3D Astronomy - Tactile Printing of HST Data

Welcome to the home page for 3D Astronomy at STScI

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We created tactile 3D representations of astronomical star clusters and their surroundings based on Hubble Space Telescope (HST) Observations. We developed an innovative process to transform 3D visualizations of HST astronomical data into solid 3D tactile patterned layers using data on star clusters. For example we used the scientific data for NGC 602 and Westerlund 2.Our ultimate goal is to produce 3D prints for objects in the universe so that anyone can experience and touch the cosmos at home, in school, in libraries and in museums. We also have produced several textures prints of galaxies from the HST LEGUS survey. Most recently, we have been producing 3D prints of JW Space Telescope data (JWST) and data from other satellites. Prints and short descriptions are available at the 3DAstronomy@STScI.

The 3D scientific data for an astronomical objects derived from observational data can be arranged into digital representations, each imprinted with touchable patterning then printed on a 3D printer. The textured layers and surfaces represent different components of complex star formation regions for star clusters (gas, dust, filamentary structure and stars) and for galaxies (star clusters, spiral arms, gas, dust, the bulge region and the central cusp often representing a supermassive black hole).

Where does the data originate?

The 3D scientific data for an astronomical objects is derived from Hubble observational data. It is arranged into digital textured layers and surfaces representing different components of complex star formation regions. The data is sliced as desired for different perspectives and can be fitted together as a stack, so that the user can explore the structure of the star cluster environment with their fingertips, slice-by-slice, analogous to a visual fly-through from near to far. Alternatively 3D models of the star formation regions can be constructed, textured and the printed pieces fitted together for exploration.

Project Description

We are using the unique process developed at STScI to transform Hubble images into tactile touchable 3D representations. These prints represent the spatial extent of the objects as seen on the sky, as well as the intensity of the radiation emitted as a surrogate for the amount of mass present in the object. Obviously, this is not a strict representation of structure and physics but neither are color images of astronomical objects.

Our approach, different than others producing 3D prints, is to use HST data to represent the main features of the objects (stars, gas, dust, spiral structure, filamentary structures) and to add specific, unique, textures to the 3D prints so that the features can be identified by touch. The goal is to enable visually impaired students, but also others, to experience and learn about astronomy in a way that does not rely on vision.

The data is from two studies, one of star clusters, including but not exclusively Westerlund 2 and the LEGUS galaxies. We have spent considerable time (years) creating the process, writing the software, and testing the 3D prints in a variety of circumstances before they could be incorporated in any *bone fide* learning environment. Through the testing process we also modified the code and continued to refine and improve the graphical user interface that allows the user to assign textures to the most significant features that should be emphasized. The resolution of the textures is dependent on a number of variables, for example the textures themselves, the plastic filament used for 3D printing, and the size of a human finger among a few.

The intent is to offer 3D prints for anyone to use, distributed primarily through the Public 3DAstronomy@STScI page. In particular, the prints for Westerlund 2 are an example. The prints produced by this project are also available on the NASA 3D website.

The collaboration with T. Madura of San Jose State University (SJSU) and others is addresses the use and associated research on the effectiveness of assistive technologies including 3D print products for teaching astronomy. Our project, called the Career Exploration Lab, focusses on creating an awareness and enthusiasm for science as well as introducing visually impaired students to career possibilities such as internships at GSFC and industries. The first lab was held at the South Carolina Commission for the Blind in 2017 and will be repeated in July 2018. A second lab will be held at the Michigan Bureau of Services for the Blind (June 2018). More labs were held in 2019 and intended for 2020 and 2021.

Project Initiation

- Adopt NGC 602 star cluster in the Small Magellanic Cloud as the prototype object
- Graphically annotate HST imagery of NGC 602 to delineate individual features
- Determine distances and intensities for each feature in the complex structure
- Assign tactile textures to the individual features
- Produce small test pieces from the data with textures imposed on feature intensities
- Test pieces at NSF National Convention
- Revise textures based on testing
- Create custom software to transform astronomical data into file formats appropriate for 3D printing
- Produce larger (approximately 8.5 x 11 inch) tactile prints
- Test and revise textures and methodology
- Integrate 3D Astronomy Products into the Astronomy Career Exploration Lab

Project Accomplishments

- Initiate project with star clusters Westerlund 2 and NGC 602 HST data
- Produce prints for
    - LEGUS galaxies using HST data

    - Other satellite data (MRO Mars Recconnaisance Observer) and other satellites for Solar System object
    - Model Exoplanets
- Test models in a variety of venues
- Obtain funding for larger Career Exploration Lab (initiated by T. Madura)
- Establish Teacher Institutes and CEL summer camps for students with B/VI

Objectives

We are creating a custom innovative process to transform imagery of astronomical objects into 3D tactile printouts. The production pieces are aimed primarily at visually impaired individuals who do not usually have an opportunity to experience Hubble Space Telescope imagery. Secondarily the 3D printouts can be used by any individual especially those who appreciate tactile learning methods.

We strive to improve public understanding of astronomy and science in general contributing to Science, Technology, Engineering and Mathematics skills for youth and any interested individual.

Deliverables

- A process for transforming astronomical data to tactile 3D printout format
- Create a method for distributing 3d print files widely for any individual to print and use
- Augment the 3D prints with informative materials for better understanding of astronomy

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Collaborations

- *Star Formation at Your Fingertips*, C. Christian, A. Nota, N. Grice, L. Bradley, J. Eisenhamer with contributions from E. Sabbi, N. Shaheen, R. Rao, L. Genth
- *Galaxies at Your Fingertips*, C. Christian, A. Nota, N. Grice, L. Bradley, J. Eisenhamer with contributions from A. Voelker, D. Calzetti and the LEGUS Science Team
- *Career Exploration Lab*, T. Madura (P.I.), C. Christian, D. Hurd, K. Silberman, W. Diaz-Merced and CEL local teams

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