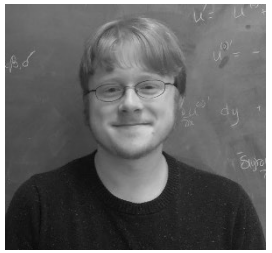
corey.ohern@yale.edu


Meng Fan

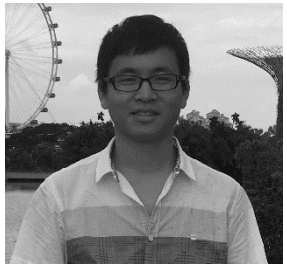

Arman Boromand


Qikai Wu

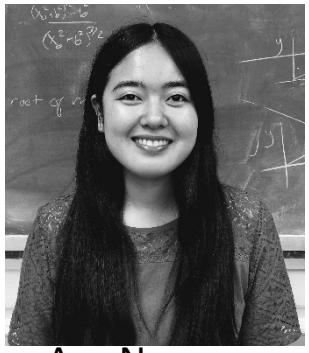

Jack Trado


Kyle Vanderwerf


Claudia Mezey


Yuan-Chao Hu


Zhe Mei


Aya Nawano


Philip Wang

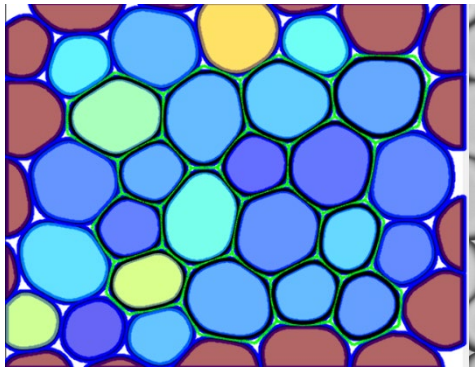

Peter Williams


Qinghao Liang

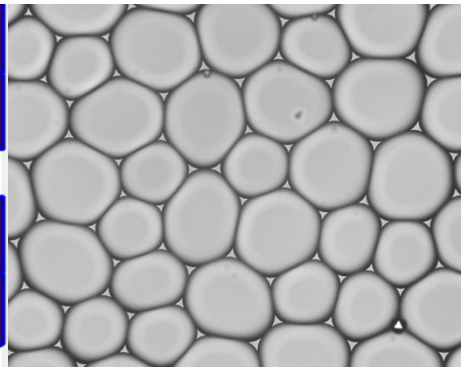
2 postdocs, 9 Ph.D. students, 2 undergraduates

Undergraduate Summer Research Projects

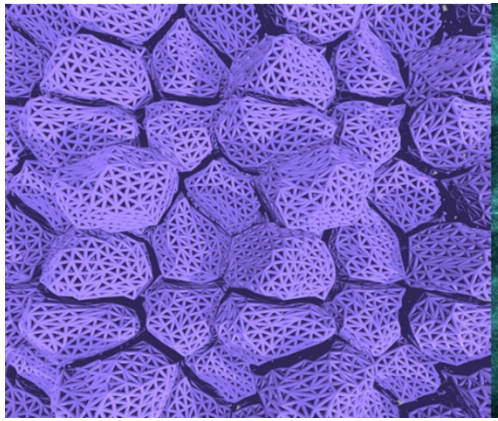
1.Computational modeling of deformable particles



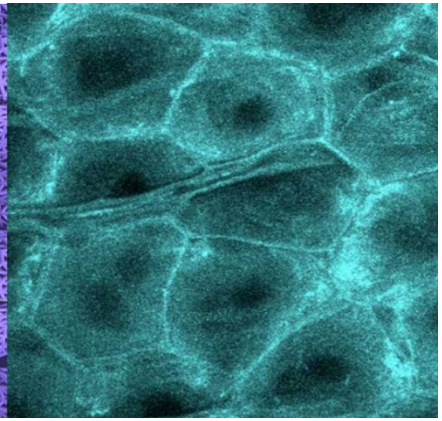
Reconstruction of bubble packing



Packing of bubbles

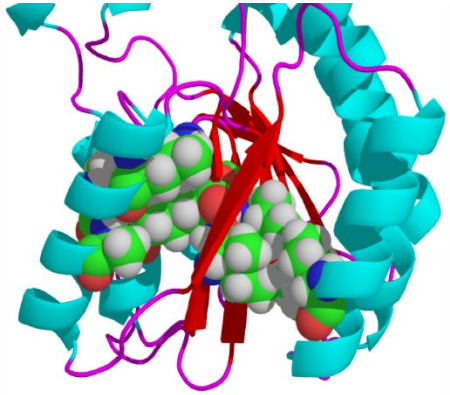


Packing of deformable polyhedra

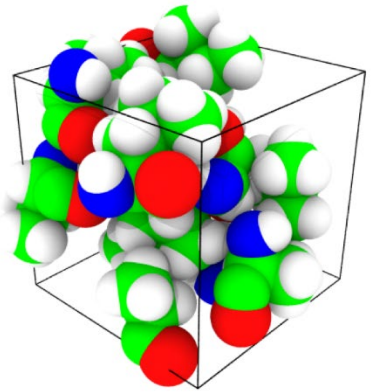


Packing of keratinocytes

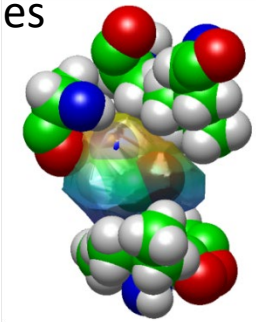
2. Dense packing in protein cores



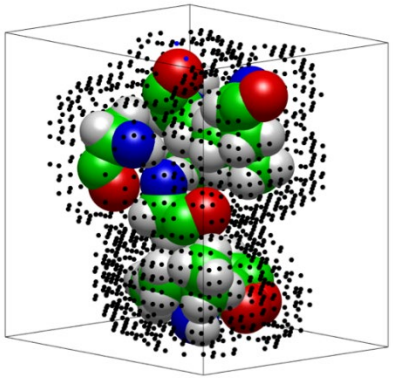
Core residues



Packing of residues



Voronoi polyhedron



Void space

Details of Mentoring

1. Computational modeling of deformable particles: Lead: Dr. Arman Boromand (postdoctoral research associate), daily meetings with Dr. Boromand, weekly updates at subgroup meetings with PI, graduate students, and undergraduates on Fridays; Office in Mason Lab, Room 313

