CSU Department of Defense (DoD) Awardees

Moderated by:
Dr. Frank A. Gomez
Executive Director, STEM-NET
Office of the Chancellor

https://www2.calstate.edu/impact-of-the-csu/research/stem-net
Speakers

Reginald Williams, Department of Defense
Department of the Navy's (DoN) Historically Black Colleges Universities and Minority Institutions (HBCU/MI) Program

Abraham Wolcott, San José State University
Diamond Surface Science, Synchrotron Radiation and the Transition Edge Sensor Detector

Scott Hauswirth, California State University, Northridge
Development of a CSUN GeoAnalytical Center for Research, Teaching, and Outreach in Earth Systems Science

Daniel Fernandez, California State University, Monterey Bay
An Infusion of DoD Equipment Funding to Help Advance an Existing Fog Research Program: My Experience

Joseph Kalman, California State University, Long Beach
DoD Funded Solid Propulsion and Combustion Research at CSULB

Akm Newaz, San Francisco State University
Electrical and Optoelectrical Properties of Natural Van der Waals Heterostructures

Frank A. Gomez  
CSU Office of the Chancellor  
fgomez@calstate.edu
Department of the Navy’s (DoN) Historically Black Colleges Universities and Minority Institutions (HBCU/MI) Program

Reginald Williams – Department of Defense

Keynote Speaker

Reginald Williams, Program Officer
Office of Naval Research
reginald.g.williams@navy.mil
Diamond Surface Science, Synchrotron Radiation and the Transition Edge Sensor Detector

Abraham Wolcott – San José State University

Reginald Williams, Program Officer
Office of Naval Research
reginald.g.williams@navy.mil
Development of a CSUN GeoAnalytical Center for Research, Teaching, and Outreach in Earth Systems Science

Scott Hauswirth – CSU Northridge

Collaborators (if any):
Priya Ganguli, Jennifer Cotton, Eileen Evans, Robinson Cecil, Joshua Schwartz, and Julian Lozos

Scott Hauswirth, Assistant Professor
CSU Northridge, Department of Geological Sciences
scott.hauswirth@csun.edu
Project Overview

- DoD Program: “Research and Education Program for Historically Black Colleges and Universities and Minority-Serving Institutions Equipment/Instrumentation Grant”

- A possibly different approach to a DoD instrumentation proposals
  - Geology and environmental science at DoD?
  - Multiple instruments for disparate research focuses?
  - All PIs first-time DoD grant proposers

- Lots of questions on our end:
  - Is there DoD interest?
  - Is it cohesive?
  - What angle for this proposal?

Scott Hauswirth       CSUN/Geological Sciences       scott.hauswirth@csun.edu
**Project Overview**

- Aimed to create a GeoAnalytical Center within CSUN Dept. of Geological Sciences (DGS) with some degree of cohesion that will:
  - Provide structured, centralized facilities to advance the department’s research capabilities
  - Expand research opportunities for graduate and undergraduate students
  - Promote integration of laboratory and computational methods into both upper and lower division courses
  - Promote use of equipment for community outreach
Project Overview

• Includes purchase of six instruments/pieces of equipment supporting all five junior faculty in the department plus 2 others

• Suite of instrumentation highlights interdisciplinary nature of research in dept.:
  • “traditional” geology
  • environmental science
  • paleobiology/climatology
  • geophysics/seismology

• And there is DoD interest in these areas!
Project Overview

- Equipment adds new capabilities and expands capabilities of existing facilities.

