Research Instrumentation
Interfacial Photochemistry

- **Dr. Jared P. Bruce**
- Assistant Professor
- Department of Chemistry and Biochemistry
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**Expertise**
- Heterogeneous Photochemistry
- Electrocatalysis
- Photocatalysis
- Atmospheric Chemistry
- Surface Chemistry and Interfacial Characterization
- Near Ambient Pressure Photoelectron Spectroscopy
Hybrid Co-Catalyst/Photoabsorber Photochemical Interfaces

- Metals often make good electrocatalysts
- Semiconductors make good photoabsorbers
- The combination of the two create a new, complex interface that can be leveraged to increase the efficiency of co-catalyst/photoabsorber devices

Mixing Liquid Jet Photoelectron Spectroscopy

- Dynamic processes are tricky to study at the liquid surface
- A small liquid jet (20µm dia.) is used to investigate the liquid surface
- Microfluidic chips provide mixing chamber to induce chemical reactions
Electronic and Magnetic Properties at High Pressure

Dr. Andrew Cornelius
Department of Physics & Astronomy
Phone (702) 895-1727

Expertise:
• Experimental high pressure measurements
• Magnetism
• Superconductivity
Superconductivity

Quantum Design PPMS at UNLV
- Measurements from 0.3 K to 400 K
  - Heat capacity, electric and thermal transport, and AC/DC magnetization
- Pressure cells to measure electrical properties (clamp to 3 GPa and diamond anvil cell to >100 GPa)

Addition of high pressure synchrotron experiments (diffraction and X-ray absorption) allows mapping of complex superconducting phase diagrams
Correlated-Electron Systems

- Modified periodic table
- Going from localized to delocalized electrons one often finds strong electron-electron correlations
- Correlated electron systems can yield interesting behavior: fluctuating valence, superconductivity, non-Fermi liquid, heavy fermion and many more

- f-electron delocalization
- X-ray absorption

- Heavy fermions
- Heat Capacity

- Fluctuating valence
- X-ray fluorescence
Art Gelis
Director, Radiochemistry Program
Actinide Separations and Recovery
Design and Testing of Advanced Separation Processes using Additive Manufacturing

- Liquid-Liquid Extraction and Separation of Plutonium, Uranium, Minor Actinides, Lanthanides and Fission Products
- Twenty-seven 3D-printed acrylic centrifugal contactors (CC), fabricated at Argonne National Lab are available at UNLV
- Contactors can be 3D-printed in stainless steel or any alloy
- Solvent extraction separations can be tailored to a specific goal
- Example: Actinide Lanthanide SEParation process - ALSEP, designed and tested for DOE-NE

**PUREX-type**

\[ \text{U, Pu, Np} \]

**ALSEP**

\[ \text{Am, Cm} \]

**FP**

**Ln**
Microfluidic Systems for Rapid Radionuclide Separation and Detection

• Microfluidic device to combine aqueous and organic phases, rapidly mix, then separate phases, following by analysis
• Selective Extraction of radionuclides on a very small scale
• Can be implemented either as a bench-top setup or as a portable detector
• Potential applications: rapid Pu separation and detection from Uranium and FP for safeguards; "dirty bomb" analysis
Surface and Interface Characterization of Materials for Energy Conversion

- **Dr. Clemens Heske**
- Professor
- Department of Chemistry and Biochemistry
- Email: heske@unlv.nevada.edu
- Website: https://heske.faculty.unlv.edu/

**Expertise**

- Electronic and Chemical Structure of Energy-Conversion Materials
- Surface and Interface Characterization
- Soft x-ray and Electron Spectroscopy
- Scanning Probe Microscopy
- Synchrotron Radiation
Surface and Interface Characterization of Materials for Energy Conversion

Cu(In,Ga)(S,Se)$_2$ Thin-Film PV Device

Method development

Electronic structure of $C_{60}$

SALSA: Solid And Liquid Spectroscopic Analysis

UNLV College of Sciences
Island – Quantum computing, quantum sensing

The Nanoscale Physics Group @ UNLV

Areas of Research

- Nanotechnology, device physics
- Photodetection and quantum sensing
- Quantum computing, topological qubits
- Non-equilibrium, driven systems
- Superconductivity, proximity effects
- Low dimensional materials

Island's Lab website
Island – Quantum computing, quantum sensing

**Quantum computing:**
Topological phases for fault-tolerant, universal quantum computing.

**Industry-disruptive photodetectors:**
Ultra-sensitive phototransistors designed with 2D materials and heterostructures.