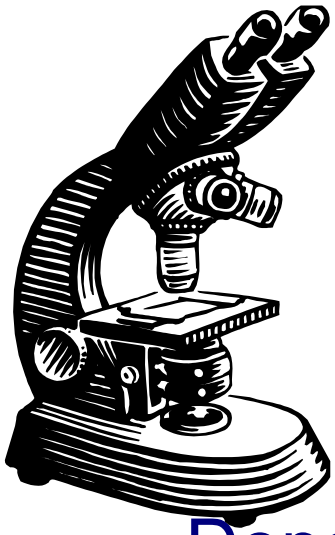
2. Dense packing in protein cores: Lead: Jack Treado (3rd year Ph.D. student in Mechanical Engineering & Materials Science) and Zhe Mei (3rd year Ph.D. student in Chemistry), daily meetings with Jack and Zhe, weekly updates at subgroup meetings with PI, graduate students, and undergraduates on Thursdays; Office in Mason Lab, Room 227

3. Skills to be learned: computer programming in C++, python, Matlab, and Cuda; running codes on Yale's High Performance Computing facilities, molecular dynamics simulations, computational modeling; research at interface of physics, biology, and engineering

4. Interested in 2-3 undergraduate researchers in summer 2019

5. Since 2002, hosted more than 50 undergraduates in summer research; 6 undergraduates have appeared as authors on publications

Yale Nanoprobe Group – The Scale of Things

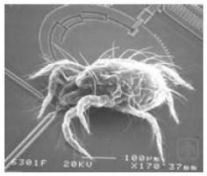


Things Natural

Things Manmade

CAN SEE

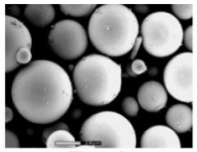
CAN'T SEE



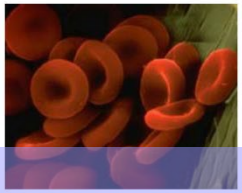
Dust mite
200 μm

Ant
~ 5 mm

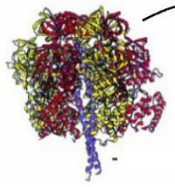
Human hair
~ 60-120 μm wide



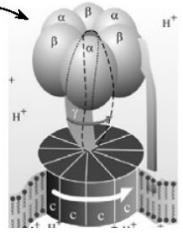
Fly ash
~ 10-20 μm



Red blood cells
(~7-8 μm)

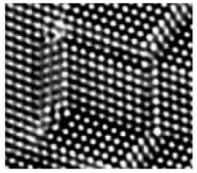


~10 nm diameter

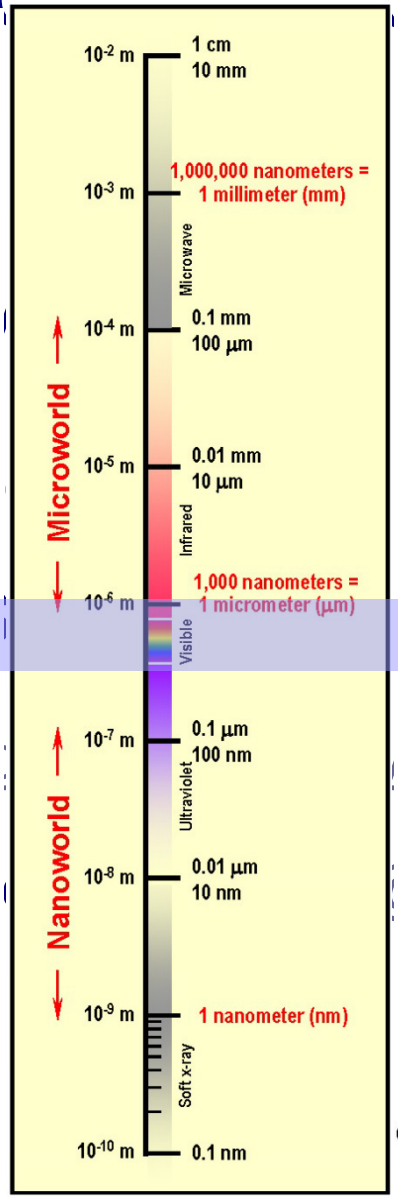


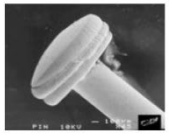
ATP synthase

DNA
~2-1/2 nm diameter

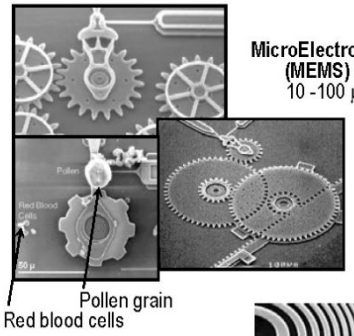


Atoms of silicon
spacing ~tenths of nm



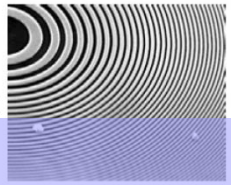


Head of a pin
1-2 mm

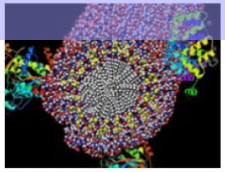


MicroElectroMechanical (MEMS) devices
10 -100 μm wide

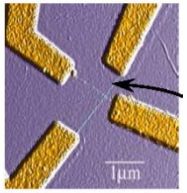
Pollen grain
Red blood cells



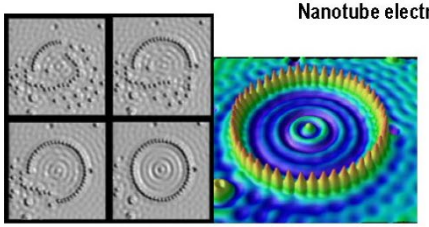
Zone plate x-ray "lens"
Outer ring spacing ~35 nm



