3D Printed Models of Astronomical Data

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Ancillary Webpages with full Project Description and references: 3D Astronomy - Tactile Printing of HST Data and subpages, as well as the public site

Duration: 1 year, with a related project which is funded for 3 years

Project Description: Please see the full project description at links above.

Anyone scientists, science interested persons and members of the general public can better appreciate the universe by viewing not only spectacular imagery but 3D renditions of objects such as galaxies, star clusters, exoplanets, planetary systems and models of individual stellar structure. But what if you cannot see? Astronomy historically is viewed as a visual science, but using tactile 3D models stimulates the imagination, allows us to make representations of the astrophysics we observe and also share this with others. This project addresses the need for assistive materials for individuals with Blindness and Visual Impairment (B/VI) as well as any other individual who can make use of tactile representations of astronomical data. Therefore the specific objective is to develop 3D prints of astronomical data derived from observations obtained with HST and other facilities. The new 3D prints to be created now are part of a larger program called the Career Exploration Lab, or CEL, developed by C. Christian and T. Madura (San Jose State University). Through the CEL we will assist educators in using the materials and also conduct camps for students with B/VI during the summers as a continuation of the previous camps held in a variety of states.

This specific project: The methodology to be used to produce 3D prints of our desired objects is derived from our proven technique to produce and test 3D prints for star clusters and galaxies (Figures 1 and 2) derived from the analysis of HST data. Our innovative process uses custom software to transform the data into solid 3D tactile objects with patterned (Christian, et al. 2015; Grice et al. 2015). Within the JHU Institutional Review Board certification process, we informally tested the materials for scientific integrity and usability in several venues (museums, STEM events, and other invited workshops and conferences for assistive technologies. We also distributed the previous prints publicly (https://tinyurl.com/Tactile3DAstro). The tested prints are used in CEL camps and shared internationally through the International Astronomical Union. This project extends the available suite of materials for the CEL by designing, creating, and testing different astronomical subjects; that is, exoplanets, multi-wavelength data and more robust 3D prints of star clusters.

Figure 1: Westerlund 2 star cluster HST data and 3D print

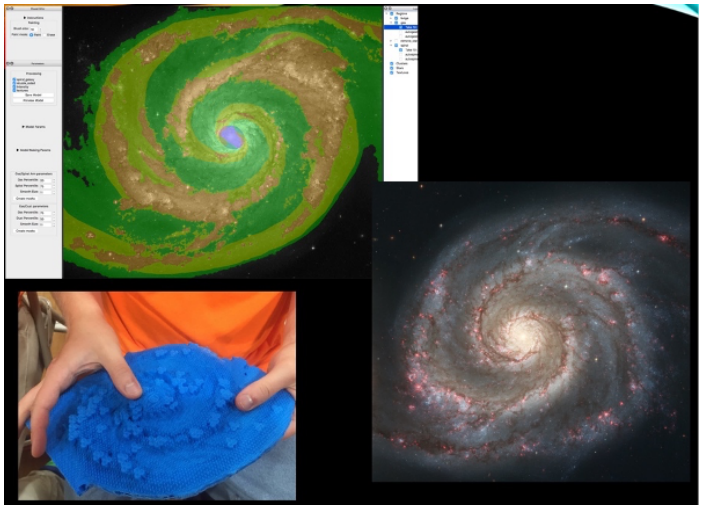

Figure 2: Top left: Whirlpool Galaxy data being processed in 3DAstro interface. Bottom left: 3Dprint being handled by student with B/VI. Right: HST image

Exoplanets: Considering the intense interest in exoplanets by scientists and the public alike, and the considerable attention from JWST as well as continued HST observations, we intend to explore the possibility of printing scale models of the various planetary systems as has been done for the solar system (c.f. Patrick, S., and Thingverse references) as well as produce 3D textured models of individual objects and planetary systems that may also contain circumstellar disks.

3D Star Clusters: We will test the creation of true 3D models of the star clusters. To do this we need to process the data with 3D modeling software (Blender, Simplify3D and others) and test printing the files with a dual nozzle printer. These programs require some training and expertise to use. The star clusters have large open spaces so a second transparent print filament and/or a thin scaffolding must be developed to hold the structure together for handling and exploration.

Multiwavelength Representation: We will test the production of multiwavelength models using both infrared and X-ray data. The Chandra mission has produced 3D prints through a program led by Kim Arcand a collaborator at CFA Other data can be obtained from other observatories, for example a Spitzer data set was tested for the galaxy NGC 1566 clearly illustrating that the IR probes deeper into the spiral structure, revealing the prolific production of star clusters beyond what is seen in the HST LEGUS data (legus.stsci.edu). It is also of interest to us to produce 3D prints of spectra for selected objects.

Our team is experienced at using a methodology including software, tactile texturing and production of 3D prints to represent astronomical data derived from HST. We use these materials in several venues, in informal outreach circumstances (museums, exhibits), in CEL summer camps serving individuals with B/VI, and international events. Our astronomical topics have focused on star clusters and galaxies. This proposal is aimed at creating new 3D print products by a) broadening the science topic to exoplanets, b) enhancing the 3D prints for star clusters, c) producing multi-wavelength and spectral representations of data and d) investigating the utility of 3D print products for sighted individuals. The testing the integrity and viability of the new prints within the IRB certification is required before integration into CEL activities which is the purpose of this project. These new products will contribute to outreach and science communication most effectively if the products are tested in informal settings before being incorporated in organized events at the local, state, national and international level.

Work to be Done:

Our goal is to process numerical data and graphical information about astronomical objects observed with HST and other complementary telescopes with software that will assemble the information into a 3-D model of the object and produce a STL file accepted by a 3-D printer. This will be accomplished by a JHU student depending upon availability. The creation of the 3-D models is experimental and involves, design, production, test and iteration through an established process we have used for several years:

- Use existing software to produce 3D prints with and without assistive texturing for multi-wavelength astronomical data
- Test and use commercial software packages to process data on star clusters specifically to make true 3D objects.
- Developing 3D prints of exoplanets, planetary systems and disk systems including development of new textures for those objects. The types of textures that we generate are on non-flat 3D printed relief surfaces as well as irregularly shaped curved surfaces. On curved and irregular surfaces, textures are more difficult to print so that spacing tuned to be uniform and understandable through touch only. The software must be adaptive to each astronomical object being rendered.
- Produce 3D prints, using the proven software, for selected object using IR and X-ray data
- Experiment with producing spectral data

The software testing and model production would involve periods of collaborative work with the PI as well as independent work for software evaluation and then creation of prints.

Students will work with the 3D printers and associated software to create models of astronomical objects. Typical models for this project take hours to print, but proof of concept models can be produced more quickly. All models produced can be used in a research environment, and also at this time used in a program