- Instruments:
  - **Isotope ratio mass spectrometer** (IRMS+EA +TC/EA +GC+Gas bench) (Cotton, Hausworth, Ganguli)
    - Measuring stable isotope ratios for C, H, N, O, S (potentially others) in:
      - Soil, water, solids (rocks, biological materials, etc.)
  - **Inductively couple plasma mass spectrometer** (ICP-MS) (Cecil, Schwartz, Hausworth, Ganguli)
    - Measuring metals concentrations (and isotope ratios) in rocks/minerals, soil, and water
    - Will be connected to existing hi-res ICP-MS with laser ablation system to allow simultaneous measurement of Pb/U (for age-dating rocks) and trace metals

Scott Hausworth       CSUN/Geological Sciences       scott.hausworth@csun.edu
Project Overview

- Other equipment:
  - Ion chromatograph (IC) (Hauswirth, Ganguli)
    - Measures concentrations of ions (chloride, sulfate, nitrate, etc.) in water
  - Ground penetrating radar (GPR) (Evans, Hauswirth, Ganguli)
    - Allows detection of subsurface structures (human-made or natural)
  - Electrical resistivity system (Evans, Ganguli, Hauswirth)
    - Measures subsurface electrical resistivity for identifying subsurface structures, fresh/saltwater interface
  - Computing node to expand seismological modeling capabilities (Lozos)
Activities

• So far: purchasing + installing equipment!
  • IC operational since Fall 2019, ICP-MS installed Winter 2020-21, IRMS system installed April 2021
  • Other equipment coming soon
Activities

• Example projects:
  
  • Effects of wildfires on water quality – ongoing project investigating Malibu Creek watershed after Woolsey fire.
    
    • Polycyclic aromatic hydrocarbons (PAHs) – toxic/carcinogenic, released during fire.
      • What are concentrations in watershed? How long do they persist?
      • What is the source? (Also from exhaust, petroleum, etc.) → measure C, H isotopes of individual PAH compounds with IRMS system to differentiate source
    
    • Ions released during fire → measure with IC
  
    • Metals released + increase transport due to increased sediment → measure with ICP-MS

Scott Hauswirth       CSUN/Geological Sciences       scott.hauswirth@csun.edu
Activities

• Contaminant cycling in coastal lagoons
  • Nutrients, metals, other contaminants transported to coastal lagoons \(\rightarrow\) affect geochemistry, ecosystems
  • Mercury can be converted to toxic, bioaccumulative methylmercury in lagoons

• Nutrients \(\rightarrow\) measure with IC, Metals \(\rightarrow\) measure with ICP-MS
• Need to know surface + groundwater fluxes into/out of lagoons
  • Identify buried channels with GPR
  • Identify saltwater/freshwater boundary, measure flux with ER

Scott Hauswirth  CSUN/Geological Sciences  scott.hauswirth@csun.edu
Development of a CSUN GeoAnalytical Center for Research, Teaching, and Outreach in Earth Systems Science

Activities

- Integration into education
  - Large underserved population in department
  - Development of new BA Environmental Science major (currently in review)
  - Hydrogeology, Env. Hydrogeology (new), Env. Field Sampling+Analysis (new), Env. Geochemistry, Applied Geophysics courses will all include project-based components using instrumentation
  - Focus on hands-on, research-oriented education, including in lower courses, aims to expand interest in department and attract high quality undergrad and grad students

Scott Hauswirth  CSUN/Geological Sciences  scott.hauswirth@csun.edu
Activities

- Integration into outreach
  - IRMS frees up an existing CO₂, H₂O, and C-isotope analyzer → will be plumbed to roof of building + will collect real-time measurements
  - Combined with O₃ and PM meters → San Fernando Valley (SFV) Air Quality monitoring station
  - Will develop high school modules using the real time data + arrange high school tours
Lessons Learned

- Without reviews, difficult to assess what was reviewed positively. Our thoughts:
  - Strong emphasis on integration of education and outreach to traditionally underserved populations
  - Identified links with multiple DoD agencies (Earth Sciences, Littoral Geosciences, Modeling Complex Systems) + emphasized not only research, but training of students on fundamental science relevant to those divisions
  - Letter of support from researcher within DoD
  - Incorporation of junior faculty and focus on growth and new directions of department

Scott Hauswirth  CSUN/Geological Sciences  scott.hauswirth@csun.edu
Next Steps/Long-Term Plans

• Remaining items will be purchased + installed this summer
• Actual analyses starting soon
• Implementation into courses starting in 2021/2022 (probably Spring).