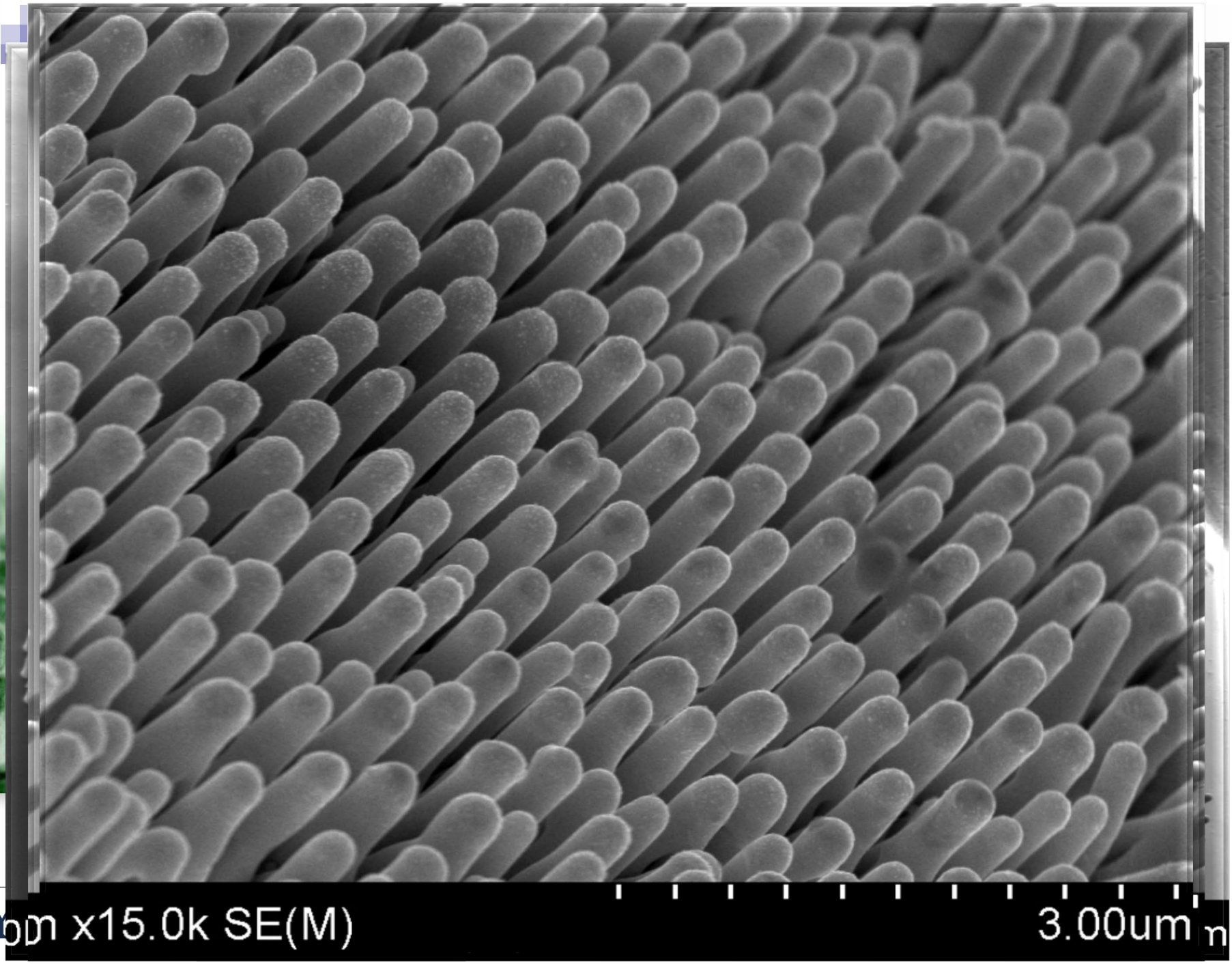
Self-assembled,
Nature-inspired structure
Many 10s of nm



Nanotube electrode



Quantum corral of 48 iron atoms on copper surface positioned one at a time with an STM tip
Corral diameter 14 nm


x15.0k SE(M)
3.00um

Working with the Yale Nanoprobe Group

- One on one meetings once every two weeks.
- Students present on their research updates.
- A maximum of two students for summer.
- My personal research experience.

Is nanotechnology the gateway to the future for human beings on Earth?

Where does your imagination take you?