**Transient phases of driven systems:**
Non-equilibrium response of pumped nanomaterials below the diffraction limit.

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Island's Lab website
Journal publications:

**Spin-orbit-driven band inversion in bilayer graphene by van der Waals proximity effect**  

**Enhanced superconductivity in atomically thin TaS2**  

**Proximity-induced Shiba states in a molecular junction**  

**T1S3 transistors with tailored morphology and electrical properties**  

**Environmental instability of few-layer black phosphorus**  

**Ultrahigh photoresponse of few-layer TiS3 nanoribbon transistors**  

**Gate controlled photocurrent generation mechanisms in high-gain In2Se3 phototransistors**  

**Precise and reversible band gap tuning In single-layer MoSe2 by uniaxial strain**  

Island's Lab website
Ubiquitin-mediated protein degradation

Dr. Gary Kleiger
Professor and department Chair
Department of Chemistry and Biochemistry
gary.kleiger@unlv.edu
https://kleiger.faculty.unlv.edu

Expertise
• Structural biology
• Proteomics
• Enzyme kinetics and biophysical assays
• Cell biology
Uncovering how the enzymes that promote protein degradation function in human cells.

Kinetics help us understand how enzymes select protein targets for modification with ubiquitin.

Small molecule inducers of protein degradation can be used to treat human disease. We study the mechanism of how they function both in test tubes and cells.

High-resolution mass-spectrometry tells us how mutations in enzymes that lead to human disease affect the stabilities of key human cellular proteins.
Novel chemistry and biology using highly ionizing radiation

Michael Pravica, Ph.D.
Professor of Physics
Department of Physics and Astronomy
Phone: (702)895-1723
Email: michael.Pravica@unlv.edu

Expertise:
Useful Hard X-ray photochemistry
High pressure Spectroscopy
Ion Beam Nuclear Transmutation Doping
High quality synthesis of vaccines using tuned hard x-rays
Pravica Group Research

A. Photochemistry

B. Novel materials synthesis

C. New Physics/Chemistry

D. Device applications

Optical mixer

Wide bandgap semiconductor

Radiation-hardened sensors/direct energy conversion devices for EXTREME CONDITIONS or tuned solar materials

Useful hard x-ray photochemistry

Novel structures of known materials produced with hard x-rays and high pressure (e.g. CsO₂)
High Pressure Fluorine Chemistry

\[ 2F_2 + O_2 \xrightarrow{hv} 2OF_2 @ 3 \text{ GPa} \]

\[ \text{XeF}_2 \xrightarrow{hv} \text{Xe} + F_2 \text{ (in situ x-ray fluorination)} \]

\[ \text{HgF}_2 + F_2 \xrightarrow{hv} \text{HgF}_4 \]

Inner shell chemistry at high pressure

Molecular mixtures at high pressure

Using tuned hard x-rays to damage viruses to create high quality vaccines by targeting specific molecular groups/bonds that resonantly absorb x-ray energy leading to decomposition chemistry.
Salamat Group – Collaboration with MSTS

Metrology – accurate mapping of P, V, T

High temperature modelling – understanding emissivity under extreme conditions
Warm dense matter – probed using EXAFS

- Development of a CO$_2$ laser heating
- Direct heating of non-metallic systems in a DAC
- First HTHP EXAFS measurements of insulators
- In situ and post heating measurements
- Determining absolute temperature from X-ray spectroscopy
Publications


Research Oliver Tschauner

- Dr. Oliver Tschauner
  - Professor of Research
  - Department Geoscience
  - Email: oliver.Tschauner@unlv.edu
  - Website: https://geoscience.unlv.edu/people/department-faculty/oliver-tschauner/

Expertise
- Crystallography.
- Mineralogy.
- Physics and Chemistry at high pressure.
- Dynamic compression.

Natural diamond with CO$_2$ inclusions at a pressure of 20000 atmospheres
Selected Publications

Zhou Lab – Experimental AMO physics

Dr. Yan Zhou
Assistant Professor
Department of Physics and Astronomy
Email: yan.zhou@unlv.edu
Website: https://www.physics.unlv.edu/~yanzhou/index.html

Research projects
- Explore new physics beyond the Standard Model by precision measurements using quantum logically controlled molecular ions
- Precision metrology and spectroscopy using optical frequency combs
- Quantum transducer – link ion trap and superconducting quantum computers
- Experimental astrochemistry – cold ion-radical collisions
Search for $T,P$-odd symmetry violation

- On-chip Quantum sensors
- Entanglement between atomic ions and molecular ions
- Scalability and multiplexing measurements
- New table-top platform to investigate nuclear physics