

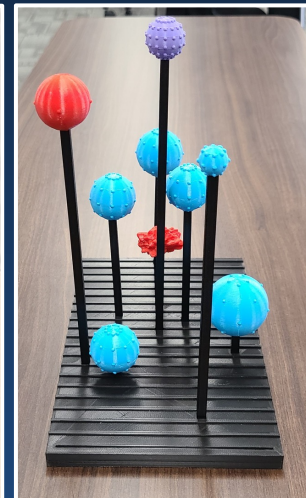
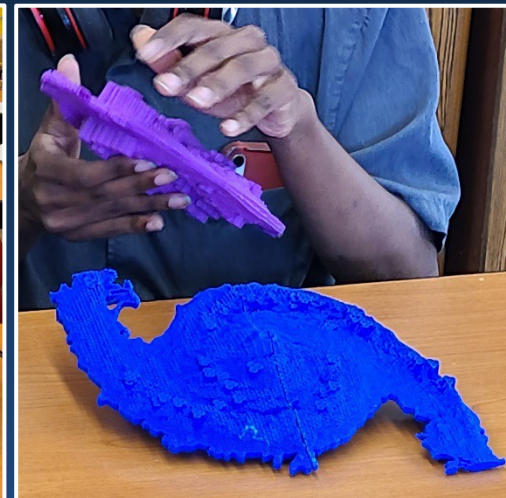
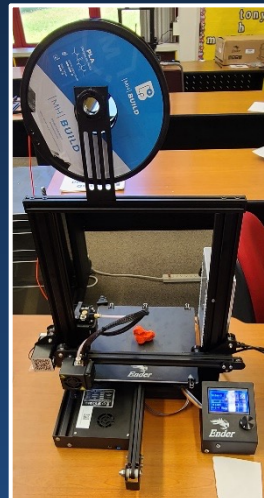


3D Astro

The Textured Universe:

Astronomical 3D Printing Technology and Materials To Stimulate Interest in Careers in Science

C. Christian (STSci), A. Nota (ISSI/STSci), T. Madura (SJSU),
L. Bartolone (AWB), N. Grice (YCDA), D. Hurd (EUPE), T. Wild (OSU)
and *many* others...





Motivation

Nearly everything we know about the Universe comes from **studying light and computer simulations**, strongly **biased to visual representations** of data

Can the **beautiful imagery** and **astrophysical results** from HST+ be accessible to a broader audience, specifically **individuals BVI**¹?

Most astronomy spatial data consist of 2D images or spectra: **Universe is at least 4D+**

Those with BVI often have very **sophisticated methods** for creating mental models of the world/universe

For students - improve opportunity → interest and skill in STEM subjects

This project: 3DAstro@STScI

- Stimulate interest, confidence, and skill in students with BVI¹
- Provide methods and materials
- Develop cohort of educators (TVI²) who can use the tools
- Conduct study

Study period 2012-2024

¹Blindness/Visual Impairment, ²Teachers of those with Blindness/Visual Impairment

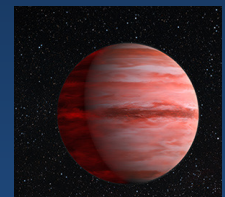


Phases of 3D print materials production

1. **Unique texturing** of astronomical objects & HST science data
2. Design, develop, test, iterate.
3. Integrate into camp program, disseminate

1) **Choice of astronomical objects:** chronology

- Westerlund 2 and other star clusters HST
- LEGUS galaxies HST
- Solar system and exoplanets some HST
- Multi wavelength JWST and Chandra





2) Textures

- Numerous textures including those used by N Grice in Braille books
 - Texture samples (think of tile samples, paint samples)
 - Tested in several venues
 - Final “**standard**” **texture palette** adopted
-
- Custom software¹ to **assign textures to object features**, also use Meshlab and Blender: produce 3D prints
 - **More testing** at numerous conferences and events: NFB, MdSchB, Air and Space, trade shows

Why all the testing? To prove **integrity** & **useability** before integration into outreach or educational settings



