UD天文シンポジウム

The Tactile Universe: Accessible Astronomy Outreach for the Blind and Vision Impaired Community

触る宇宙：視覚障害者向け天文学普及活動

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概要　宇宙論と重力研究所のアウトリーチチームが、視覚障害者が現在の天文学に興味を持ってもらうために、３Ｄプリンタを使って触れる銀河の画像の開発を行いました。銀河の形や大きさ、距離、組成をわかってもらうために、模型を使ってどのような説明を行っているのかご紹介します。

The overall aim of the Tactile Universe project is to engage the blind and vision impaired (BVI) community with the latest astronomy, astrophysics and cosmology research in the UK; making these traditionally visual areas of research more accessible to the BVI community.

The Tactile Universe pilot project has been running since July 2016 and is funded until December 2016 by a South East Physics Network (SEPnet) public engagement award. We have been creating and printing 3D images of galaxies, where the 'intensity of light' has been converted into 'height above the base', as shown in Figures 1 and 2.

As part of our pilot, we showed these images to representatives from Guide Dog Association for the Blind Southampton, the University of Portsmouth Equity and Diversity Unit, and Action for Blind People Salisbury, at a project information session held on campus. We have also run two test sessions with a Portsmouth City Council vision impairment support group at Southsea library, the first with these test models, and the second with models, modified and improved based on their feedback and suggestions. These groups have advised on the final dimensions of the 3D prints, the best language to use when describing astronomy concepts to vision impaired or blind individuals, as well as on decisions such as public event venue, timing etc.

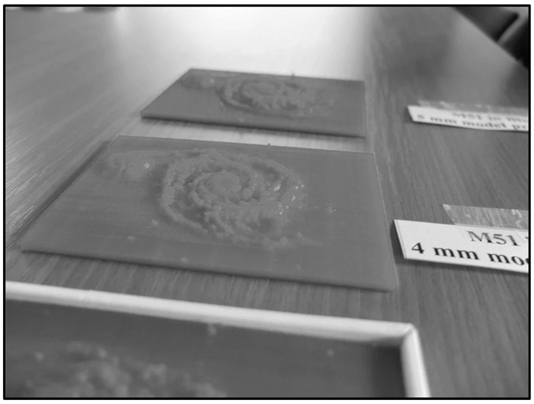

Figure 1　Test 3D printed images of the galaxy Messier 51 in B-band (blue), with different image projection heights.

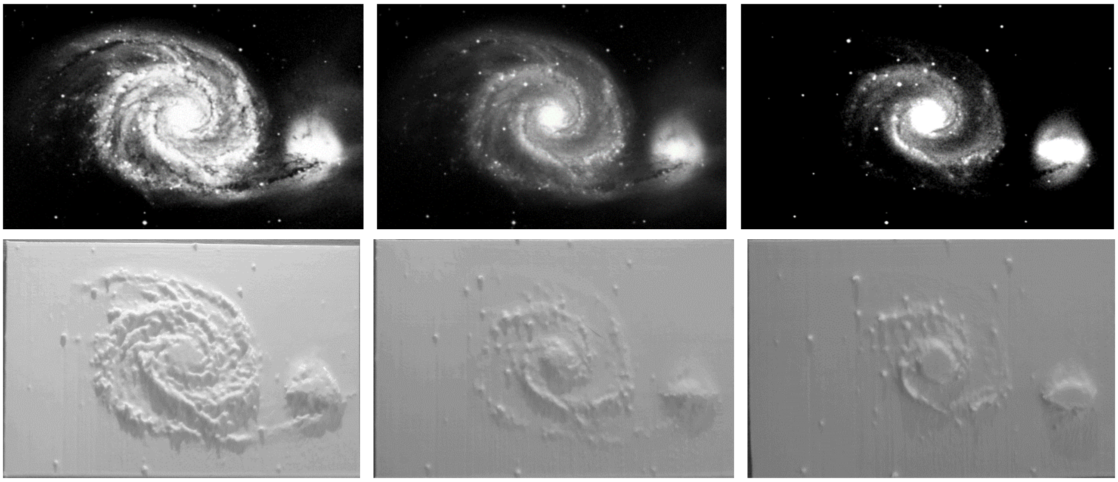

Figure 2 The Second Digitized Sky Survey Blue, Red, and IR images (from left to right of the upper panels) of galaxy Messier 51. The corresponding 3D printed galaxy images for each band are on the lower panels.

We have now 3D printed 39 different tactile galaxy images from the Digitized Sky Survey database, representing 13 galaxies printed in 3 photometric bands each. One example of this is shown in Figure 2, where we compare the photometric images of galaxy Messier 51 with the resulting 3D printed images. Each galaxy we have chosen for our sample is distinct, and shows a different morphological trait, such as the presence of a central bar, tightness and number of spiral arms, or whether the galaxy is uniform in its light distribution and has no features at all. The galaxies also host a variety of stellar populations. By printing galaxies in R-band (Red), B-band (Blue) and Infra Red, we also show the contribution to each galaxy of different (hotter/younger or cooler/older) stellar populations.