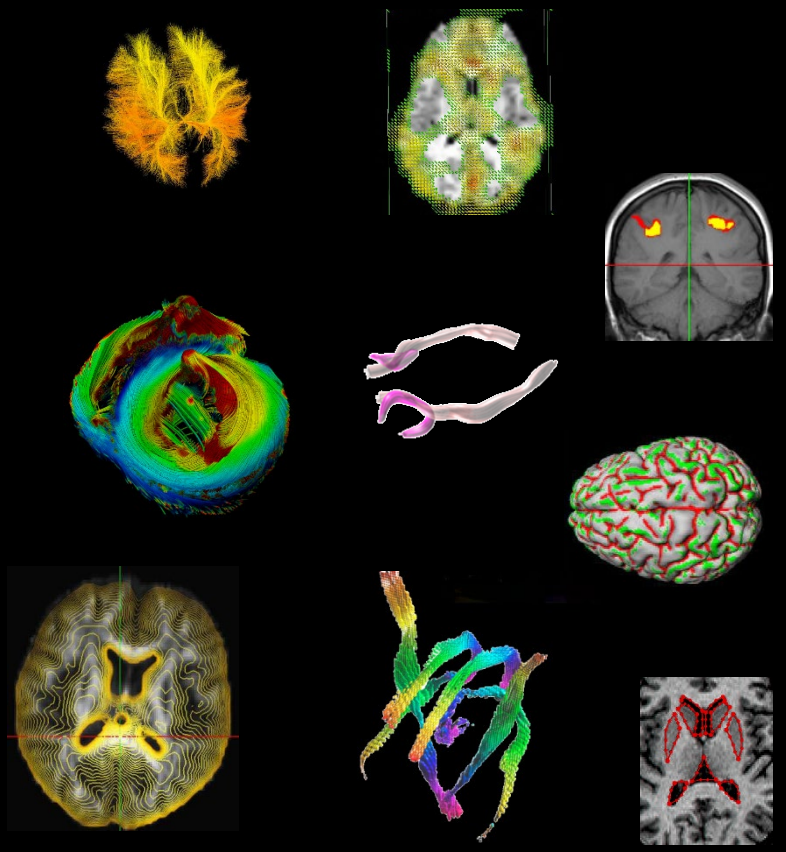
Lawrence Staib

Departments of Biomedical Engineering and
Radiology & Bioimaging Sciences

lawrence.staib@yale.edu

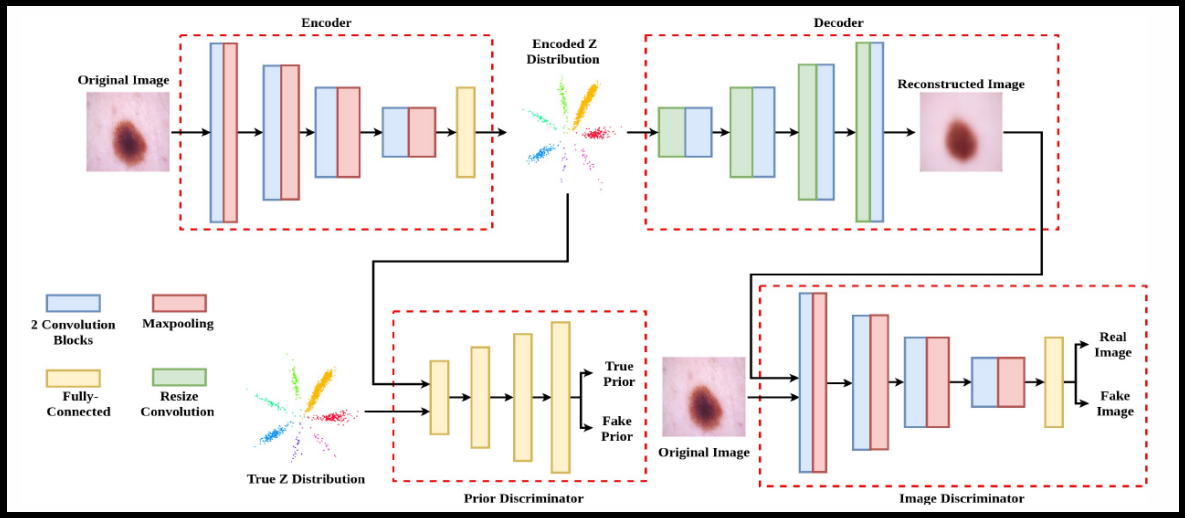
- Focus on:

Medical Image analysis
and Machine Learning
for quantification
and characterization
of normal and pathological
structure and function
for diagnosis and prognosis



Potential Projects

- Biomedical Image Processing & Analysis with Machine Learning
- Applications in neuroimaging, cardiology and cancer

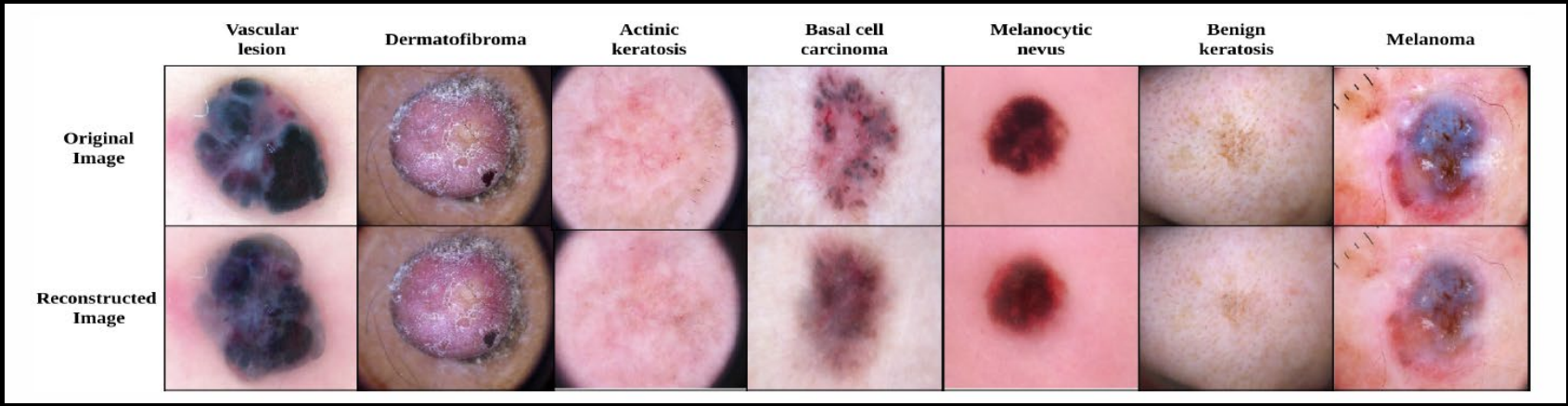


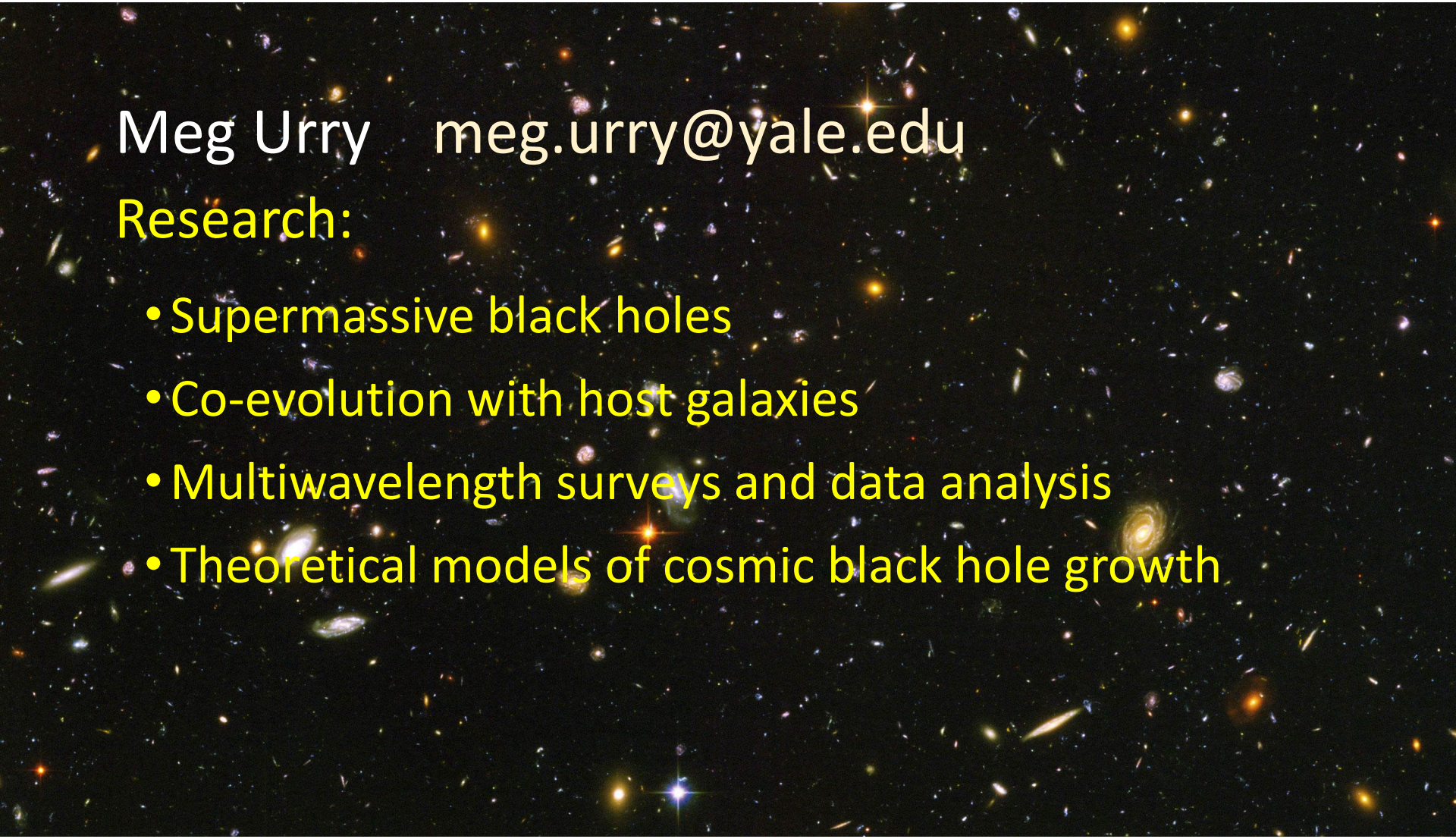
- Image segmentation
- Image classification
- Outcome Prediction
- End-to-end quantification