¹SW Engineers: P. Greenfield, J. Eisenhamer, L. Bradley, N.Kerman

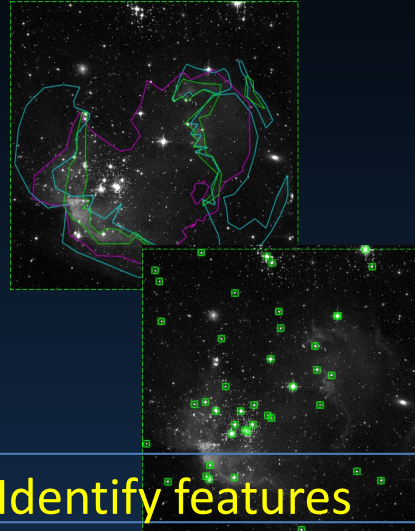


3D Astro

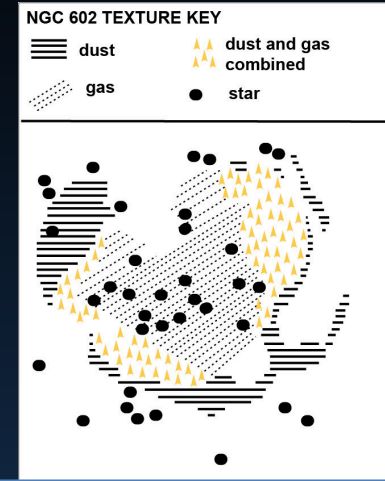
Unique Textures Development: NGC 602 Star Cluster



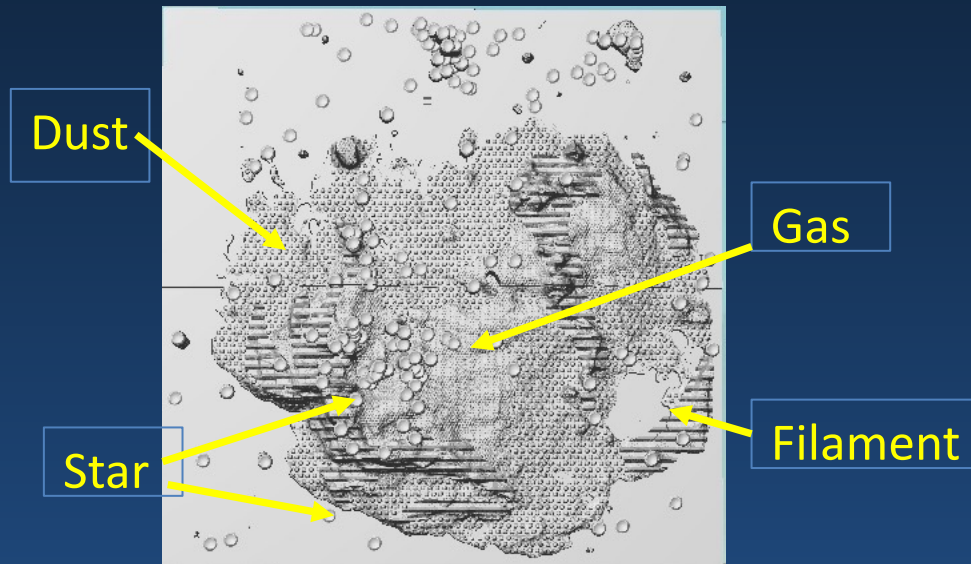
HST



Identify features



Braille Texture Key



Dust

Gas

Star

Filament

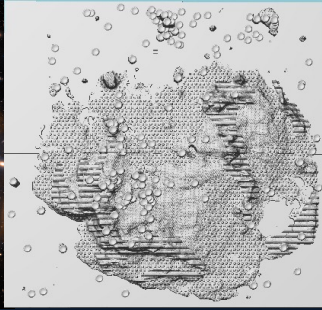


3D Astro

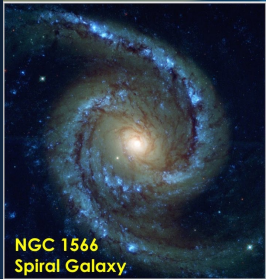
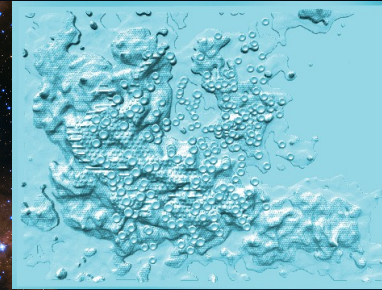
Sample prints



