

Multi-Diverse Activities

Hands-On
Sensory Field Trip to Space!



The Fermi Mission

NASA's Fermi Gamma-ray Space Telescope was launched on June 11, 2008 into low Earth orbit, from which it continues to map the entire high-energy gamma-ray sky roughly every three hours. The satellite's name was chosen to honor the famous Italian-American physicist Enrico Fermi, who first proposed the eponymous mechanism for the acceleration of cosmic rays that creates many of the high-energy gamma rays that the satellite detects. NASA's Fermi mission was built and is operated by an international collaboration between astrophysicists and particle physicists from the United States, France, Germany, Italy, Japan and Sweden.

About the Interactive Activities

This booklet includes a variety of Fermi science-themed activities inspired by the "stained glass" illustrations created by A. Simonnet (see resources links). The activities are designed to aid in the development of fine motor skills and the stimulation of various senses. We recommend that parents or educators support the reader in any way that assists in their experience of this work. However, anyone can enjoy these fun activities while learning about the exciting Fermi mission and its study of the gamma-ray sky!

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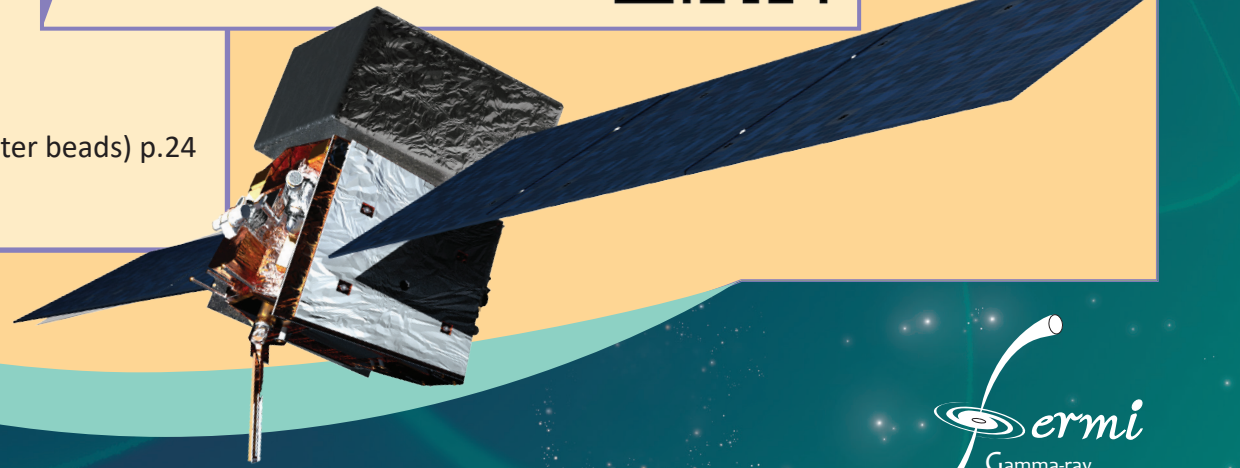
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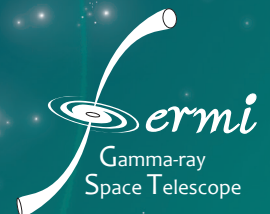
7. Watch Me (Gamma-ray sky in a bottle) p.26

While you can make copies of the activities, the files are also available for download in both 8.5 by 11 and 11 by 17 inches formats. (See Resources or scan the QR code).



Credit:

The activities have been developed as part of the EdEon STEM Learning at Sonoma State University. Contributors to this activity booklet include Prof. Lynn Cominsky, Dr. Laura Peticolas, Dr. Judith Racusin, Dr. Elizabeth Hays, Hannah Hellman, Sarah Tucker and Aurore Simonnet.



fermi.sonoma.edu

Glossary

Accretion Disk: the flattened disk of matter swirling just outside the black hole's event horizon.

Active Galaxy: a galaxy with a supermassive black hole at its core that is being actively fed with gas and dust causing it to shine brightly in gamma rays.

Binary Neutron Star Merger: When two dense stellar remnants inspiral and merge together creating a lightshow across the electromagnetic spectrum along with gravitational wave signals.

Black Hole: an object so small and dense that inside the event horizon, its escape velocity is faster than the speed of light. In an active galaxy, the central black hole may have millions or even billions of times the Sun's mass.

Fermi: Enrico Fermi was an Italian-American physicist who created the first nuclear reactor. He also hypothesized the acceleration of charged particles that would create gamma rays, which is a main reason why NASA named the Fermi Gamma-ray Space Telescope after him, following launch on June 11, 2008.

Galaxy: a collection of gas, dust, and millions to billions of stars, held together by gravity.

Jet: a thin, highly focused beam of matter and energy emitted from the cores of some active galaxies. Jets can be hundreds of thousands of light years long.

Skymap: a projection of the entire sky onto a flat surface, typically displayed with the Milky Way galaxy across the center.

Supernova Remnant (SNR): the slowly expanding gas and dust left over from a supernova explosion.

Resources

For more information:

- This activity booklet along with the downloadable files and the original "stained glass" posters are available at: fermi.sonoma.edu/resources



For more on the material used:

- See the back cover for examples of the illustrations.
- You can find a detailed list of the materials used in these activities, along with suggested quantities and where to purchase them at: fermi.sonoma.edu/resources

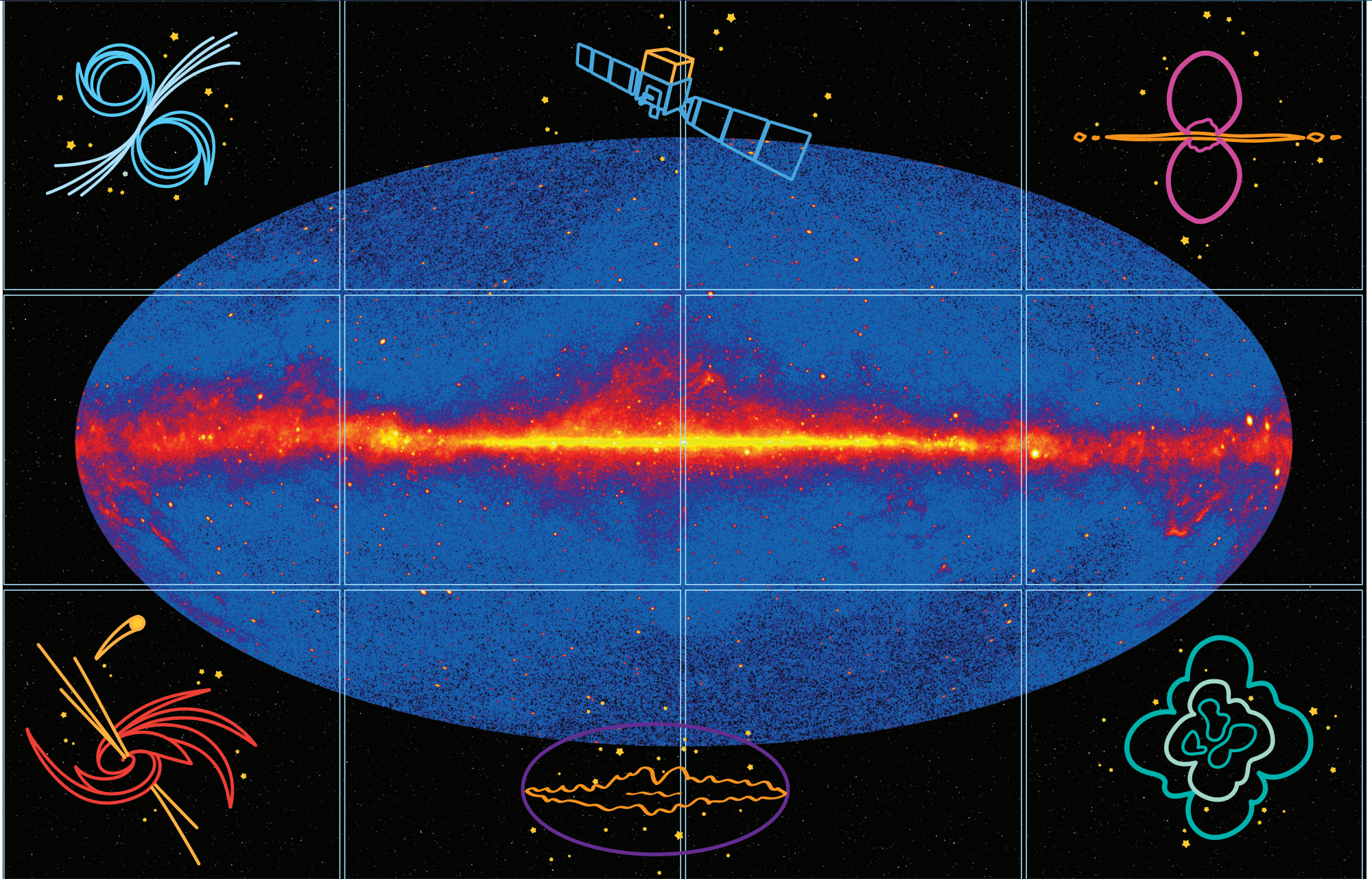
Other Online Resources:

- Official NASA website: nasa.gov/fermi
- NASA Goddard mission website: fermi.gsfc.nasa.gov/
- NASA Imagine the Universe: imagine.gsfc.nasa.gov
- Fermi "Stained Glass" coloring book: imagine.gsfc.nasa.gov/features/coloring_pages/fermi/
- NASA Space Place: spaceplace.nasa.gov
- The Astronomy Picture of the Day: apod.nasa.gov/