Biomedical Image Processing and Analysis
Applications in neuroimaging, cardiology and cancer

- Mentoring: touch base with me every day with a longer meeting each week; open door policy

- Prior projects:
  - Predicting liver tumor growth from imaging features
  - Lung lesion segmentation/classification
  - Dermoscopic image generation





Meg Urry meg.urry@yale.edu

Research:

- Supermassive black holes
- Co-evolution with host galaxies
- Multiwavelength surveys and data analysis
- Theoretical models of cosmic black hole growth

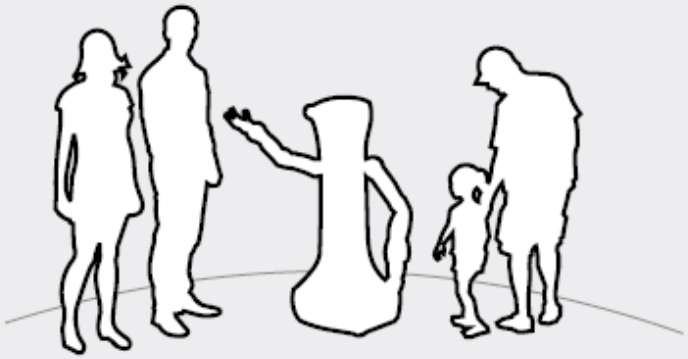
Potential summer student projects

- Studies of host galaxies of accreting black holes (BHs)
  - Fitting galaxy models to new high-resolution optical images
  - Using Artificial Intelligence to isolate galaxy light
  - Comparing data at different depths, signal-to-noise ratio, wavelength
  - Fitting spectral energy distributions
  - Measuring stellar masses of Active Galactic Nuclei (AGN)
- Diagnosing BH accretion w X-ray spectra of AGN
- Detecting new AGN in X-ray imaging data from the Chandra satellite
- Separating stellar light and black hole accretion in dusty galaxies

Urry group *2017*

- Typically 3-6 undergrads per summer
- Weekly group meetings (everyone summarizes work done, work planned)
- Additional meetings as needed
- Daily supervision by grad student or postdoc
- Granville Academy (astro skills + social justice issues)

Are you interested in helping us build prosocial computing technologies?



Marynel Vázquez
Assistant Professor, Yale Computer Science
http://www.marynel.net
marynel.vazquez@yale.edu

Yale
INTERACTIVE MACHINES GROUP

Are you interested in HCI, HRI, Robotics, AI, or Applied ML?

Design

Social Perception

Decision Making

Group Interactions

Yale

INTERACTIVE MACHINES GROUP

Marynel Vázquez
Assistant Professor, Yale Computer Science
http://www.marynel.net
marynel.vazquez@yale.edu

Contact us!

What can you do in the lab? Help us prototype robotic systems, conduct user experiments, and/or implement algorithms.

Mentoring: Direct supervision by Marynel. Weekly meetings.

Students: We are looking for 2-3 students.

Want to learn more? http://interactive-machines.gitlab.io

Marynel Vázquez
Assistant Professor, Yale Computer Science
http://www.marynel.net
marynel.vazquez@yale.edu

Yale
INTERACTIVE MACHINES GROUP

Nisheeth Vishnoi

nisheeth.vishnoi@yale.edu

Joined Yale Computer Science in Jan. 2019

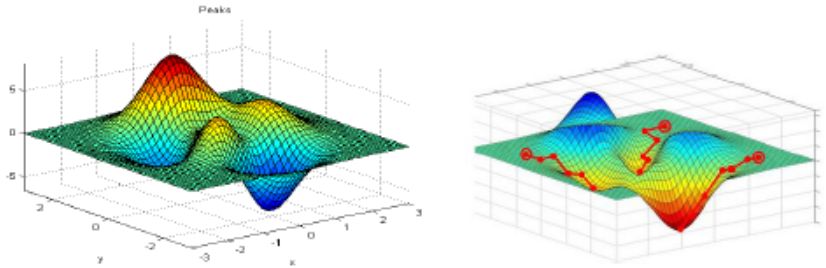
Research interests:

- Theoretical CS, Optimization, Machine Learning
- What design principles nature drive nature's algorithms?
- How to design AI systems for societal/humanitarian good?