NGC602



Westerlund 2



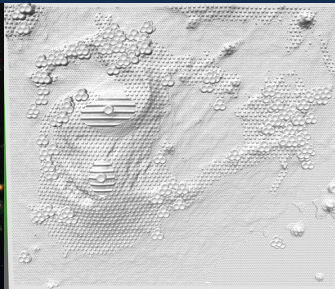
NGC 1566
Spiral Galaxy



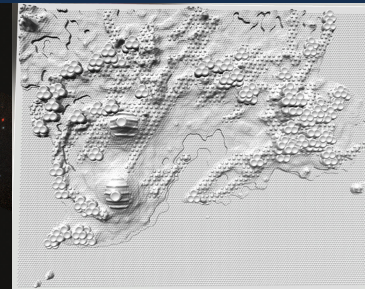
Whirlpool



NGC7318 HST



NGC7318 JWST Miri



Mars



Jupiter



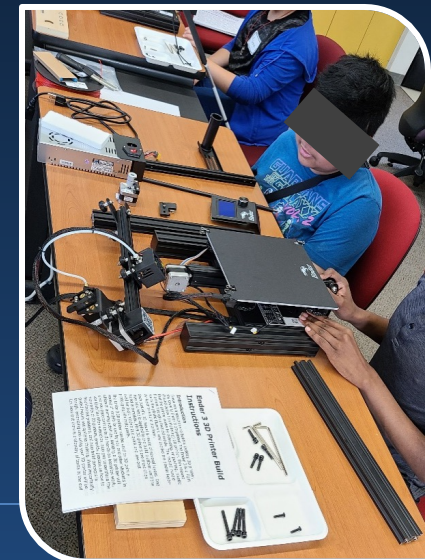
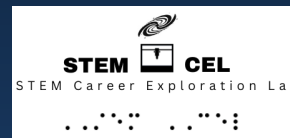
2) CEL Summer Camps

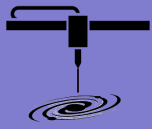
GOALS (for High School Students with BVI)

- Use 3D printing **technologies**, tactile models, and astronomy for students to explore STEM & STEM careers
- Introduce students to **successful STEM professional role models** with BVI
- Motivate students to pursue a **higher education and career** in a STEM field
- Investigate if 3D printed tactile models can help HS students learn **STEM/astronomy**

Camp Details

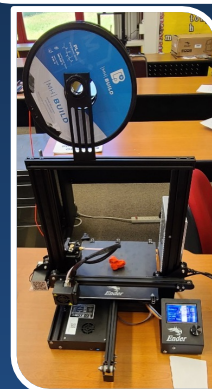
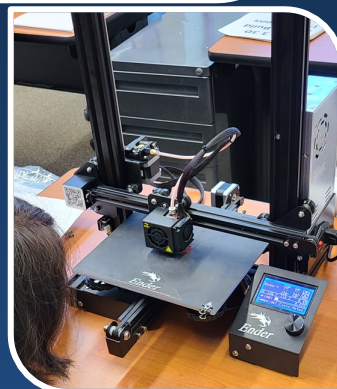
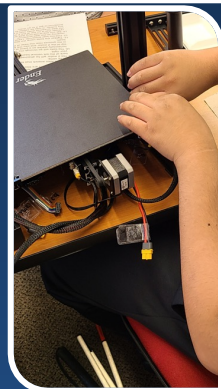
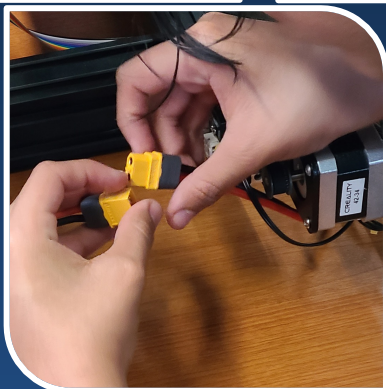
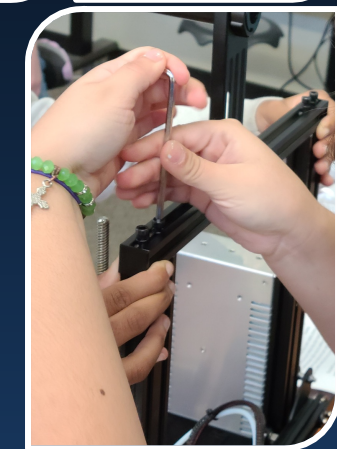
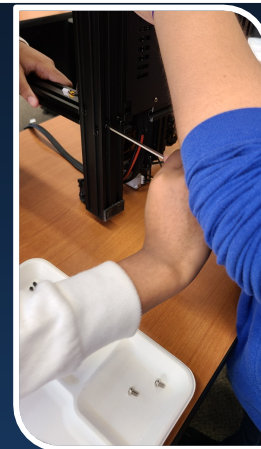
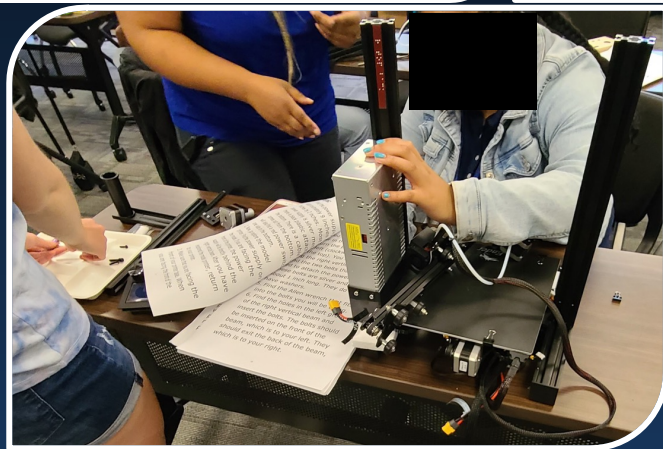
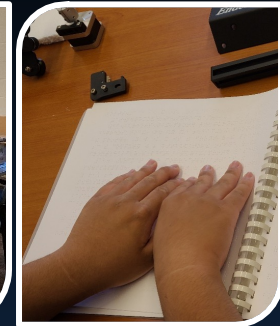
- State Bureaus and Schools for the BVI
- Week long
- Students build printers
- Content: Astronomy --constellations to cosmology
- Methods: Verbal, kinesthetic