Solve Me

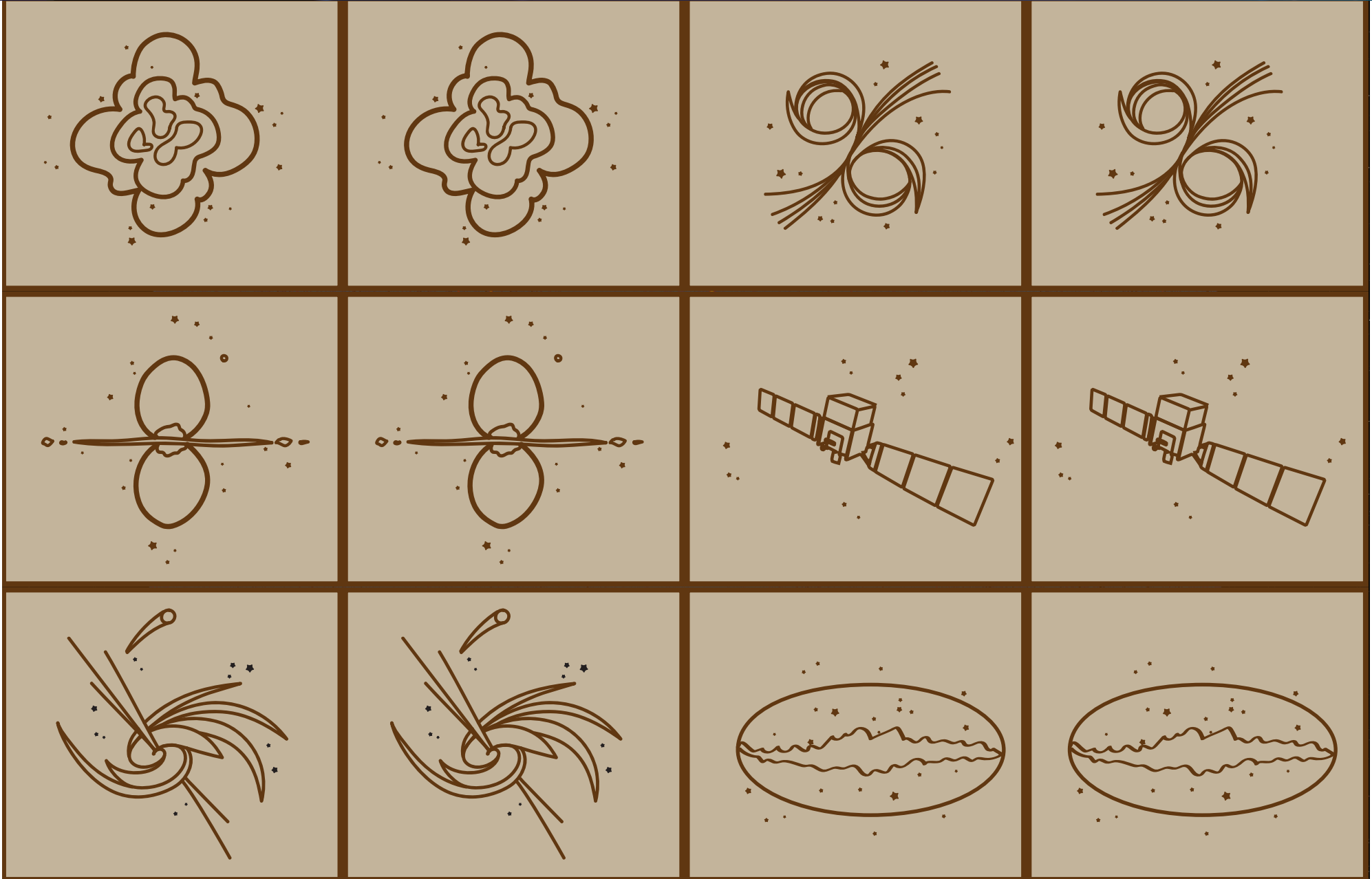
What You Need: 12 puzzle pieces.

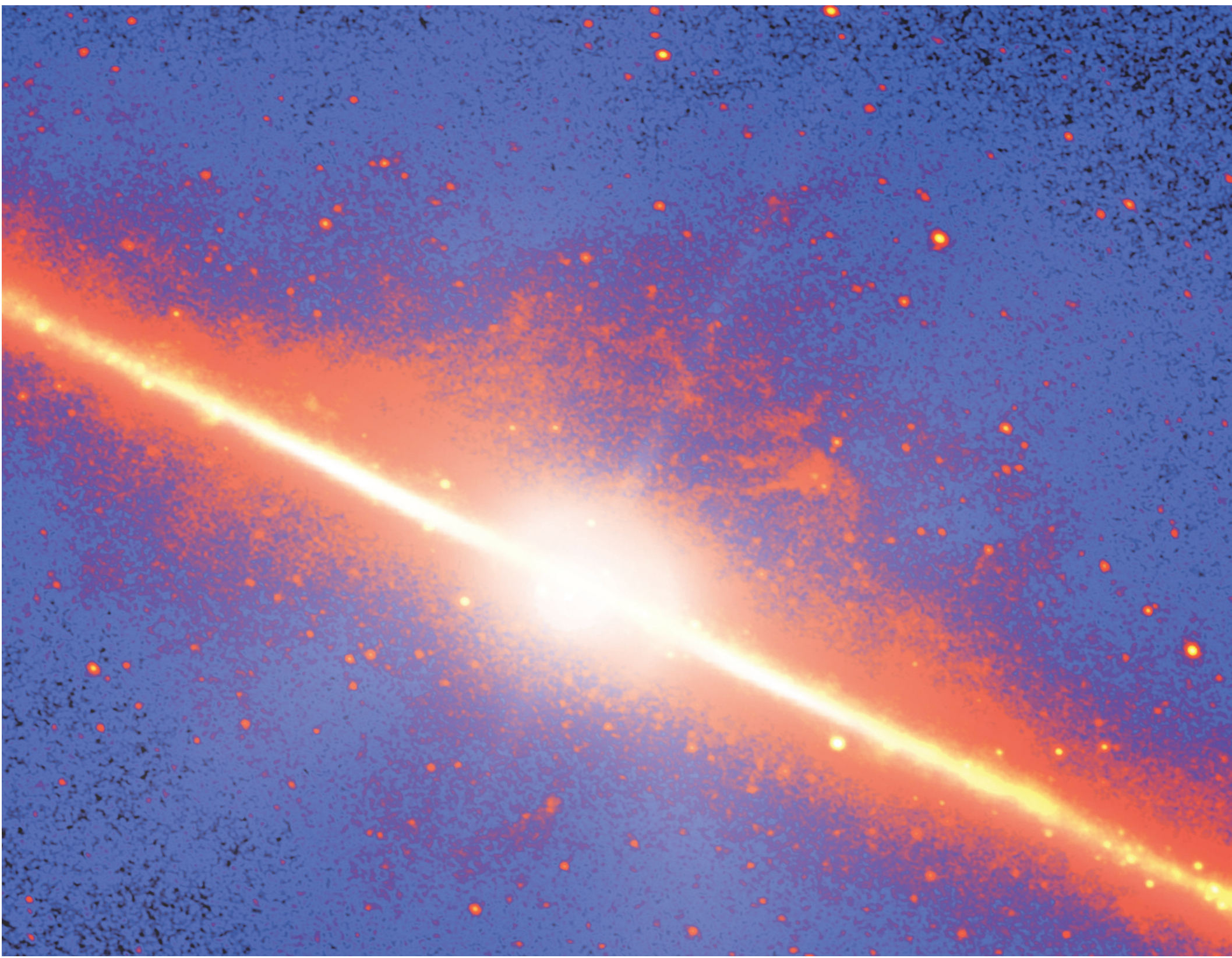
Instruction: Print, cut out and assemble the Skymap puzzle.



Match Me

What You Need: Print the 12 cards on p.6 with the graphic on p.7 on the back. Cut them out.
Instructions: Place all cards picture-face down. Turn two cards over.
A match is made if the two cards turned picture-side-up are identical.





Model Me

What You Need:

Clay of various colors (suggested color varies with each activity), a ruler.

Instruction: Model space objects out of colorful clay!

Supernova Remnant

Material Preparation:

The pictures provided can be used to estimate the size of the clay chunks.

1. Prepare 8 round chunks of dark green clay, with 4 slightly larger than the other 4.
2. Prepare 7 chunks of medium green clay, with 4 slightly larger than the other 3.
3. Prepare 3 chunks of light green clay.

Now that your clay is ready, you can move on to building your own Supernova Remnant!

Building Instructions:

4. Take the 8 chunks of dark green modeling clay and form 4 larger balls (1 cm) and 4 smaller balls (0.75 cm).

Dark Green

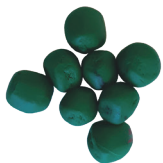


Fig. SR 1

5. Place the balls on the table as in [Fig. SR 2](#) then flatten them all together to form the bottom layer shape. Adjust if necessary. [Optional: use a tool to help you flatten the balls.] Then put aside.



Fig. SR 2

6. Take the 7 chunks of medium light green modeling clay and form 4 larger balls (1 cm) and 3 smaller balls (0.75 cm)

Medium Light Green



Fig. SR 3

7. Place the balls on the table as in [Fig. SR 4](#) then flatten them all together to form the middle layer shape. Then put aside.



Fig. SR 4

8. Take the 3 chunks of the light green modeling clay and form 3 balls of different sizes, no larger than 0.75 cm (use photo as a guide, [Fig. SR 5](#)).

Light Green



Fig. SR 5

9. Flatten the balls together. Adjust with your hands if you wish. These will be used as the top layer of the overall shape.
10. Assemble the Supernova Remnant, [Fig. SR 6](#):
 - Place the bottom layer (dark green) on the table.
 - Place the middle layer (medium light green) roughly centered on top of the bottom layer.
 - Add the top small light green shapes on top of the middle layer.