Scott Hauswirth  CSUN/Geological Sciences  scott.hauswirth@csun.edu
Development of a CSUN GeoAnalytical Center for Research, Teaching, and Outreach in Earth Systems Science

Scott Hauswirth  CSUN/Geological Sciences  scott.hauswirth@csun.edu
An Infusion of DoD Equipment Funding to Help Advance an Existing Fog Research Program: My Experience

Daniel Fernandez – California State University, Monterey Bay

Daniel Fernandez, Professor
California State University, Monterey Bay, Department of Applied Environmental Science
dfernandez@csumb.edu
An Infusion of DoD Equipment Funding to Help Advance an Existing Fog Research Program: My Experience

• A bit about me.
• Fog research.
• A hook to DoD research.
• My grant specifics.
• Suggestions for you if you choose to apply for this opportunity.
• A short time-lapse video of the FM-120 deployment.
An Infusion of DoD Equipment Funding to Help Advance an Existing Fog Research Program: My Experience

Daniel M. Fernandez

CSUMB Professor since 1996. I teach classes in Physics and Environmental Studies.

Since 2005, I have been involved in fog research, specifically, collection of water from fog.
Fog Research

- Deploys “standard fog collectors” statewide to collect and measure volumes of water from fog.
Examples of DoD Interest

Visibility and operations in foggy environments.

Daniel Fernandez
CSU Monterey Bay, Applied Environmental Science
dfernandez@csumb.edu
An Infusion of DoD Equipment Funding to Help Advance an Existing Fog Research Program: My Experience

Example of DoD Interests, ct’d

Potential for collection of usable water.
Grant Specifics

• Funding pot is specifically for equipment (particular emphasis on HIS and on engaging students from HSI). Can include training.

• Theme: How to make more precise and exacting measurements of fog characteristics. Equipment requested to purchase:
  • 2 Specialized fog monitors (FM-120) designed to measure the sizes of and count the number of fog droplets per unit volume.
  • 2 ceilometers designed to measure the cloud ceiling height.
  • 3 chilled-mirror hygrometers, designed to measure very accurately the relative humidity.
  • Three 2-D sonic anemometers, designed to measure the wind speed and wind direction.
  • One 3-D sonic anemometer.
  • Laptops.

Daniel Fernandez
CSU Monterey Bay, Applied Environmental Science
dfernandez@csumb.edu
Grant Features

• Reflected my deep engagement with this research to date.

• Emphasized regional applications (no $ for travel included, but don’t need it!). This worked out well given COVID. Did go to training on FM-120 in Colorado (right before lockdown!!). All equipment also received prior to lockdown.

• Specific outcomes and experiments anticipated.

• Emphasized relevance to DoD.

• Emphasis on intended student engagement and prior student engagement.

• Donation letter to support anticipated yearly calibration costs.

Daniel Fernandez
CSU Monterey Bay, Applied Environmental Science
dfernandez@csumb.edu
Work thus far

- Video of regional FM-120 deployment.
- Course-based Undergraduate Research Experience (CURE) in 2nd semester physics class.
DoD Funded Solid Propulsion and Combustion Research at CSULB

Joe Kalman, California State University, Long Beach (CSULB)

Joe Kalman, Assistant Professor
CSULB, Department of Mechanical and Aerospace Engineering (MAE)
Joseph.Kalman@csulb.edu
DoD Funded Solid Propulsion and Combustion Research at CSULB

Project Overview

• Office of Naval Research
  • Development of High Pressure and X-ray based Diagnostics for Solid Propulsion (Advanced Energetic Materials, current)
  • Interfacial Properties towards Additive Manufacturing of Solid Propellants (HBCU/MI, current)
  • Solid Propulsion Mix and Characterization for Research in Propulsion Technologies (DURIP—equipment only, ends this year)

• Air Force Research Laboratory
  • Interfacial Physics of Propellants (ends this year)
  • Strain Measurements and Damage in Propellant Microstructures (ended)