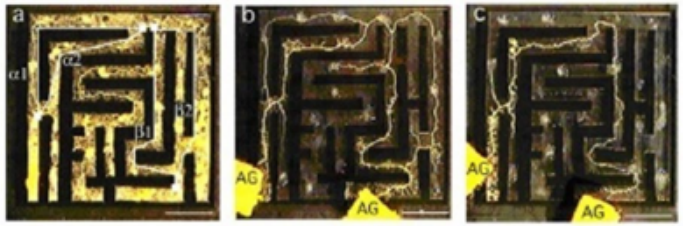
Given access to $f: \Omega \to \mathbb{R}$

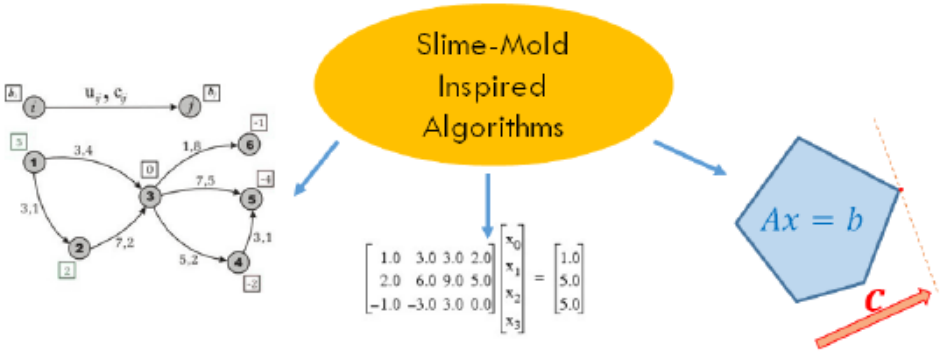
Optimize $\min_{\theta} f(\theta)$

Sample θ with prob. $\propto e^{-f(\theta)}$



Increasingly physics-inspired!





Can we design robust and fair AI systems?