Fig. SR 6

"Bubble"

Fig. B 1

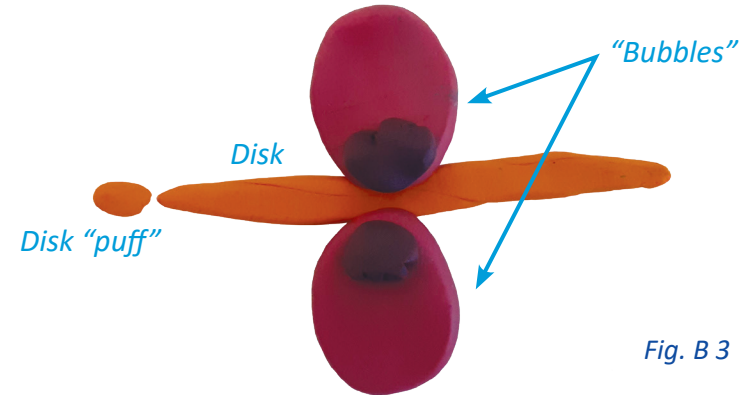


1. Take one of the pink clay balls and flatten it to an egg-shape.
2. Take one of the small purple clay ball and flatten it to any shape on top of the flattened pink egg. Use Fig. B 2 as a guide.



3. Repeat step 1 and 2 with the other pink and purple clay balls.

4. Take the orange string and flatten it to a long, thin shape. [Optional: cut a piece off to create the extra disk "puff".]
5. To assemble your "Bubble," take all flattened shapes and place them as seen in Fig. B 3.



Satellite

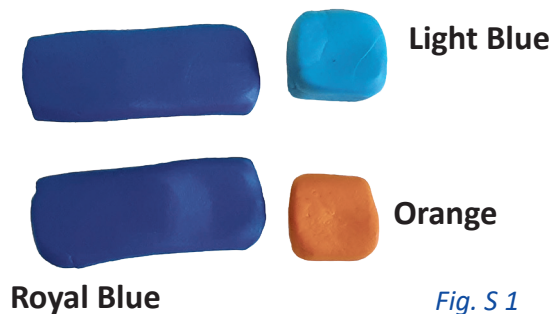
Material Preparation:

1. Take 2 chunks of royal blue clay, and roll them into two thick cylinders.
2. Prepare a chunk of light blue clay, and a chunk of orange clay.

Now that your clay is ready, you can move on to building your own Satellite!

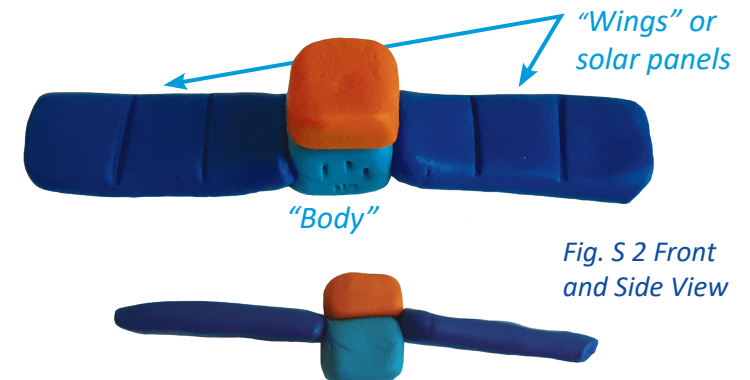
Building Instructions:

3. Take one of the royal blue cylinders and flatten as in Fig. S 1. Repeat with the second royal blue cylinder.
4. Take the light blue ball and shape it to a cube. Use Fig. S 1 as a guide. Repeat this step with the orange ball.



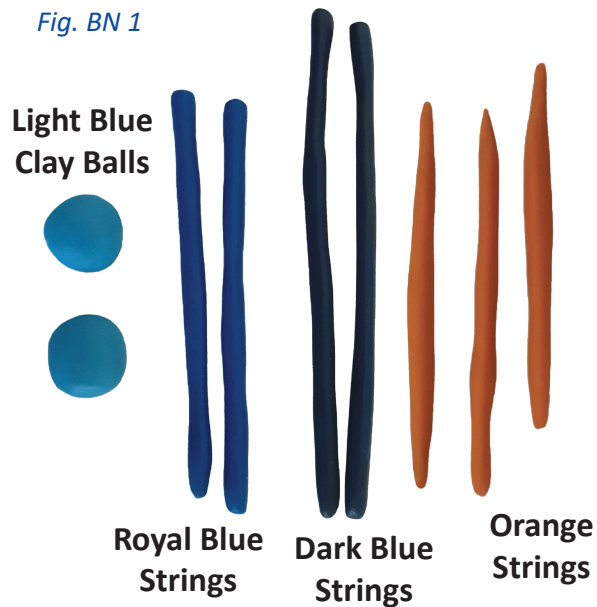
5. Assemble the Satellite:

- Place the orange cube on top of the light blue cube. Press lightly together to make them stick. That is the "body".
- Place each royal blue shape ("wings") on either side of the body as in Fig. S 2. Press lightly together to make them stick.
- Optional: with the tip of a pencil, carve a few lines to add details!



Binary Neutron Star

Fig. BN 1



Material Preparation:

1. Take one of the light blue chunks and roll it into a ball. Repeat this step with the second light blue chunk. See [Fig BN.1](#).
2. Take one of the royal blue chunks. Roll and stretch it into a thin string.
3. Repeat step 2 with the second royal blue chunk, the two dark blue chunks and the three orange chunks.

Now that your clay shapes are formed, you can move on to building your own Binary Neutron Star!

Building Instructions:

4. Take one of the light blue balls and flatten it into a thick disk. Repeat this step with the second light blue ball.
5. Take one of the royal blue strings and wrap it all the way around one of the light blue thick disk shape as in [Fig. BN 2](#). Repeat this step with the second royal blue string and light blue thick disk.



6. Take one of the dark blue strings and wrap it around one of the royal blue strings as in [Fig BN.3](#). Repeat this step with the second dark blue string. Use [Fig BN.3](#) and [4](#) as a guide. These are your "stars".



7. Assemble the Binary Neutron Star:
 - Take your three orange strings and place them in a narrow fan-like arrangement. Press them lightly together to make them stick.
 - Place each assembled "star" near the center on either side of the "jets". Press them lightly together against the jets to make them stick.

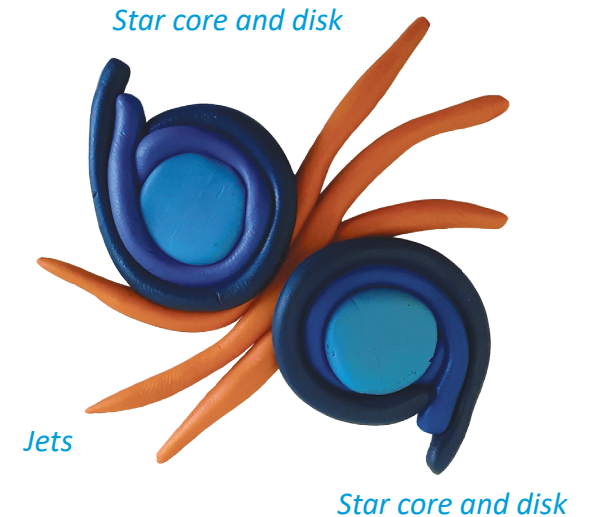
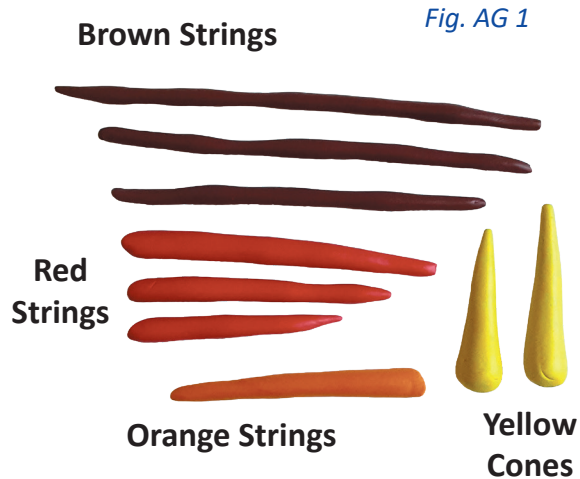


Fig. BN 4

Anatomy of a Binary Neutron Star at a glance (see glossary for more on p 4):

- Neutron Star Center (core)
- Neutron Star Disk
- Jets

Active Galaxy



Material Preparation:

1. Take one yellow chunk and shape it into a cone as in *Fig AG 1*. Repeat with the second chunk.
2. Take the orange chunk. Roll it while stretching it into a string.
3. Repeat step 2 with the three red chunks making them three different lengths.
4. Repeat step 2 with the three brown chunks. Make them thinner and longer than the red ones. Use *Fig AG 1* as a guide.

Now that your clay shapes are formed, you can move on to building your own Galaxy.

Building Instructions:

4. Take a yellow cone and bend it as in *Fig. AG 2*. Repeat with the second yellow cone, then place the two yellow shapes together (*Fig. AG 2*). Press them together gently to make them stick.



5. Take the orange string and wrap it around one of the yellow shapes (*Fig AG 3*). Press them together gently to make them stick.

