Acknowledgments

From Left to Right: Brandon Ho, Dr. Caixia Bu, Dr. Daniel Savin, Khushi Taori, Dr. Michael Hahn, Dr. Garima Joshi

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Outline

- **Motivation**
- **Project 1: Data Analysis**
- **Methodology**
- **Results**
- **Project 2: Building a Vacuum Test Stand**
Rocky Planet Formation

- All 4 inner planets + the Moon have an iron core
- Most also have a iron-rich surface, except for Mercury
- Was Mercury’s formation process different?
Exosphere Composition

- Sodium is abundant in the exosphere around Mercury
- Predicted to come from the surface
- Exosphere carries information about surface composition, which can constrain formation models
Surface Composition of Mercury

Map of the surface of Mercury. NP-LMg is a region of low magnesium, contains relatively more sodium.
Apparatus used to study ion sputtering
Sample Stage Inside Target Chamber

- Ions incident on sample at angle of 45 degrees
- Catcher foils placed in half-dome shape around sample
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My Project

- Write Python script to analyze beam profile monitor (BPM)
- Determine beam’s shape, position, and intensity profile versus time
- Use script to calculate total number of ions delivered to the sample in order to calculate sputtering yields
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Monitoring Beam Shape

- BPM records intensity profile of the beam
- Gaussian fit performed that determines the center and width of the beam
Data Cleaning and Processing

- Select only relevant data where irradiation is taking place
- Remove outlier points
  - Calculate the averages and standard deviations of selected variables
  - Outlier - not within 5 standard deviations of mean
Integrating Intensity over Time

- BPM measures ion current (intensity) versus time
- By integrating these measurements over the duration of data collection, total charge of beam is calculated
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Beam Intensity vs. Time - Cleaned Data

Data cleaned to remove points where the beam does not reach the sample

- Outliers still present that can affect total dose results
Beam Intensity vs. Time - Outliers Removed

Data further processed to remove outliers

- Data within a much smaller range (within 5 standard deviations of the mean intensity)
Total Dose and Ions calculation

- Total charge delivered to sample
  - 3/4/22 - 6.772e-3 Coulombs
  - Over 10 days - 1.019e-1 Coulombs

- Each ion has a charge of +1.6e-19 Coulombs
  - 3/4/22 - 4.232e16 ions
  - Over 10 days - 6.366e17 ions
Calculating Sputtering Yield

- Number of atoms captured by each catcher foil found by measuring change in mass
- Sputtering Yield = ratio of atoms captured to total dose of ions delivered
- Sputtering yields can be plotted versus polar and azimuthal angles
Sputtering Yield Plotted versus Angles
Next Steps

- Repeat this process for loose powder sample
- Use ions similar to those in the solar wind - specifically hydrogen and helium
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Vacuum Test Stand

- Pictured is an example of a vacuum pump keeping inside of apparatus at low pressure.
Temporary Mounting of Chamber
Progress Pictures

- Pictured - pieces midway through assembly
Progress Pictures

- The process was not completely smooth!

Pictured - a screw that was stripped in the building process
Final Result

Next steps

- Mount vacuum pump and chamber to frame
Thank you!
Beam Intensity vs. Time

Intensity of beam plotted through entire course of data collection

- Data obscured, points when irradiation not occurring also taken into account