

A HOLOtta Fun: Explaining Astronomy with 3D Holograms

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Abstract. Traditional visual aids used in astronomy outreach (such as 2D telescope images) can fail to effectively convey complex and abstract ideas to lay audiences. With the advent of impressive CGI images widely available in film and other media, these aids may also not meet their expectations or visually engage people. To address this, we have been employing 3D holograms in lieu of 2D images for astronomy-based outreach activities both in-person (pre-pandemic), and virtually since the start of the pandemic. Here we demonstrate how the reader can make and incorporate holograms in their own virtual talks (no budget required) and present the feedback we've received so far.

Keywords. techniques: image processing, general: standards

1. Introduction

Astronomy can be challenging to effectively teach at the best of times, being an inherently complex and abstract research topic. Under normal circumstances a lecture with 2D telescope images is often the go-to for informal education settings, such as school workshops and public events. However, as visual technologies have made massive leaps and bounds in the past decade, so have people's expectations, and as a community we must keep up in physics if we want to continue inspiring the next generation. Prior to the pandemic we developed a successful 3D hologram workshop program which enabled researchers to provide fun, interactive talks to explain complex topics in an easy-to-understand format in informal education settings, all while capturing the imagination of participants.

Since the start of the pandemic, virtual talks and audiences have become the norm and so the need to employ technology to provide an innovative, powerful, highly effective and attention grabbing experience is now essential. In particular, studies suggest a positive correlation between childrens' participation in informal out-of-school learning activities with their understanding and general interest in the subject matter (Ofsted 2008, Bell *et al.* 2009, Stockmayer, Rennie & Gilbert 2010, Dabney *et al.* 2012) but that to be successful, activities need to have the 'potential to amaze' (Walan & Gericke 2019). Therefore at a time when childrens' physics education is undergoing varying degrees of disruption, there is a strong argument for the creation of innovative and engaging virtual school outreach programmes. Our approach to this issue is the use of 3D holograms to explain astronomical topics in virtual workshops. Below we demonstrate how with a little bit of effort – and no budget – the reader can make and incorporate 3D holograms in their virtual outreach activities.

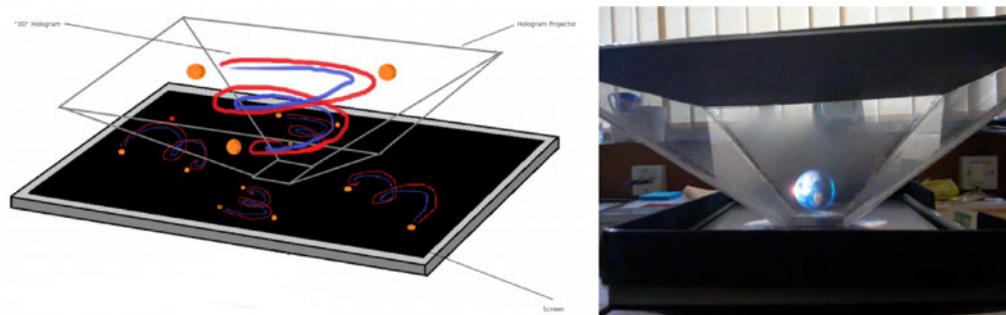


Figure 1. (Left:) Diagram of equipment used to generate holograms and (Right:) Photo of an Earth hologram.

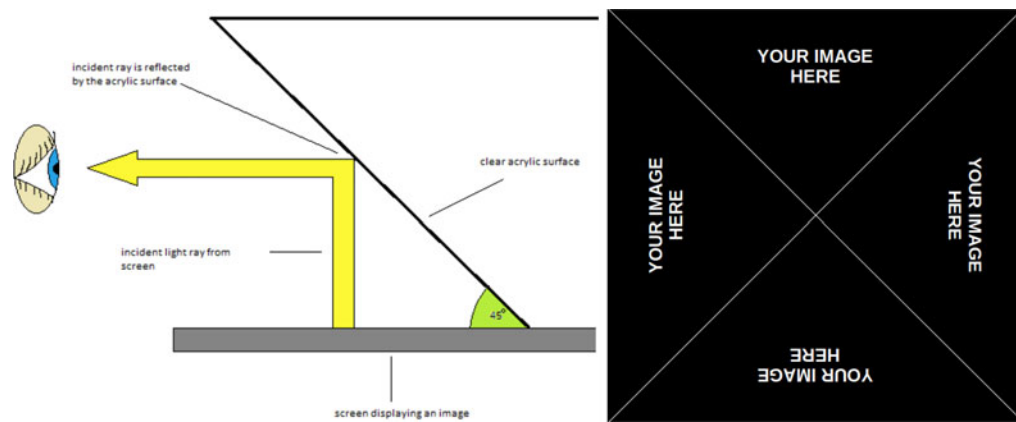


Figure 2. (Left:) Diagram showing the path of the light ray from the image on screen to the observer and (Right:) how the image is displayed on the screen. The white lines mark out the portions of the screen projected onto each side of the perspex pyramid.