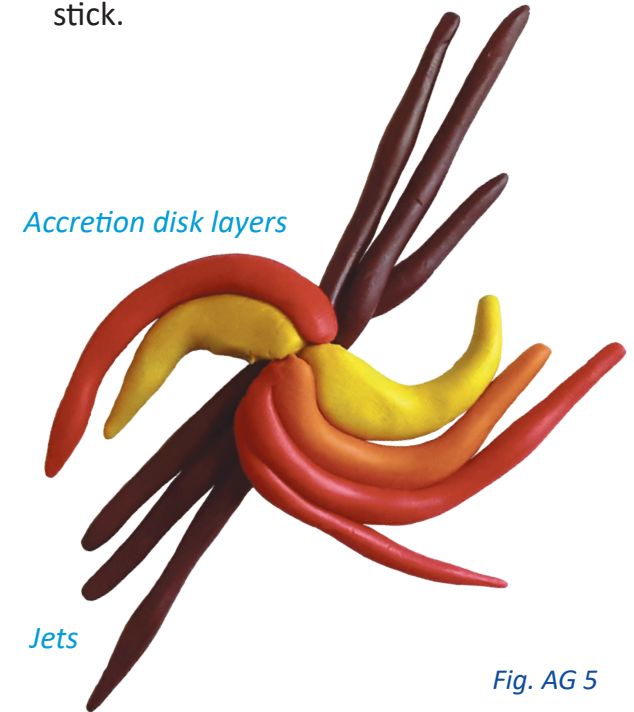


6. Take one of the red shapes and bend it as in (*Fig AG 4*). Repeat this step with the second and third red strings (*Fig AG 4*). These are the layers of your "Disk."



7. Assemble the Active Galaxy:

- Take your three brown strings and place them in a narrow fan-like arrangement (*Fig AG 5*) to create the "jets." Press them against the jets to make them stick.
- Place your Disk assembly centered on top of the jets. Press them lightly together against the jets to make them stick.



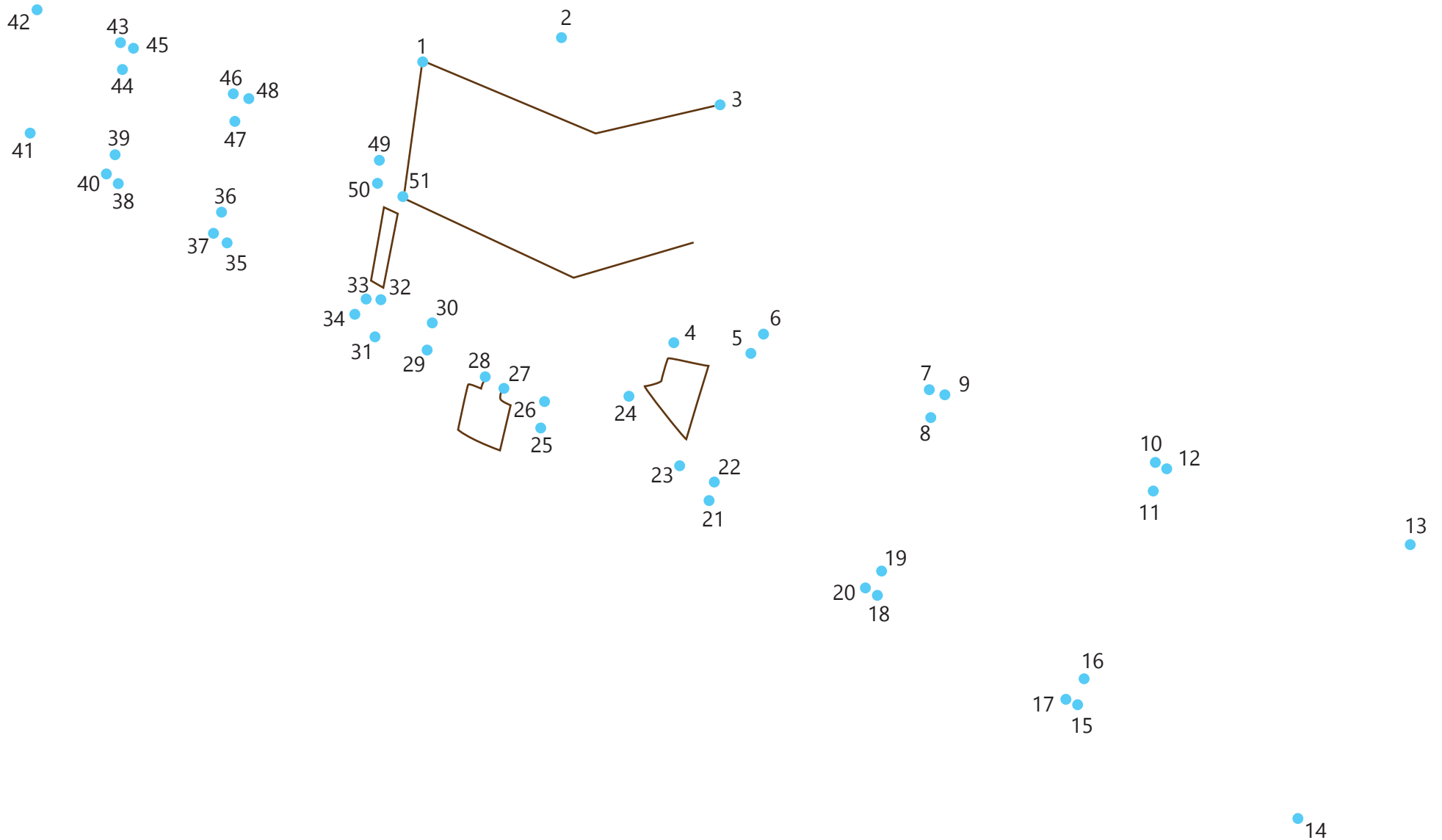
Anatomy of an Active Galaxy at a glance (see glossary for more on p 4):

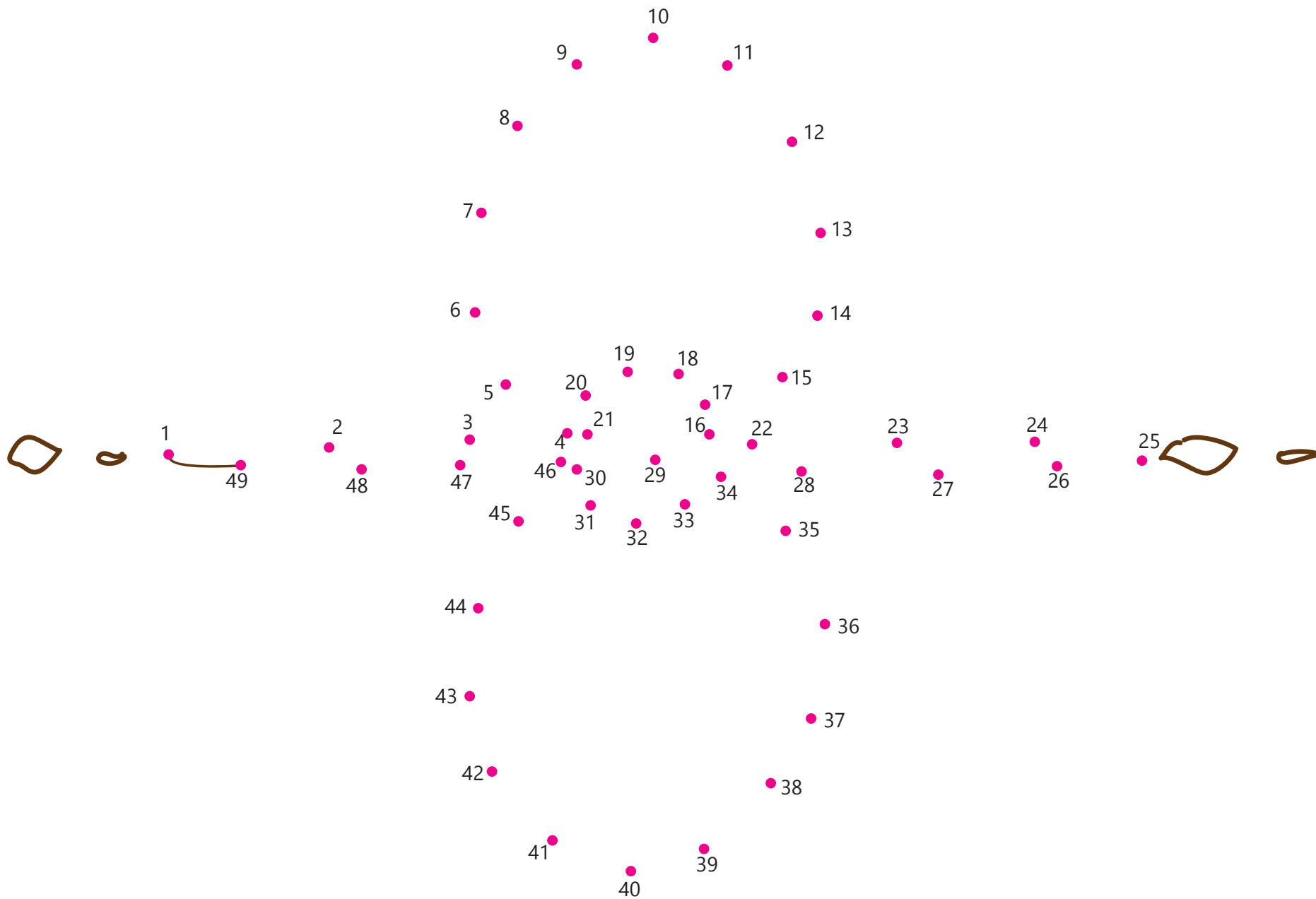
- Accretion disk composed of several layers of gas and particles.
- Jets
- A Black Hole is often found at the center (not represented in our model)