Joe Kalman CSULB/MAE joseph.Kalman@csulb.edu
Project Overview

- Office of Naval Research
  - Development of High Pressure and X-ray based Diagnostics for Solid Propulsion (Advanced Energetic Materials, current)
  - **Interfacial Properties towards Additive Manufacturing of Solid Propellants (HBCU/MI, current)**
    - Solid Propulsion Mix and Characterization for Research in Propulsion Technologies (DURIP—equipment only, ends this year)
- Air Force Research Laboratory
  - **Interfacial Physics of Propellants (ends this year)**
  - Strain Measurements and Damage in Propellant Microstructures (ended)
Motivation

- Particle-Binder Dewetting
  - Reduces mechanical strength
  - Pores for convective combustion

Results

- Static Contact angles
  - Polymer structure influence
  - Solvent effects on surface

<table>
<thead>
<tr>
<th>Solvent</th>
<th>Average (deg)</th>
<th>Std. Dev. (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toluene</td>
<td>41.35</td>
<td>3.92</td>
</tr>
<tr>
<td>Hexanes</td>
<td>34.04</td>
<td>0.71</td>
</tr>
<tr>
<td>Ethyl Acetate</td>
<td>22.61</td>
<td>2.86</td>
</tr>
<tr>
<td>Ethyl Methyl Ketone</td>
<td>27.62</td>
<td>5.26</td>
</tr>
<tr>
<td>Methanol</td>
<td>33.83</td>
<td>2.80</td>
</tr>
<tr>
<td>Distilled Water</td>
<td>35.92</td>
<td>1.24</td>
</tr>
</tbody>
</table>


Student: David Ramirez
Undergraduate Honors thesis
DoD SMART Scholar

Student: Aaren Cortes
Current MSAE Student

Joe Kalman
CSULB/MAE
joseph.Kalman@csulb.edu
Results

- Simulate interaction (shear rate) in mixer
- HTPB/Toluene mixtures on AP
  - Spreading ratio decrease with polymer content
  - Evaporation of toluene during spreading


Joe Kalman  
CSULB/MAE  
joseph.Kalman@csulb.edu

Student: Sahson Raissi  
Current MSME Student
Lessons Learned (and tips)

• Know (or find out) problems DoD is interested in solving

• Partner or collaborate with DoD researchers

• Propose ideas that:
  • do not require too much infrastructure/experimental development
  • Are easily broken down to ‘simple’ problems

• Be prepared for administrative work
  • Plan for course release
  • Lots of time teaching students
  • New research can ‘scare’ campus administration/safety, limitations at a CSU

Joe Kalman  CSULB/MAE  joseph.Kalman@csulb.edu
Questions

- Thank you!
- Please feel free to reach out for questions, collaborations, etc.
Optoelectronics of a Natural van der Waals Heterostructures

Akm Newaz– San Francisco State University

Franckeite

S
Pb
Sn

Akm Newaz, Associate Professor
Quantum Materials and Nanodevice Laboratory
Department of Physics and Astronomy, SFSU
Graphite

- Molybdenite
- Bi$_2$Te$_3$
- Boron Nitride

Graphene

- Mono-MoS$_2$
- B$_2$Te$_3$
- Mono-hBN

2D layered atomic crystals

- masslees Dirac fermions
- Strongest-ever
- Highest T-cond
- Record mobility
- ....

- Complex-metallic compounds: TaSe$_2$, TaS$_2$, ...
- Magnetic materials: FeSe$_2$, CoSe$_2$, ...
- Superconducting: NbSe$_2$, Bi$_2$Sr$_2$CaCu$_2$O$_{8-x}$, ZrNCl$_2$, ...
- Hundreds more!!!
Making 2D Atomic Crystal

Mechanical Exfoliation

Optoelectronics of a Natural van der Waals Heterostructures
Van der Waals Heterostructures (vdWH)

Artificial

Novoselov, Nature (2012)

WSe₂/MoS₂ Heterostructure

vdWH devices
Van der Waals Heterostructures (vdWH)

- Designer materials at atom levels.
- Attractive for novel functional devices.

