Interactive Plate Activity

1. Begin at http://voyages.sdss.org/launch/milky-way/sdss-constellations/discovering-constellations-using-sdss-plates/

2. Follow online instructions to get brightest stars. Change '20' in the code to number of pairs/groups/students in your class so that is in the format shown below.

```
select top **NUMBER OF GROUPS** spa.ra, spa.dec, spa.dered_r as magnitude,
spa.class, spa.z, soa.xfocal as x, soa.yfocal as y
from specphotoAll as spa
join specObjAll as soa on soa.specObjID = spa.specObjID
where spa.plate = **PLATE NUMBER**
and spa.dered_r > 0
order by spa.dered_r asc
```

   Having more objects will work better for the 3D display, so keep the groups small. If you have a smaller class size it may be best for each student to have their own object.
3. Randomly allocate each object to a pair/group/student
4. Go to https://voyages.sdss.org/for-educators/ground-control/sdss-plates-for-education/plate-workshop-resources/ and follow the link to the document **"Locating Objects on your Plate"**
5. Using the instructions to help you, find all of the student's objects on your plate.
6. Go to http://skyserver.sdss.org/dr15/en/tools/chart/navi.aspx
7. Ask each pupil to input the RA and DEC* of their object into the navigator. This will result in an image and a spectrum of the object.
   *RA and DEC are astronomical coordinates. More information about them can be found at http://voyages.sdss.org/preflight/locating-objects/ra-dec/
8. Ask each pair/group/student to save and print the image and spectra of their object that they found using the navigator.
9. Go through the Preflight section on spectra:
   http://voyages.sdss.org/preflight/light/spectra/
10. Ask students to annotate their spectra and photos with information about the object that they have learned from the spectra Preflight section.
11. Go through the redshift Preflight section:
    http://voyages.sdss.org/preflight/light/redshift/
12. Discuss how redshift tells us about the distance to an object. The **plate packet introduction** document can help with this step: https://voyages.sdss.org/for-educators/ground-control/sdss-plates-for-education/plate-workshop-resources/
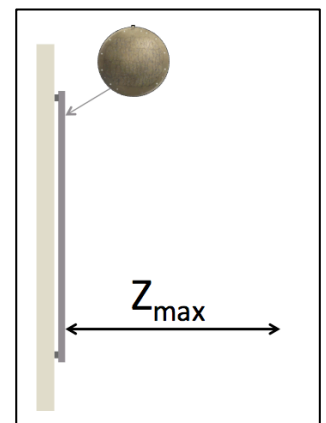
Making a 3D Display

There are two ways to transform your object into a 3D display; one involves attaching it to the ceiling, one to the wall. If you chose to create this display using either method **it is your responsibility to secure the plate safely and securely.** Attaching the plate to the ceiling results in the most effective display, but securing the plate to a ceiling may not be a viable option in all schools so the wall display is an effective alternative. The idea behind the display is to provide a physical representation showing the distances to astronomical objects.

Additional Materials Needed for Making 3D Display	
Wall Display	**Ceiling Display**
1.5mm – 2mm thick wire. Thin enough to fit through holes on plate, strong enough to stay straight when held horizontally.	Beads with letters on them, or wooden beads that you can write letters onto with a marker pen
Pliers to cut and bend the wire safely	Thread strong enough to hold the beads
Masking tape/ tape that you can write on	Pipe cleaners
Duct tape/Gaffer tape	Scissors
Blue tack or hot glue	

Wall Display

1. Attach the plate to your wall. You may do this using either screws, c-hooks or large command strips depending on the wall in your classroom. The plates are approximately 5kg. If attaching it to the wall is not a viable option in your classroom, you may lean the plate against a wall while it sits on a counter or desk; this will not look quite as impressive but will still be functional.
   a. **Command strips** can be found at this address: https://tinyurl.com/amazoncommandstrips be sure to follow the instructions on the package carefully. Once the plate is securely attached to the wall, the command strips act like Velcro, so the plate can be put up and removed from the wall as needed.
   b. If using **screws or c-hooks**: hold the plate to the wall where you wish to attach it, and then have someone mark out with a pencil where the large holes round the edge of the plate are on the wall. Remove the plate from the wall, and secure the hooks or screws into the points marked on the wall. Depending on the type of wall and the type of screws, you may not need screws in every hole, just ensure there are enough to securely hold the plate in place. Leave enough of the screw out of the wall that you can hang the plate on them.
2. While the plate is on the wall, work out the furthest distance out from the plate you could have wires protrude safely. This distance will be referred to as Z_{max}, as it is will be the largest z coordinate.
3. Out of the brightest objects on your plate, find the furthest away one. *Will this be a large redshift or a small redshift? Why?*
4. Convert the redshift distance into light years using the tables linked to at the bottom of this page http://voyages.sdss.org/launch/milky-way/sdss-constellations/discovering-constellations-using-sdss-plates/.

This distance will be represented in the display by a length of wire that is Z_{max} long.