Link Me

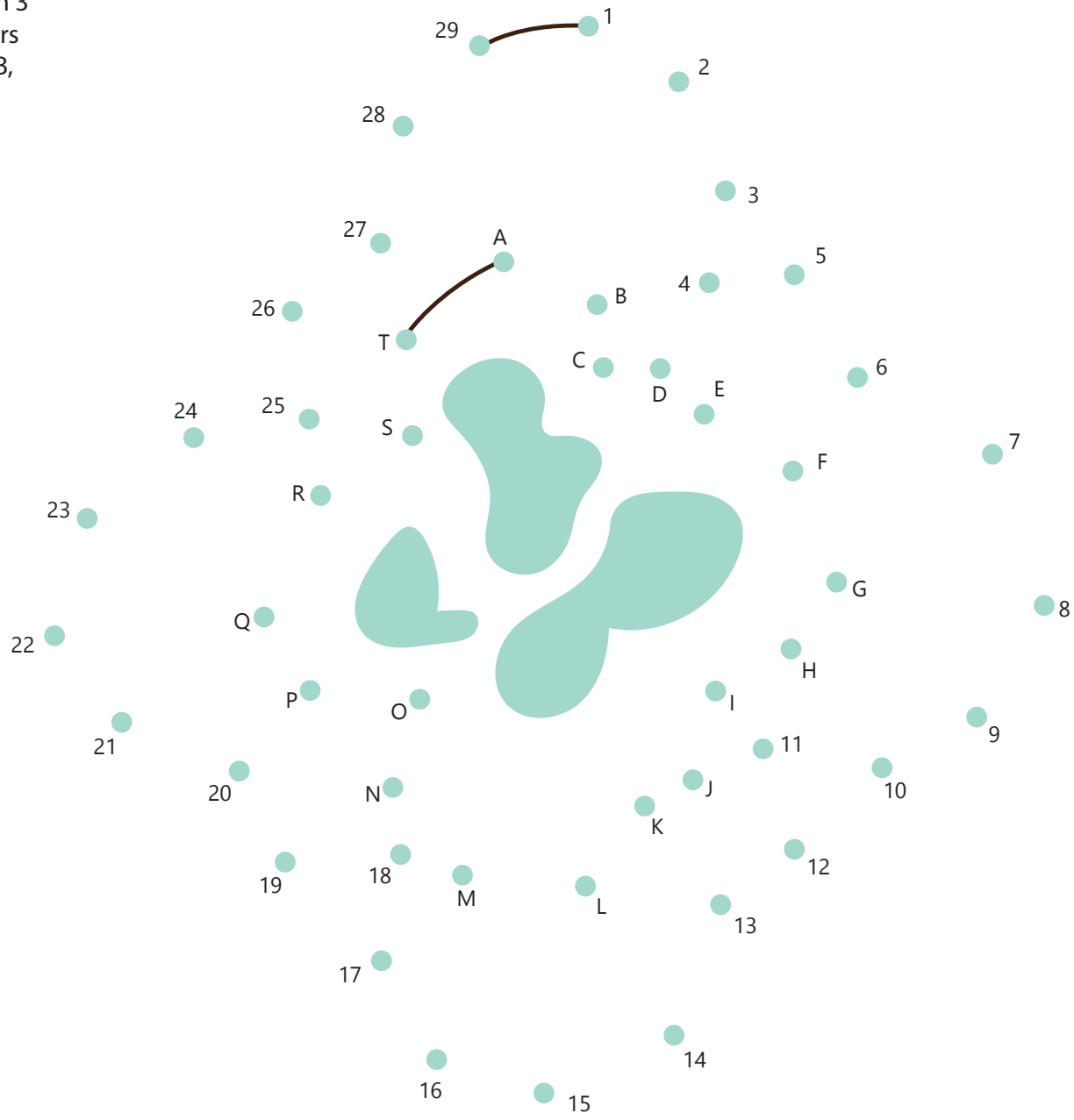
What You Need: A drawing tool. We recommend a regular pencil with an eraser to fix any mistakes made along the way.

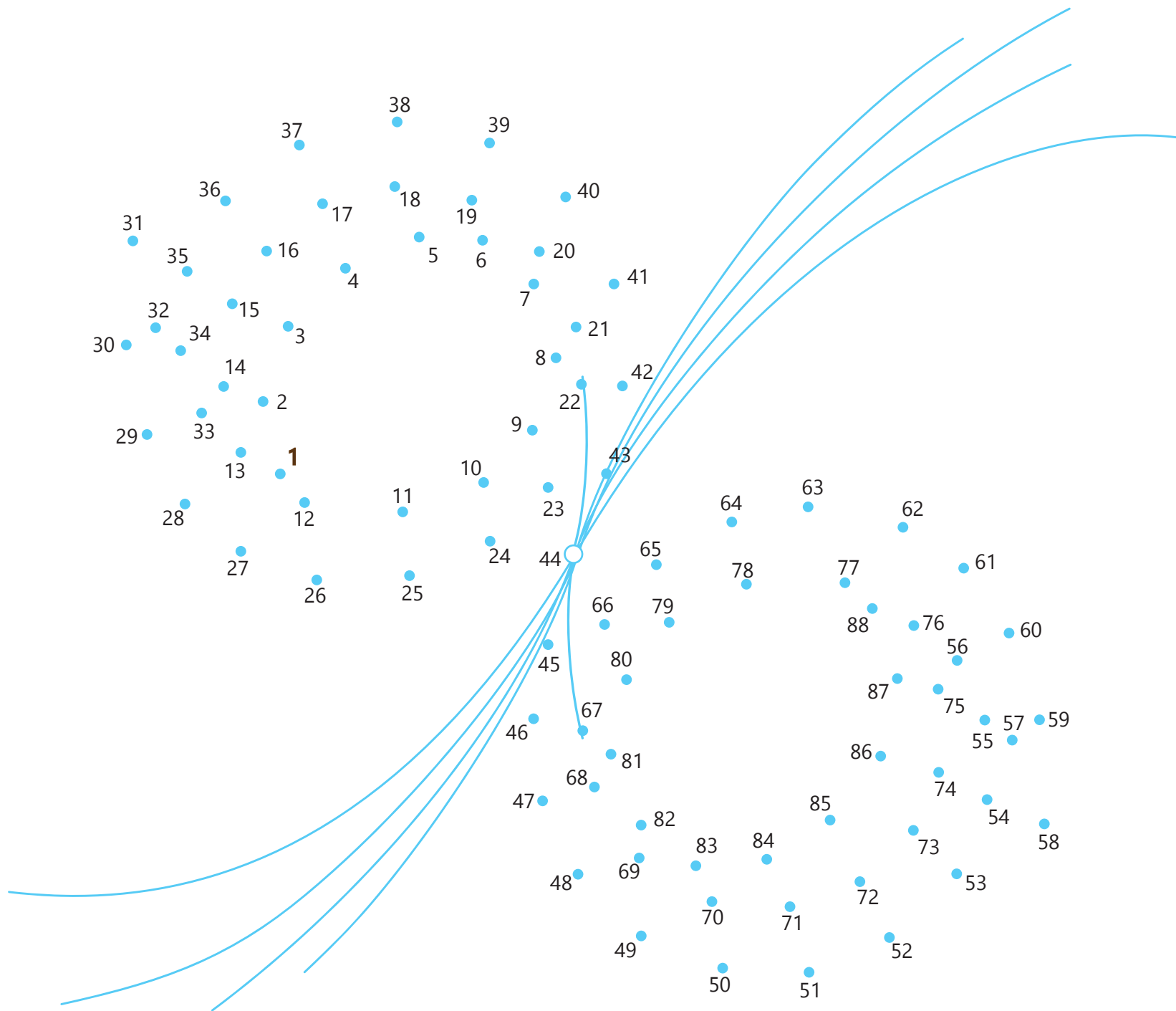
Instructions: Draw a line from 1 to 2, then 3 until you run out of numbers!