Hardware

Training algorithm

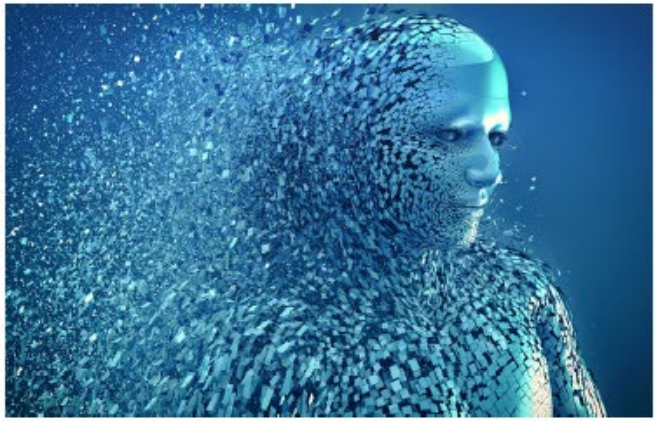
Model

$$f(\theta) = \sum_i \ell(\theta; x_i, y_i)$$

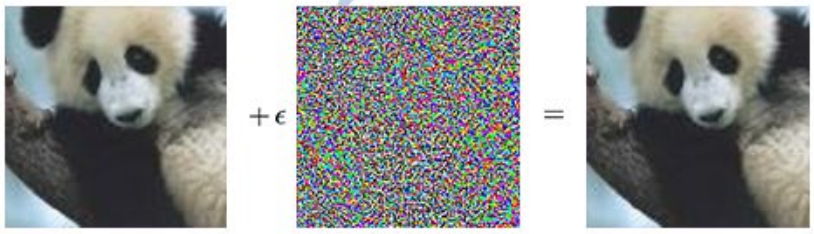
Data

Optimized for some metric of accuracy

Machine Learning



Artificial Intelligence



"panda"
57.7% confidence

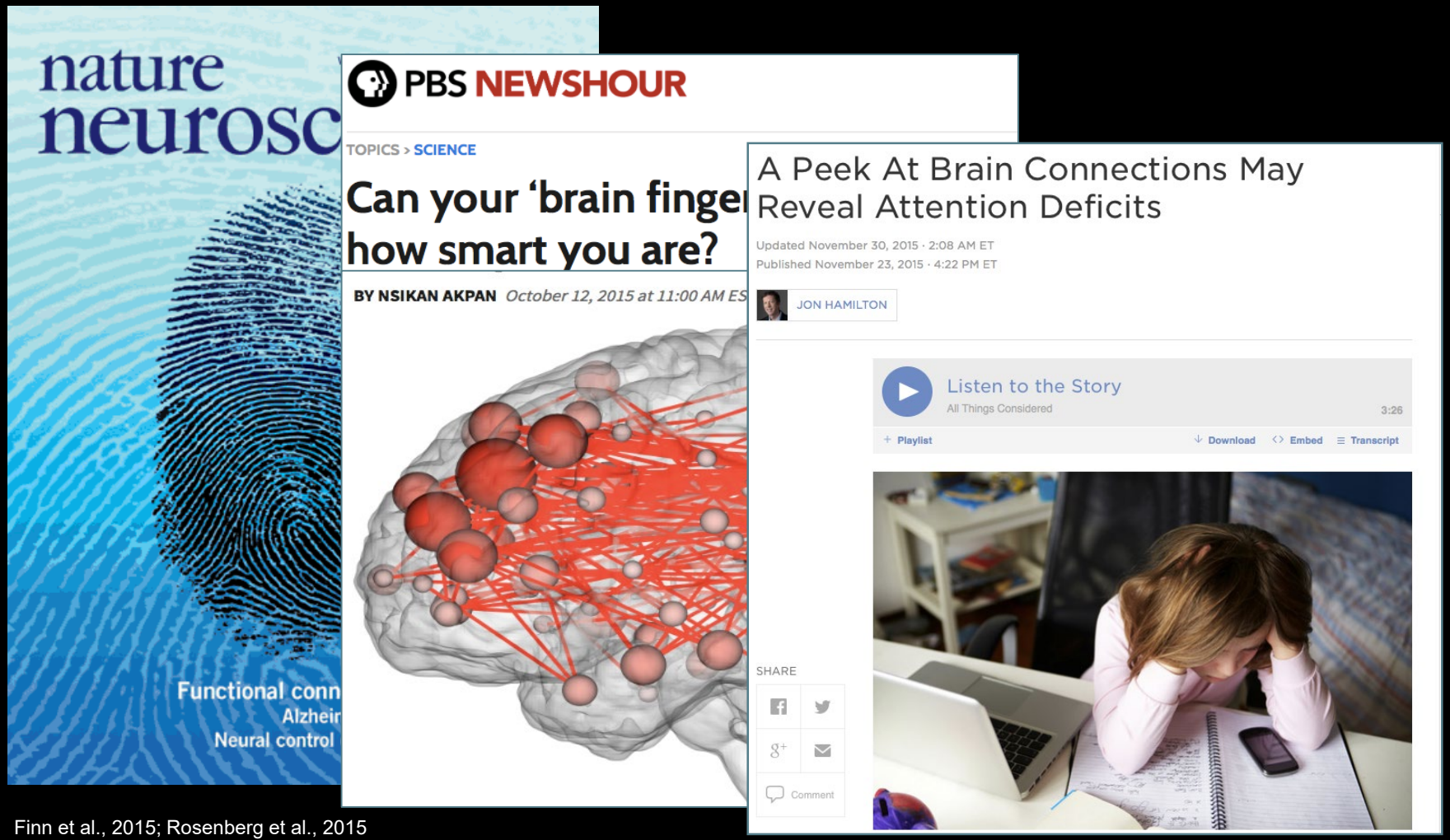
"gibbon"
99.3% confidence

Percentage of women in top 100 Google image search results for CEO: 11%
Percentage of U.S. CEOs who are women: 27%

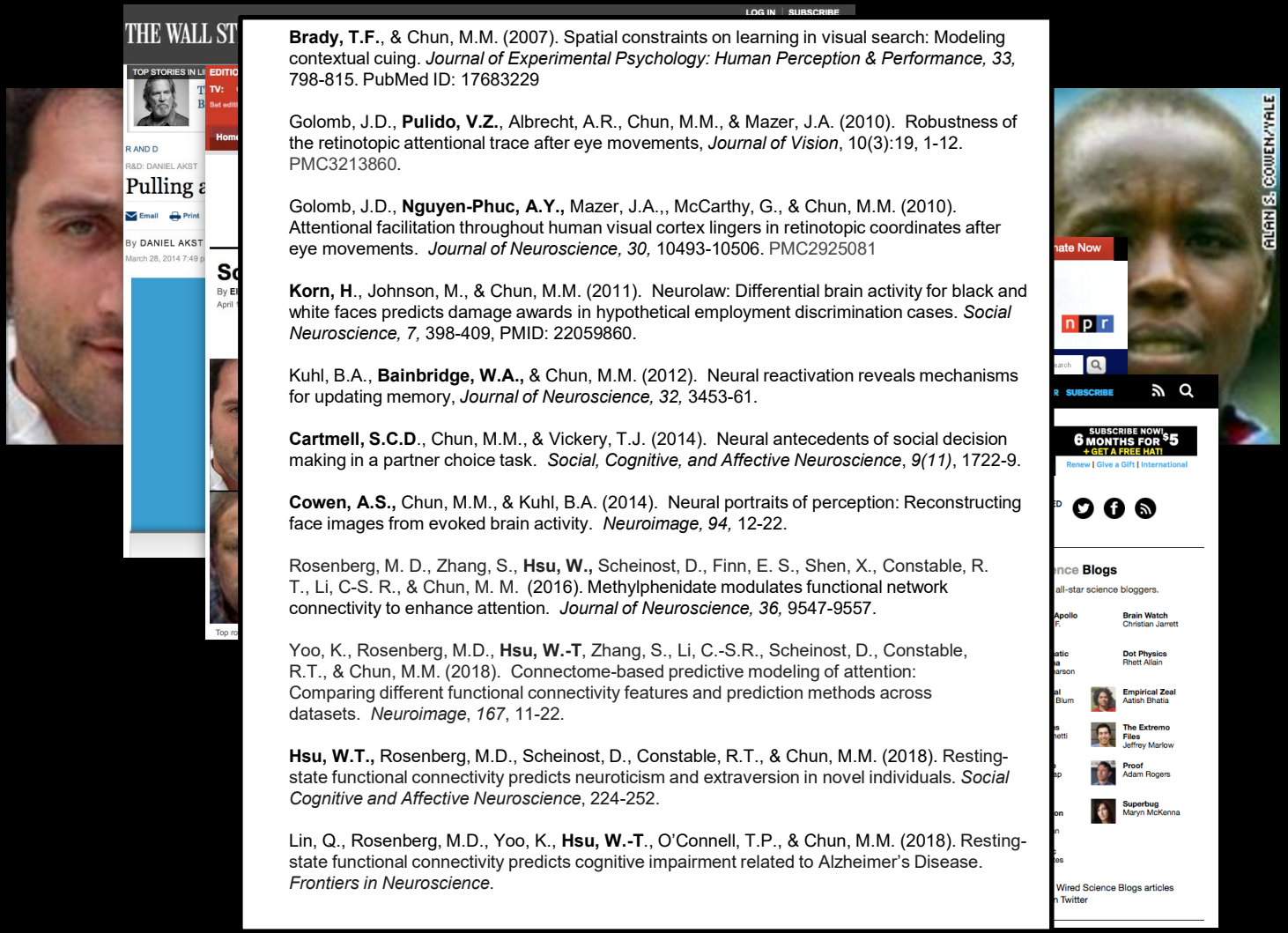
Mentoring

Quality	• Strong mathematical background with a passion to design AI systems for social good
Mentoring	• Will help formulate the precise problem, guide through the process of solving it and developing a demo for the solution
Meetings	• Once a week one-on-one update meeting including project update reports. Informal drop ins welcome
Funding	• Looking for up to two students, encourage to find funding of your own!

Good Luck!



Finn et al., 2015; Rosenberg et al., 2015



Brady, T.F., & Chun, M.M. (2007). Spatial constraints on learning in visual search: Modeling contextual cuing. *Journal of Experimental Psychology: Human Perception & Performance, 33,* 798-815. PubMed ID: 17683229

Golomb, J.D., **Pulido, V.Z.**, Albrecht, A.R., Chun, M.M., & Mazer, J.A. (2010). Robustness of the retinotopic attentional trace after eye movements, *Journal of Vision*, 10(3):19, 1-12. PMC3213860.