We will use 5 such sets of galaxies to run a pilot public event in mid-January 2017. These props will allow us to teach participants about galaxy evolution.

Though the underlying physics that drives galaxy evolution is complex, many of the core concepts can be easily conveyed to the non-specialist community through the examination of shapes and colours of galaxy images. If a galaxy is optically red, this usually indicates it is no longer forming stars; while if a galaxy is optically blue, it must be currently star-forming. The optical colours of galaxies allow us to determine the types of stars that occupy different parts of galaxies (e.g. typically the cores of spirals are redder and contain older stars than the bluer spiral arms).

In terms of shape and overall light distribution, if a galaxy is disky, and has a clean spiral structure, it is most likely to be star forming, whereas, if its structure and distribution of light is smoother, it is likely to be a much older object. Distorted or ‘messy’ objects are intermediate between the two, and are examples of galaxies which have undergone (or are currently undergoing) interactions, or other more subtle physical processes, that are changing their shape and possibly driving galaxy evolution.

Figure 2 provides a prime example of this. Messier 51 is an interacting pair of galaxies. The larger of the two galaxies has a reddish core and blue spiral arms, where star formation is still occurring. Its companion is mostly composed of older, cooler red stars, as its interaction with its larger neighbour has likely truncated its star formation. When we compare the photometric images in each band with the 3D printed images, we clearly see that the larger galaxy’s arms are much more pronounced in the B-band image, whereas the core and the smaller companion galaxy are much more obvious in the R-band and IR prints.

In addition to the printed images, we can also use simple props such as a rugby ball and soccer ball, to show the various shapes of elliptical galaxies, and a CD with marble embedded in the middle, to demonstrate the basic shape of a disk galaxy.

We are also in the process of developing demonstrations to use these 3D galaxies to convey other specific astronomical concepts.

The images in Figure 3 show a simple prop designed to convey the concept of angular size where the angle can be felt between the strings (if an object is closer, it will appear larger, if it is further away, it will appear smaller, regardless of actual size).

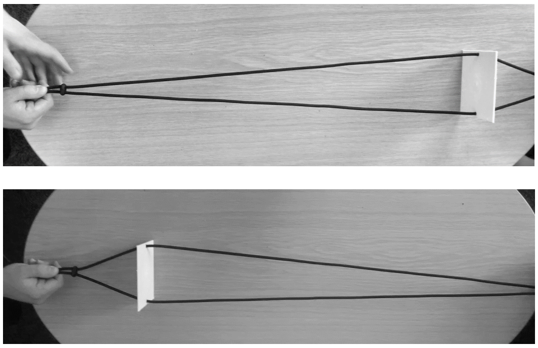

Figure 3 An initial design for a model to demonstrate the concept of angular size.

Figure 4 3D printed examples of inclined galaxies. The top-left shows a face-on, inclination = 0 degrees galaxy, the top-right shows an inclination = 30 degrees galaxy, the bottom-left shows a galaxy with inclination = 60 degrees, and the bottom-right shows an edge-on, or inclination = 90 degree galaxy.

The set of galaxies in Figure 4 will be used to explain how the appearance of a galaxy will change based on its inclination. We will use these galaxy images in conjunction with a prop which will consist of a tilting disk (a representation of a spiral galaxy), set inside a fixed ring (a point of reference for the plane of the background sky).

As the disk tilts, participants will be able to feel the angle it makes with the ring, and then compare this to the printed galaxy images.

We are currently applying for funding to extend the project beyond its six month pilot. With continuing funding, we will use the props already developed to create workshops that we will then run in primary and secondary schools. We will also develop other props and demos, for example:

- Printing tactile galaxy spectra, to show how different spectra are more common in different galaxy morphological types.
- Converting galaxy spectra into sound. There is a pre-existing code that can do this easily. We will experiment with ranges in pitch and tone to determine which option is the easiest to interpret.
- Using all of the above to run a small-scale tactile and audio version of the Galaxy Zoo citizen science project (classifying galaxies by shape and features through touch and sound, rather than visually).
- Offer observing sessions with robotic telescopes, then allow participants to print their observations to take home

With this additional funding, we will also put together project starter packs, which will contain scripts to run our activities, ‘best practice guides’ based on our experiences working with the blind and vision impaired community, some example 3D printed galaxies, along with digital versions of our other models for printing, and the software and instructions needed to make them.

Initially we will send these starter packs to interested outreach groups, schools and universities around the UK. We will also offer training, to make sure that anybody who wants to run the event will feel comfortable doing so. Once the project has begun to pick up interest in the UK, our goal will be to provide starter packs and training to any interested international groups.

Regardless of whether we obtain further funding, our aim is to make our developed activities, documentation, software and props available to everybody for free under a Creative Commons license.

For more information on the team at Portsmouth and the Tactile Universe, please visit our project website at http://www.icg.port.ac.uk/tactileuniverse or follow @TactileUniverse on twitter.