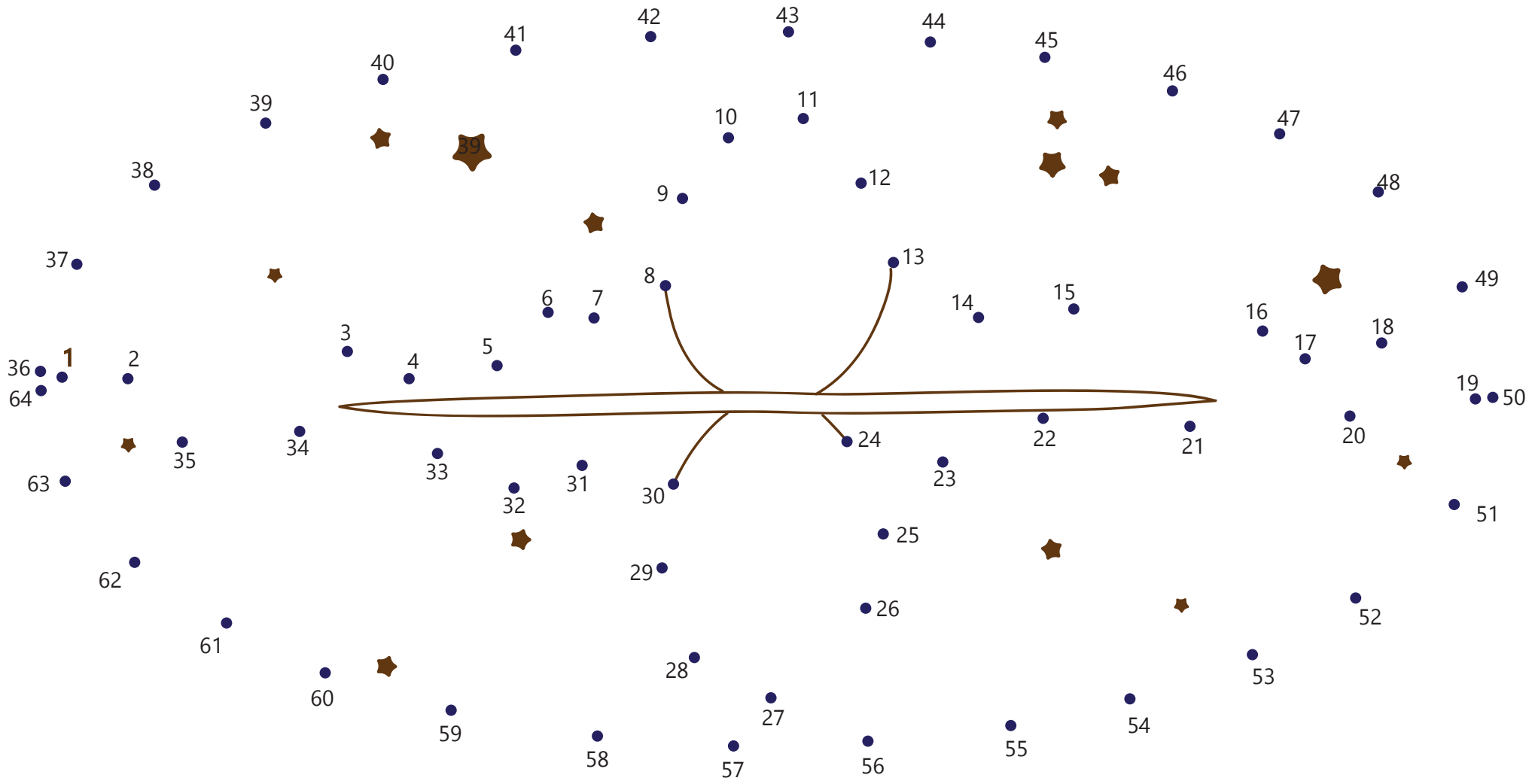


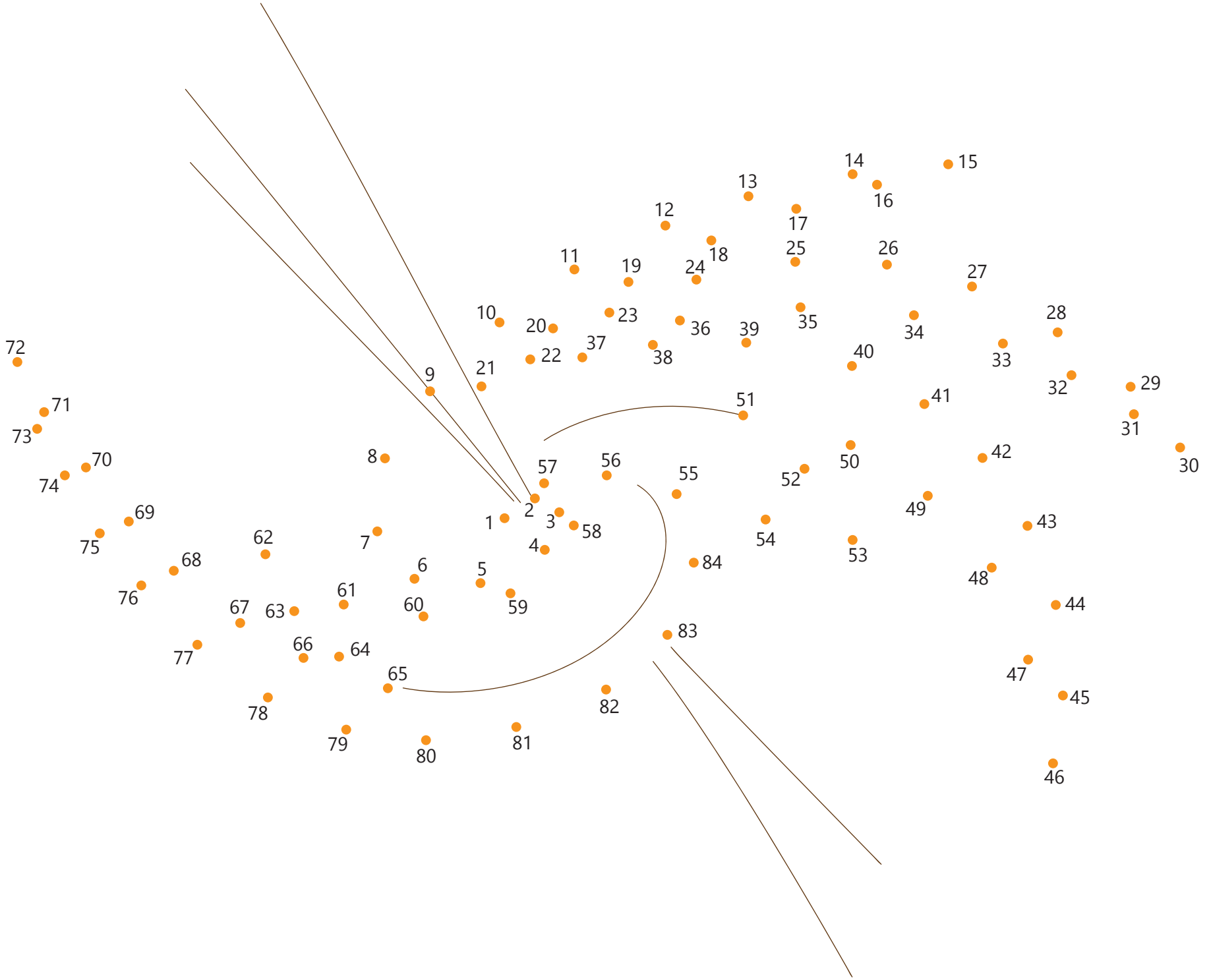


1. Draw a line from 1 to 2, then 3 until you run out of numbers
2. Then draw a line from A to B, then continue through the alphabet until the letter T.