3D Astro

First Activity: The 3D Printer Build





Lunar Phases, Light and Energy, CMB, The Sun,
3D Constellations, HR Diagram, Tuning Fork Diagram



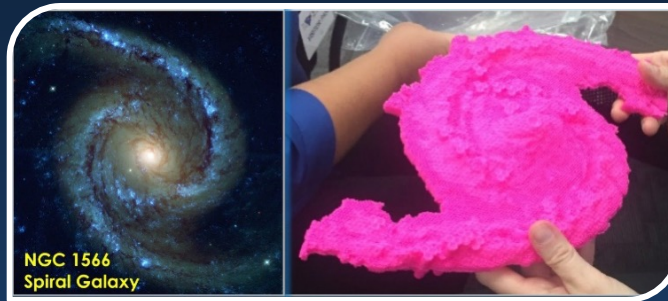
- Star Clusters



NGC 602



- Galaxies



NGC 1566
Spiral Galaxy



Research results will be published later this year.
IRB approval from JHU and SJSU



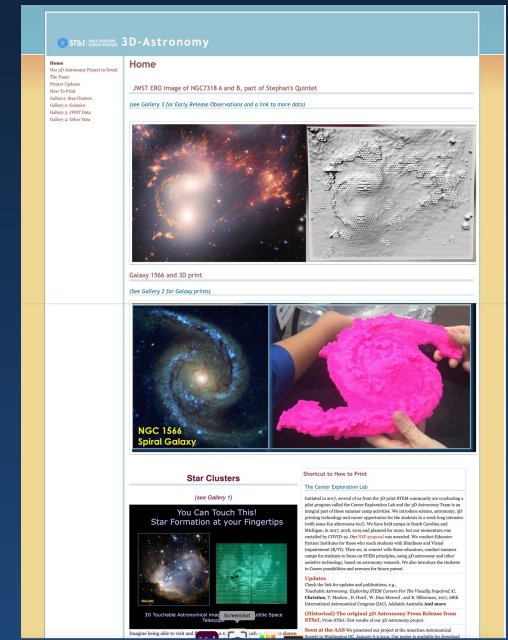
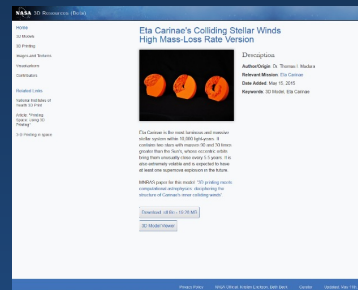
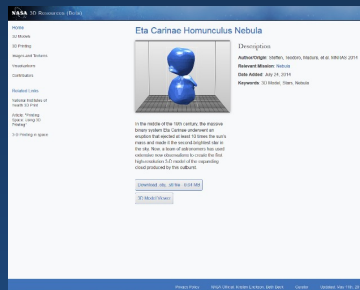
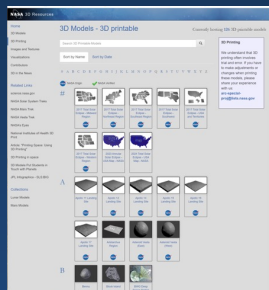
3D Astro

Some 3D Models Freely Available via NASA and STScI Websites as they are tested and verified

Contact: carolc@stsci.edu

<https://nasa3d.arc.nasa.gov/models/printable>
(search for Contributors C. Christian and T. Madura)

<https://www.stsci.edu/~carolc/3dastronomy/3D-Astronomy.html>
(Including all references)





The Research Questions:

Assess and measure changes of students due to the Camp

- I. Conceptual understanding
- II. Self efficacy levels
- III. What science and engineering practices do students with BVI employ during the CEL activities, specifically, the 3D printer build?
- IV. Attitudes towards STEM, STEM careers, and astronomy?
- V. Astronomy content knowledge, astronomy understanding, and spatial thinking skills
- VI. What effect does participation have on the attitudes of STEM HS teachers towards students with BVI?

Supplemental