

2026-27 HIVE Summer Internship Project

Exploring spacedust - Developing 3D visualization models of asteroid particles.

Primary Academic Supervisor

Dr. Maree McGregor

Project Background

What is star dust? How did the solar system form? What are asteroids made of?

Part of my research is to help answer these questions by studying materials from asteroids that orbit our Earth. Thanks to NASA's OSIRIS-REx and JAXA's Hayabusa missions, we now have access to pristine asteroid materials here at Curtin University! My work focuses on investigating materials collected from three asteroids in our solar system – Bennu, Ryugu, and Itokawa.

Asteroid materials are made of different types of components that can be studied. My research is focussed on trying to understand:

- (1) the chemistry of the early solar system was before Earth formed;
- (2) when in our solar systems 4.6 billion-year history these asteroids were created?; and
- (3) do they contain materials formed within stars other than our own? And if so, what was the chemistry of these stars?

Despite the enormity of what asteroid materials can tell us, this information is locked inside extremely small particles (some are less than the width of a human hair!). To help unlock the secrets held within asteroids, this project aims to use X-ray Computed Tomography and 3D microscopy to provide an interactive, 3D visualization of particles from the asteroids Bennu and Ryugu.

By working closely with planetary scientists from Space Science & Technology Centre and researchers within the HIVE, you will develop skills within data visualization, microscopy, and planetary geology. This is an

opportunity for those with a more technical background to gain hands on experience working with extraterrestrial materials and potentially a doorway into working with NASA and JAXA.

Project Description, Expected Outputs, Possible Stretch Goals

Most of our research is done in 2D, and unfortunately critical information that may be found in 3D is lost. This project will involve using X-Ray Computed Tomography slices and various types of microscopy data of asteroid Bennu particles to help visualize the materials in greater detail.

There are two main aims of this project:

(1) Produce a microscopy-based photogrammetry data set of the exterior of asteroid particles from Bennu and generate 3D visualization models.

(2) Process existing X-Ray Computed Tomography data from Bennu and Ryugu particles to provide a 3D virtual reality visualization of the material.

A possible stretch goal will be to conduct advanced processing of the above datasets X-Ray to provide a interactive model which allows different spatial features (e.g., fracture networks) and lithological components (e.g., rock types) to be observed. This will involve developing an imaged-based machine learning algorithm for automated segmentation of different components identified within the XCT scans and microscopy images.

Ultimately, our hope is to provide the planetary research community a novel, automated, and interactive way to study precious, extraterrestrial samples in three dimensions.

Links to background reading and any relevant recent work in the field

- <https://science.nasa.gov/missions/osiris-rex/asteroid-bennus-rugged-surface-baffled-nasa-we-finally-know-why/>
- Low thermal inertia of carbonaceous asteroid Bennu driven by cracks observed in returned samples | Nature Communications
- Abstract: X-Ray Computed Tomography of Samples from Asteroid Bennu: Textural Analysis and Sulfide Segmentation for Lithology Characterization (2024 Goldschmidt Conference)

What type of visualisation will the student develop or produce?

The student will develop two 3D visualization models: one which uses existing XCT slices and a second which uses either SEM and/or optical microscopy data. The latter will involve the working alongside the supervisor/co-supervisor to conduct 3D photogrammetry of particles using various types of microscopy equipment. In both cases, the student will be required to create VR experience of the data. As a stretch goal, the student will work to develop a feature mapping algorithm that can be used to l

How will the visualisation contribute to your research outcomes?

- Characterization of material in 3D at high spatial resolution to understand relationship between component populations that will provide context for geochronology analyses
- Visualisations of fracture networks used to relate shock deformation in metals to fracture propagation.
- Interactive model for public outreach/high schools, where interactive VR experienced of rocks from space may help engage students in STEM fields which remains low across WA. This has a wealth of creative possibilities.

If the project is successful, where would you consider publishing the results?

If successful, this data may be published in conjunction with other datasets. It will likely be disseminated to researchers in a more informal conference/collaborative setting where we use the visualizations to discuss and generate ideas.

Additionally, if we can do this for other particles in the OSIRIS-REx and Hayabusa catalogues they will be very valuable for researchers across the board.

Draft Project Timeline:

Week 1

Nov 16 - Full day HIVE induction

Nov 17 - Area and Project Induction with Primary supervisor

Develop project plan with HIVE and academic team

Literature and relevant project review

Project Familiarisation

Week 2

Data collection:

- Student provided with XCT data and briefed through its content/geologic context
- Student works with HIVE to start creating XCT VR model

Week 3

Data collection:

- Student provided with XCT data and briefed through its content/geologic context
- Student works with HIVE to start creating XCT VR model

Week 4

Final VR product using XCT data created

Week 5

Data collection for particle microscopy

Week 6

Data collection for particle microscopy

Week 7

Processing VR photogrammetry model

Week 8

Processing VR photogrammetry model/ finish model

Week 9

Focus on report writing and presentation (including demo) preparation

Week 10

*Focus on report writing and presentation (including demo) preparation
5th Feb Final Showcase Day and final report due*

Student Experience and Supervision:

How often will you meet with the student over the 10-week period?

Once a week or as needed by the student/depending on extra availability of supervisor.

Your work desk location and the location of student desk

The Fish Bowl (Building 314, same hall as primary supervisor)

Student Attributes:

Please indicate any preference for student's academic discipline or field of study

data science, mechatronics, someone with an interest in space science and a technical background, spatial science, student with broad technical skills,

What competencies are required to start this project

Beginner - 3D modelling software (Blender, 3ds Max)

Beginner - Game engine development (Unity, Unreal. Godot, etc.)

Beginner - Virtual Reality Development (rendering pipelines, scene content design, interaction)

Beginner - Data structures, analytics, statistical modelling

Do you have any other student attributes you think are important to the project?

A passion data, science and exploration, an eagerness to learn!