Problems:
1) Poor control on crystal orientation.
2) Impurities, such as air bubbles or adsorbates can sit at the interface.

Artificial

Novoselov, Nature (2012)
Van der Waals Heterostructures (vdWH)

What if mother nature get involved in preparing vdWHs?

- Perfect crystal orientation!
- New functionality may appear

Franckeite

Akln Newaz
San Francisco State University / Department of Physics & Astronomy
akmnewaz@sfsu.edu
Sample Fabrication

(a) MoS₂
PDMS
Glass

(b) Glass
PDMS
Franckeite
Target Substrate

(c) Stamping stage (xyz)

Microscope

SS
GS

Sample Fabrication

Raman Shift (cm⁻¹)

165 210 257 320

Raman Intensity (a.u.)

160 240 320

5 µm
Optoelectronics of a Natural van der Waals Heterostructures

Electrical Transport Properties

**Graph 1:**
- Voltage (V) vs. Current (µA)

**Graph 2:**
- Resistance (R) vs. 1/T (K⁻¹)
- Data points and fitted line
Optoelectronics of a Natural van der Waals Heterostructures

Opto-electronics of Natural vdWH

(a) $T=77K$ $V_{ds}=1V$

(b) $T=220K$ $V_{ds}=1V$

- Photon Wavelength (nm)
- Photon Current (nA)
- Temperature (K)
- Integrated PC (nA)
Time response of Photocurrent

- Rise time and fall time 0.5 mS so the frequency is ~2 KHz.
- A potential candidate for broadband nanoscale photodetector
We determined the crystal structure and all possible phonon vibrations.

We have found several low vibrations mode.

The Raman modes behave differently with respect to temperatures.
Acknowledgements

SFSU group

University of Oklahoma group

Stanford group (Prof. E. Pop)

Prof. E. Pop

K. Smithe
HBCU/MI grant: REP and Instrumentation Grant

DEPARTMENT OF DEFENSE
Research and Education Program
for Historically Black Colleges and Universities and Minority-Serving Institutions (HBCU/MI)
Fiscal Year 2018
Funding Opportunity Announcement
W911NF-17-S-0010

Issued by the U.S. Army Contracting Command-Aberdeen Proving Ground
Research Triangle Park Division on behalf of the Army Research Office (ARO)
and the
Assistant Secretary of Defense for Research and Engineering
(Research Directorate/Basic Research Office)

Deadline is usually second week of August
Tips

1) Find and contact the program manager in your field

2) Project Relevance to the interest of XXXXXX and the potential contributions to the DoD mission

3) Total length 25 pages long including the facilities and References
Speaker Contacts

Reginald Williams, Department of Defense
reginald.g.williams@navy.mil

Abraham Wolcott, San José State University
abraham.wolcott@sjsu.edu

Scott Hauswirth, California State University, Northridge
scott.hauswirth@csun.edu

Daniel Fernandez, California State University, Monterey Bay
dfernandez@csumb.edu

Joseph Kalman, California State University, Long Beach
Joseph.Kalman@csulb.edu

Akm Newaz, San Francisco State University
akmnewaz@sfsu.edu
Next Steps/Closing Remarks

Dr. Frank A. Gomez
Executive Director, STEM-NET
Office of the Chancellor

https://www2.calstate.edu/impact-of-the-csu/research/stem-net
Webcast Feedback Survey
Please take a few moments to tell us about your webcast experience

Join our CSU STEM-NET Community listserv
csustemnet@lists.calstate.edu

Begin a Conversation with Colleagues and Join our
Private CSU STEM-NET Facebook Group
https://www.facebook.com/groups/2629611737269292
Save the Dates

STEM-NET Virtual Research Café 10.0
- May 26, 2021
  Registration Link: TBA

STEM-NET June Webcast
- CSU NSF RUI Exemplars
  Registration Link: TBA

Frank A. Gomez  CSU Office of the Chancellor  fgomez@calstate.edu