Golomb, J.D., **Nguyen-Phuc, A.Y.,** Mazer, J.A.,, McCarthy, G., & Chun, M.M. (2010). Attentional facilitation throughout human visual cortex lingers in retinotopic coordinates after eye movements. *Journal of Neuroscience, 30,* 10493-10506. PMC2925081

Korn, H., Johnson, M., & Chun, M.M. (2011). Neurolaw: Differential brain activity for black and white faces predicts damage awards in hypothetical employment discrimination cases. *Social Neuroscience, 7,* 398-409, PMID: 22059860.

Kuhl, B.A., **Bainbridge, W.A.,** & Chun, M.M. (2012). Neural reactivation reveals mechanisms for updating memory, *Journal of Neuroscience, 32,* 3453-61.

Cartmell, S.C.D., Chun, M.M., & Vickery, T.J. (2014). Neural antecedents of social decision making in a partner choice task. *Social, Cognitive, and Affective Neuroscience*, *9(11)*, 1722-9.

Cowen, A.S., Chun, M.M., & Kuhl, B.A. (2014). Neural portraits of perception: Reconstructing face images from evoked brain activity. *Neuroimage, 94,* 12-22.

Rosenberg, M. D., Zhang, S., **Hsu, W.,** Scheinost, D., Finn, E. S., Shen, X., Constable, R. T., Li, C-S. R., & Chun, M. M. (2016). Methylphenidate modulates functional network connectivity to enhance attention. *Journal of Neuroscience, 36,* 9547-9557.

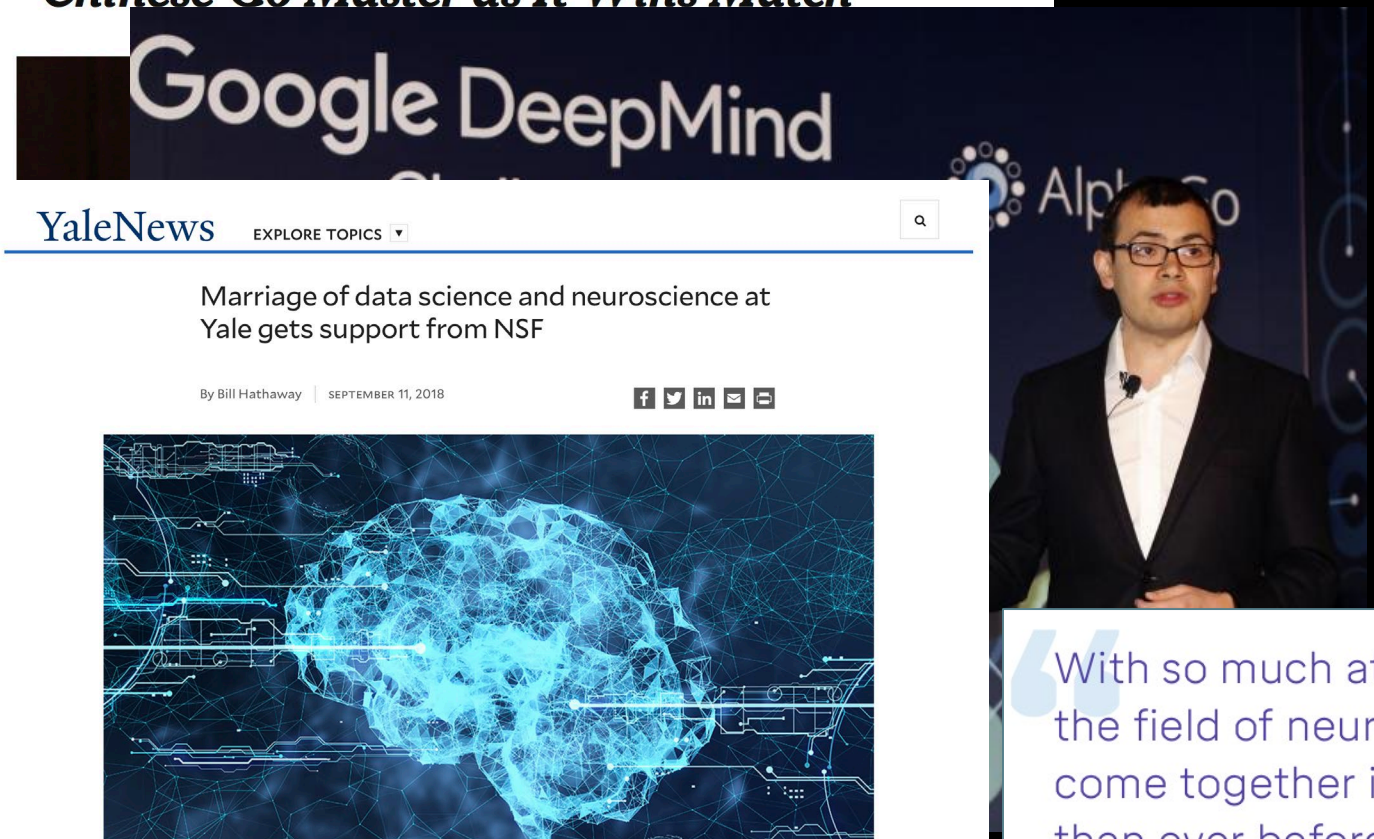
Yoo, K., Rosenberg, M.D., **Hsu, W.-T**, Zhang, S., Li, C.-S.R., Scheinost, D., Constable, R.T., & Chun, M.M. (2018). Connectome-based predictive modeling of attention: Comparing different functional connectivity features and prediction methods across datasets. *Neuroimage*, *167*, 11-22.

Hsu, W.T., Rosenberg, M.D., Scheinost, D., Constable, R.T., & Chun, M.M. (2018). Resting-state functional connectivity predicts neuroticism and extraversion in novel individuals. *Social Cognitive and Affective Neuroscience*, 224-252.

Lin, Q., Rosenberg, M.D., Yoo, K., **Hsu, W.-T**., O'Connell, T.P., & Chun, M.M. (2018). Resting-state functional connectivity predicts cognitive impairment related to Alzheimer's Disease. *Frontiers in Neuroscience*.

Google's A.I. Program Rattles Chinese Go Master as It Wins Match

The New York Times



YaleNews EXPLORE TOPICS

Marriage of data science and neuroscience at Yale gets support from NSF

By Bill Hathaway | SEPTEMBER 11, 2018

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> With so much at stake, the need for the field of neuroscience and AI to come together is now more urgent than ever before.
>
> Google DeepMind

Acknowledgements

Donalee Slater	Assistant Director, SC/QR Education
Dr. Alexia Belperron	Director, STEM Fellowships