5. Work out what lengths of wire would represent the distances to the other brightest objects on the plate using the equations below.

$$Z_{object} = Z_{max} \frac{Distance_{object}}{Distance_{max}}$$

6. For each object, cut a piece of ~1.5mm thick wire to approximately Z_{object} + 2cm
7. Using pliers, bend one end of the wire at a right angle so that the longer end is exactly Z_{object} long.
8. Do this for all of the brightest objects.
9. Insert each of the wires into the correct hole on the plate for that object, with the 2cm short piece on the back of the plate.
10. Duct tape the 2cm piece of wire to the back of the plate, with the end of the wire pointing up towards the tab.
11. Wrap a piece of masking tape around the long end of your wire and label it with a letter or an initial. Ensure the label is different for every object.
12. **For safety reasons, you may want to cover the end of the wires with blue tack or hot glue.**
13. Repeat this for all of the brightest objects.
14. Once this has been done for all of the objects, reattach the plate to the wall.
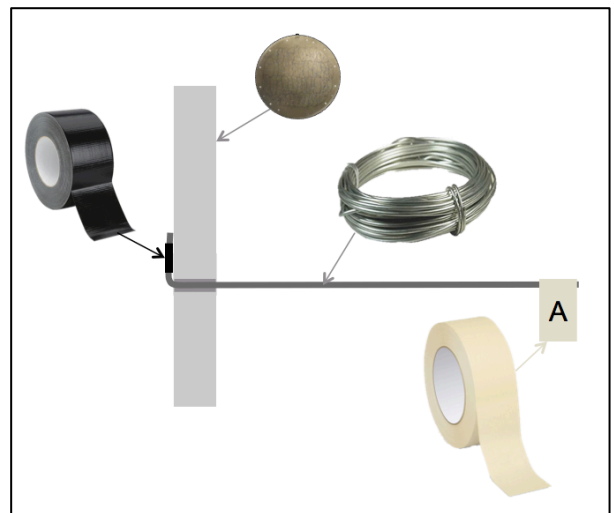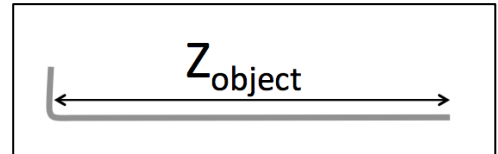
Suggestions for additional posters you can add to the wall around the plate

1. An information sheet explaining what the plate is and what is used for.
2. A scale to demonstrate what the lengths of wire represent in real distances.
3. 'Profiles' of each of the brightest objects, labelled with the same letter that is on the piece of wire for that object. These profiles could include:
   a. The spectra of the object
   b. An image of the object
   c. A description of what kind of object it is.
   d. An explanation of what the features in the spectra represent
   e. What the colour of the object might tell us
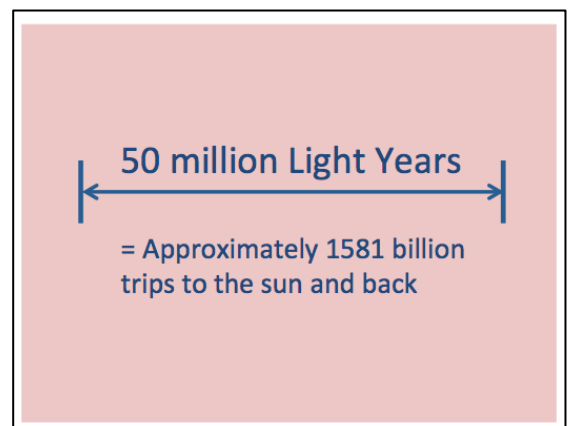
Take a photo of your final display and send it to us at voyages@SDSS.org *!*

Ceiling Display

If you chose to use this method, it is your responsibility to **safely and securely** attach the plate to the ceiling. This method results in a larger Z_{max}, so will demonstrate the scales more accurately that attaching it to the wall.

This display follows a similar idea to the wall set up, except instead of wire, thread is used, and instead of command strips, you must bolt the plate to the ceiling.

1. Work out how you can securely attach the plate to the ceiling. You will not need to attach the plate to the ceiling until the end, so for now place the plate between two stools/desks/chairs with a gap between them that is a little smaller than the plate's diameter. This way, you can access the top and bottom of the plate to assemble the display. Make sure the front of the plate (with the lines drawn on it) is facing the floor.

2. Follow steps 2 to 5 of the Wall Display instructions, but with Z_{max} being the longest distance you can hang a thread down from the ceiling.

3. For each object cut a length of thread about 5cm longer than Z_{object}. Tie one end of the thread onto a bead.
In order to keep track of which object is represented by each string, it is a good idea to label the beads. This can either be done with wooden beads and a marker pen, or by using coloured beads with letters on, and then keeping a spread sheet or list of which bead represents which object.

4. Cut a pipe cleaner into pieces approximately 5cm long. Cut enough pieces to have one for each object.

5. Tie the other end of the thread onto the middle of a piece of pipe cleaner so that there is a bead at one end, a piece of pipe cleaner at the other, and a length of thread between the pipe cleaner and the bead that is equal to Z_{object}.

6. Trim off any excess thread.

7. Locate the appropriate hole on the plate for this object, and insert the pipe cleaner through the hole from the front to the back. The thread should now be hanging below the plate.

8. Repeat this for all of the brightest objects, and attach the plate to your ceiling.

9. Take a look at the section on the previous page labelled **Suggestions for additional images and posters you can add to the wall around the plate.**

Take a photo of your final display and send it to us at voyages@SDSS.org *!*