2. What are Holograms?

Holograms are a light-based optical illusion in which 2D images gain the appearance of a physical 3D object to the observer. This is not a new concept, originating from the illusion known as ‘Peppers Ghost’ first conceived by scientist John Henry Pepper in 1862. Magicians and theatre productions have been doing this illusion for over 150 years. More recently, modern technological advances have enabled the enhancement of holograms making it possible to both create more complex objects and objects with a more realistic appearance, leading to use of holograms being adapted for other mainstream entertainment formats (e.g. music festivals). Still, they remain uncommon in education settings. As shown in Figures 1 and 2, modern holograms are generated by displaying images on a screen which are reflected off the surface a perspex pyramid (known as the ‘hologram projector’) placed centrally on top of the screen. Images can either be videos or pictures but must be carefully chosen (ideally they should have a high resolution and opaque colouring) to create sharp non-fuzzy holograms. Once an image has been selected it needs to be formatted such that it appears four times on the screen with a rotation of 0° , 90° , 180° and 270° (right panel Figure 2). Projecting the image onto all four side surfaces of the hologram projector enhances the illusion (when viewed) that the image is actually a physical 3D object inside the pyramid. We have published a free online tutorial[†] detailing how to properly format images.

[†] <https://www.youtube.com/watch?v=Xv7YH-y7UzQ>

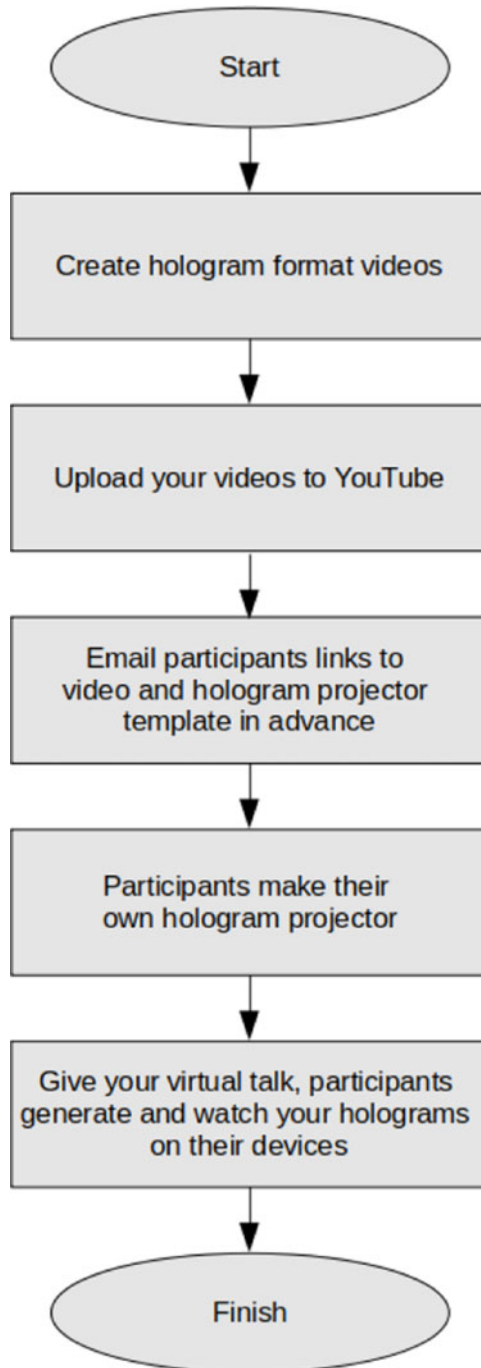


Figure 3. Flowchart showing how holograms can be incorporated into virtual talks.

3. Using Holograms in Virtual Talks

Being star cluster researchers, we use holograms to show how they form and evolve – but holograms can be used as engaging visual aids for talks on any topic. The flowchart in Figure 3 details how we suggest they can be incorporated into virtual talks. In brief,

the lecturer sends their hologram-formatted videos to each participant prior to the talk, along with instructions on how to make a hologram projector for a smartphone and/or tablet. Participants make their hologram projectors in advance of the talk, such that they can view the holograms on their own devices during the lecture when instructed to do so. Equipment needed by the participants (P) and the lecturer (L) are given below.

Phone or Tablet (P) To be the screen, as shown in the left panel of Figure 1.

Hologram projector template (P) The size of the projector scales with the size of the screen. Many templates are freely available online for screens of various sizes, and the participants can custom scale the pre-existing templates for a specific screen size. Our template of choice to send to participants is by Beals Science† as it contains two templates to fit typical phone and tablet screen sizes respectively, and includes a clear step-by-step guide on how to create the hologram projector.

Transparent acetate sheet or similar (P) To create the hologram projector. Alternatively any rigid clear plastic can be used e.g. a CD case, food packaging etc.

Scissors, tape and a pen (P) Tools required to create the hologram projector.

Video or picture (L) To convert into a hologram, either the lecturer's own or taken from a free database, for example NASA image archives, with accreditation.

Video editor (L) It is possible to convert videos/images to the hologram-format with many editors. Our free editor of choice is the VSDC Free Video Editor‡.

Hologram Gridlines Template (L) To guide the placement of images during the conversion process, as shown in the right panel of Figure 2. Our free template of choice is by Cyberlink§.

4. Student Feedback

Preliminary feedback from students has been positive. Initially we were concerned that generating the holograms on a phone/tablet would take away from the enjoyment of the workshop, as with our previous in-person workshop holograms were generated with 32" and 65" screens (i.e. the holograms were significantly larger). However this does not seem to be the case so far, with no negative comments regarding the holograms' smaller size, and prevalent expressions of excitement and awe towards their use.

References

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† <https://preview.tinyurl.com/y3nkye43>

‡ <https://preview.tinyurl.com/l6vx6ox>

§ <https://preview.tinyurl.com/yxk7zkpa>