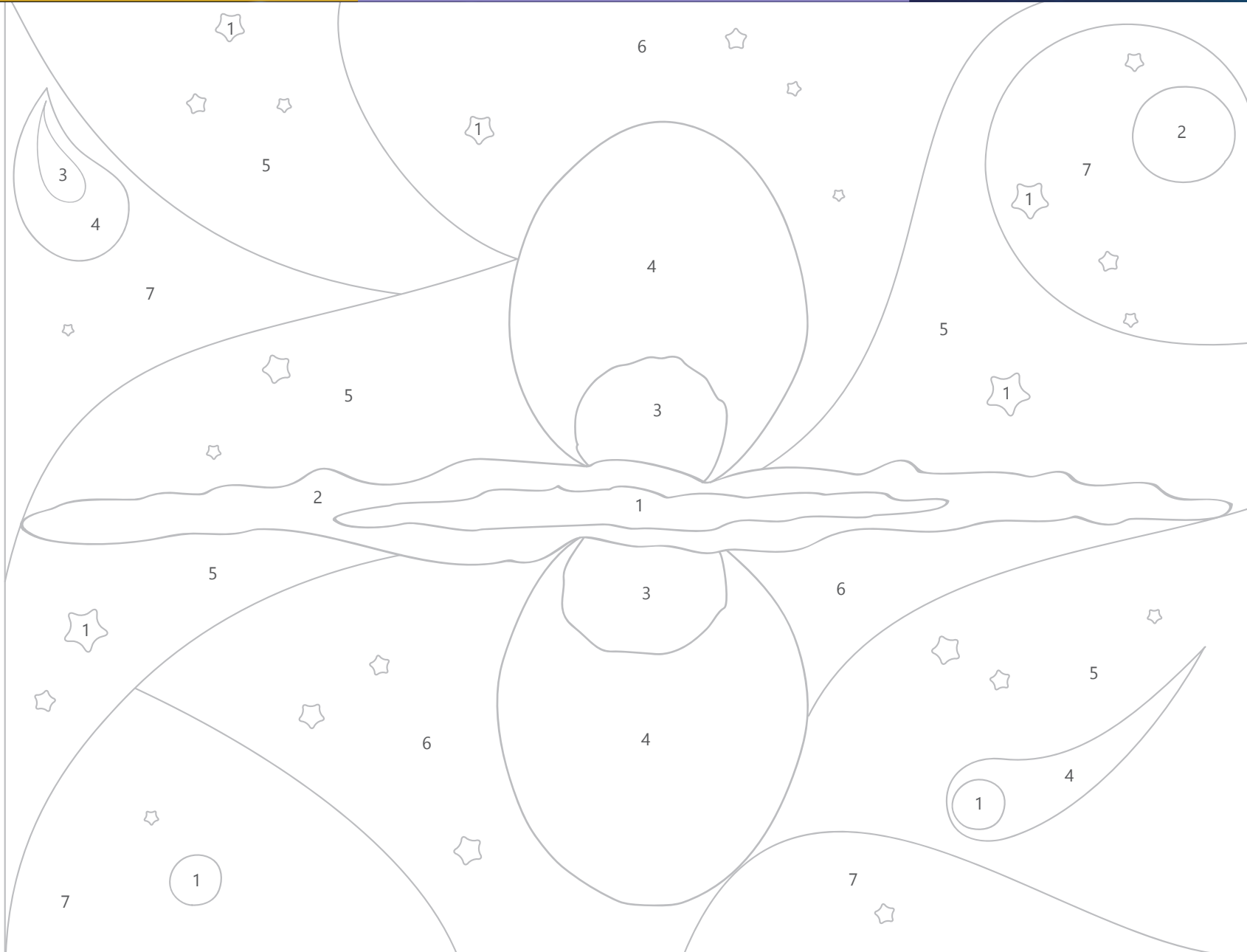






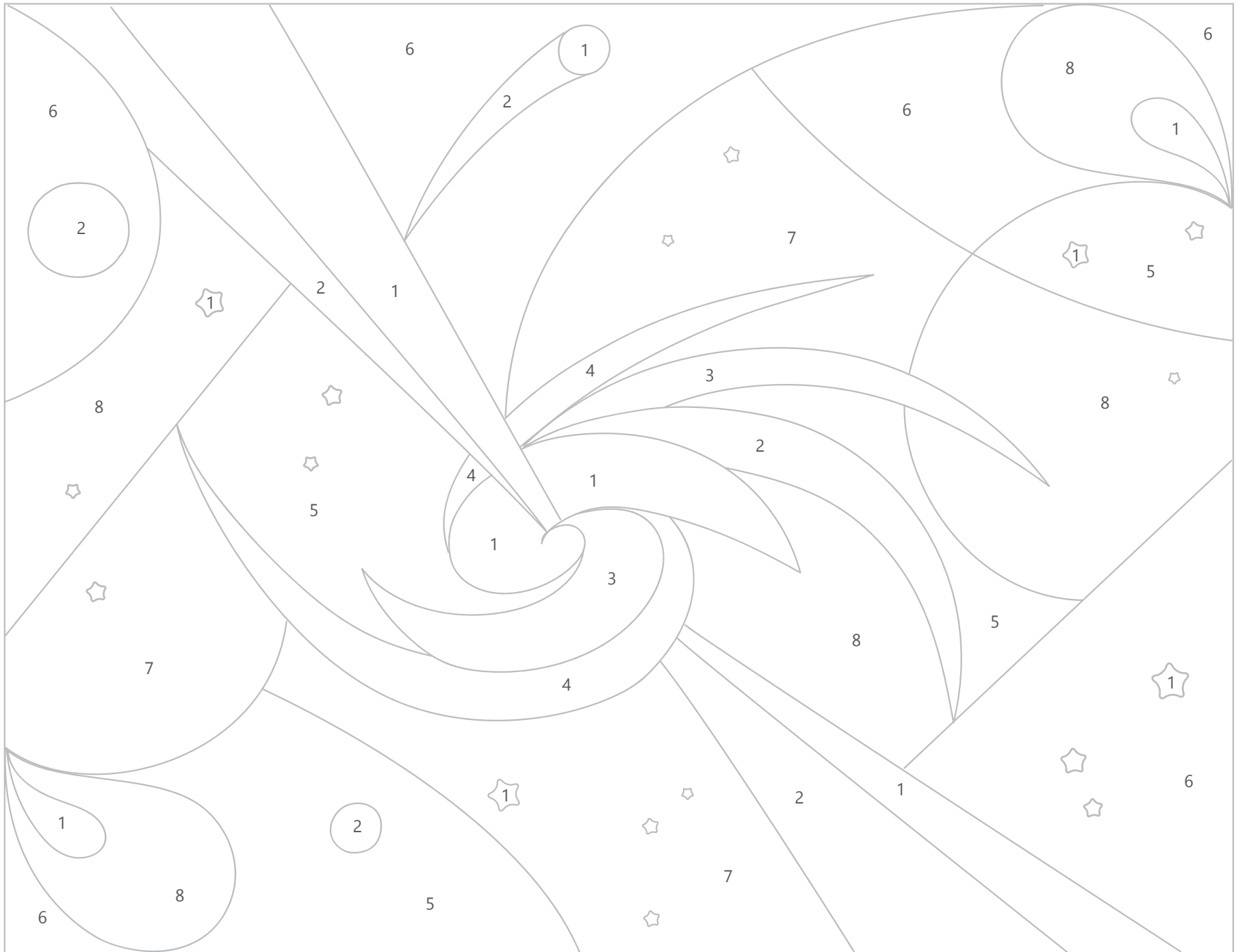
Color Me

What You Need: A set of colored pens or pencils.
Instructions: Follow the number color guide to color each section or make up your own!



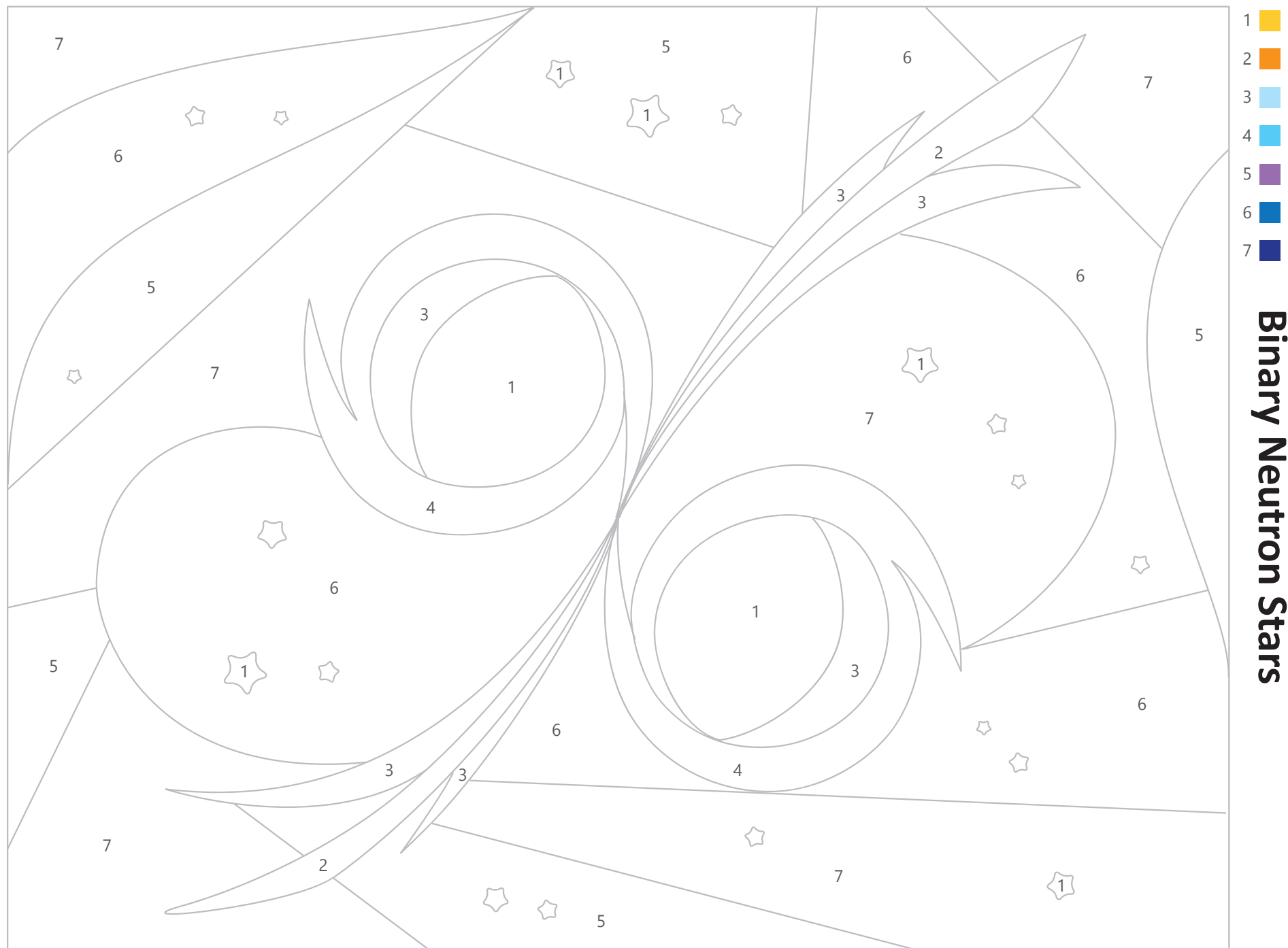
- 1 
- 2 
- 3 
- 4 
- 5 
- 6 
- 7 

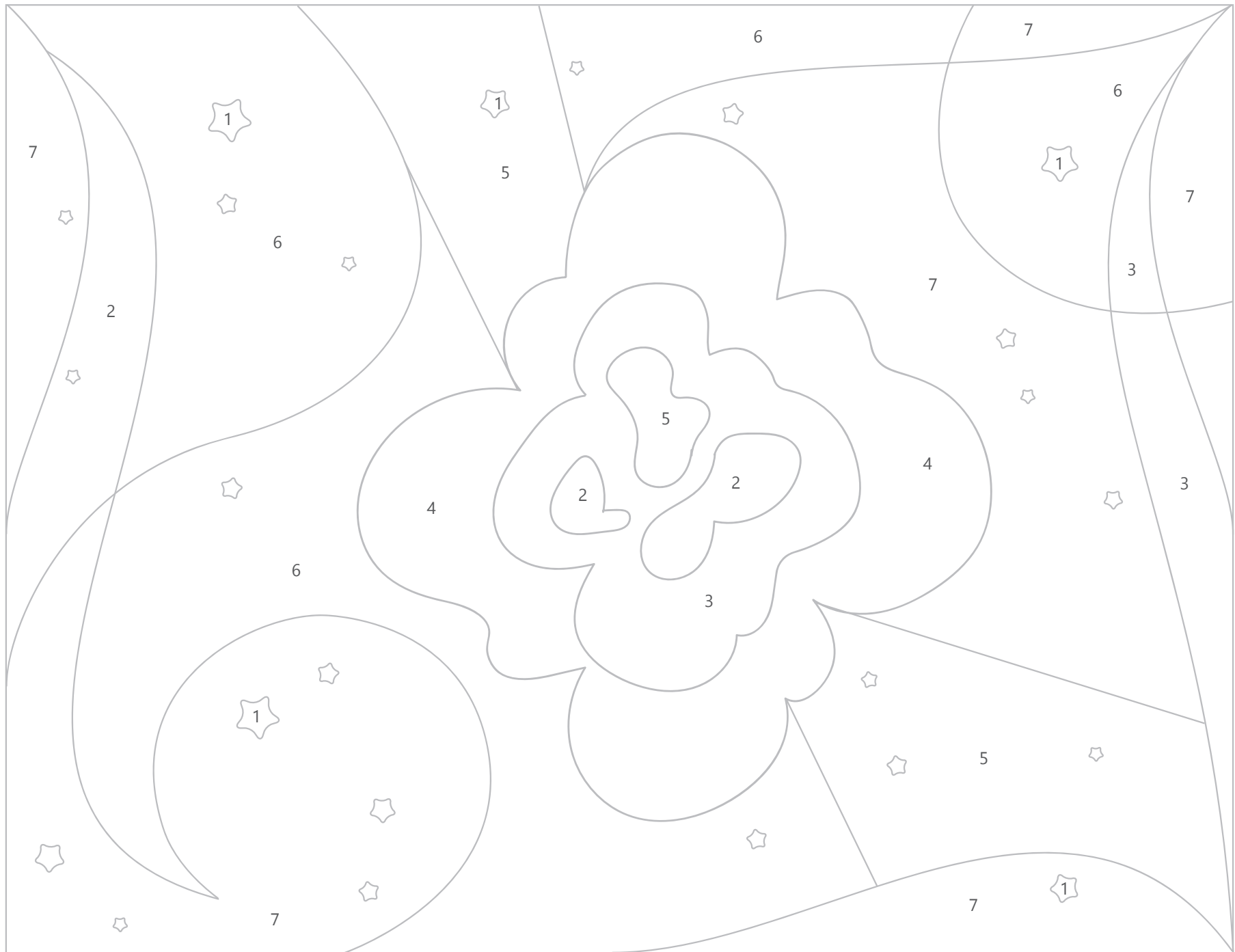
Fermi "Bubble"



- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

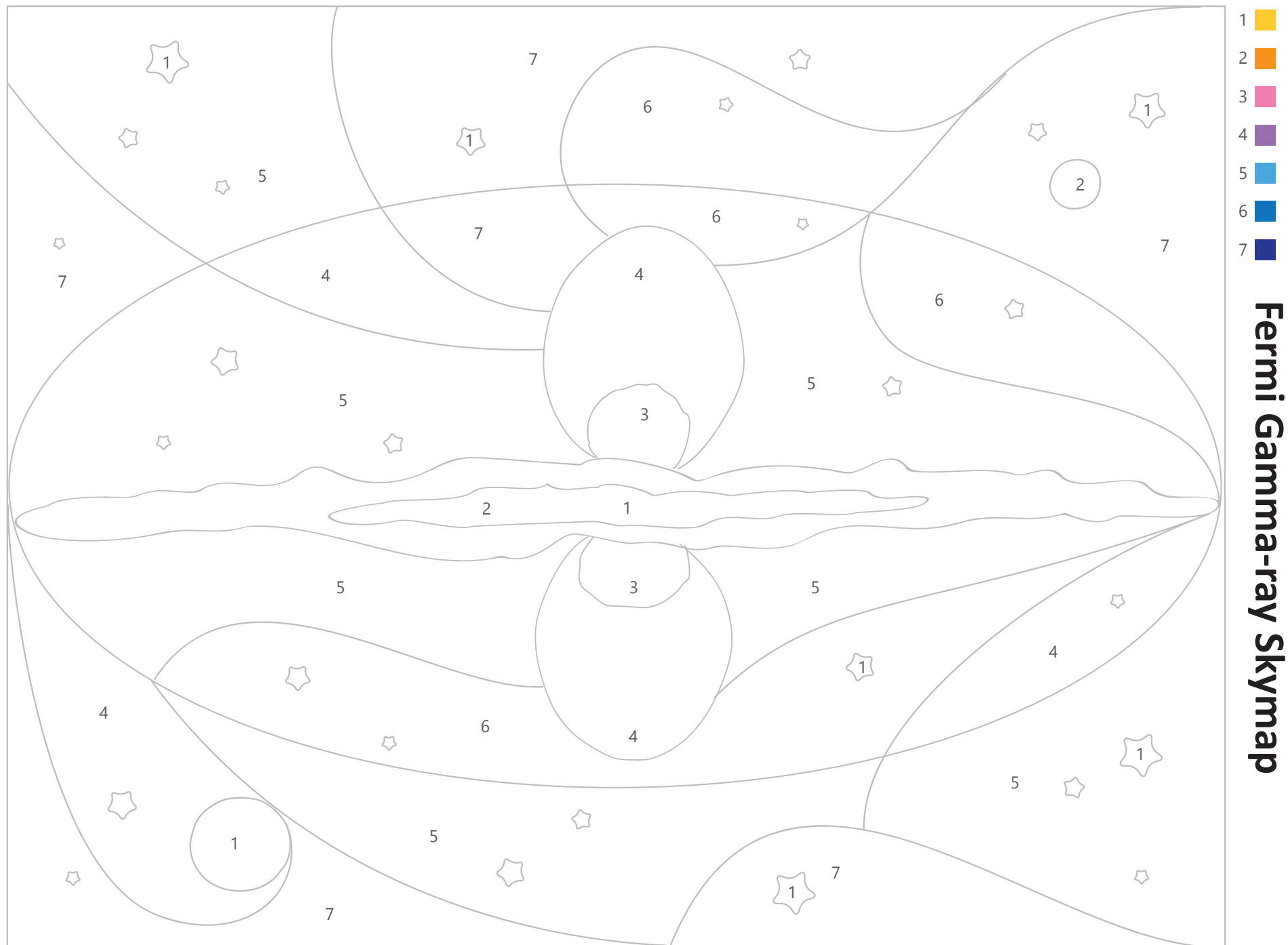
Active Galaxy

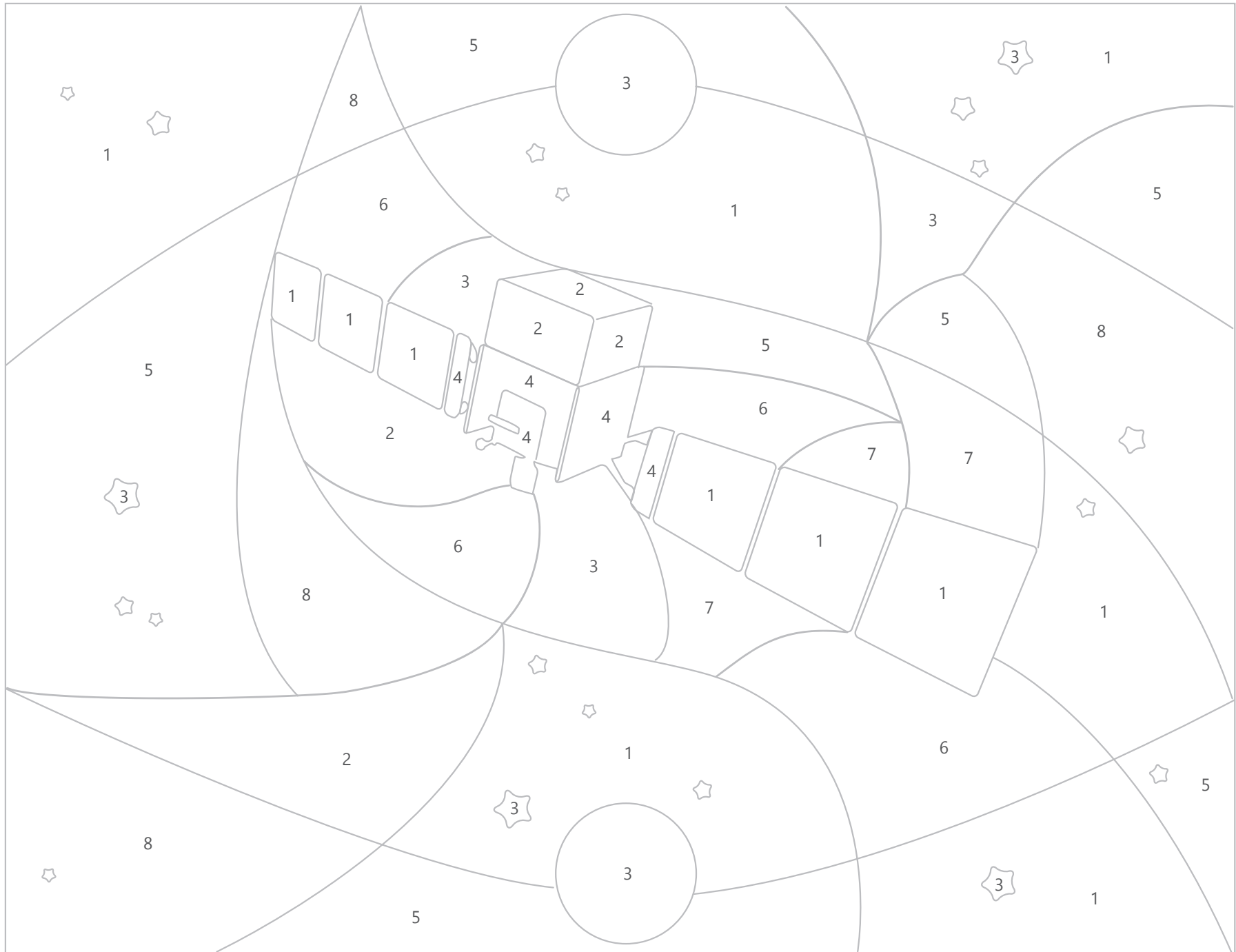




- 1
- 2
- 3
- 4
- 5
- 6
- 7

Supernova Remnant





- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Fermi Satellite

Feel Me

Note: Advance preparation required.

Instructions:

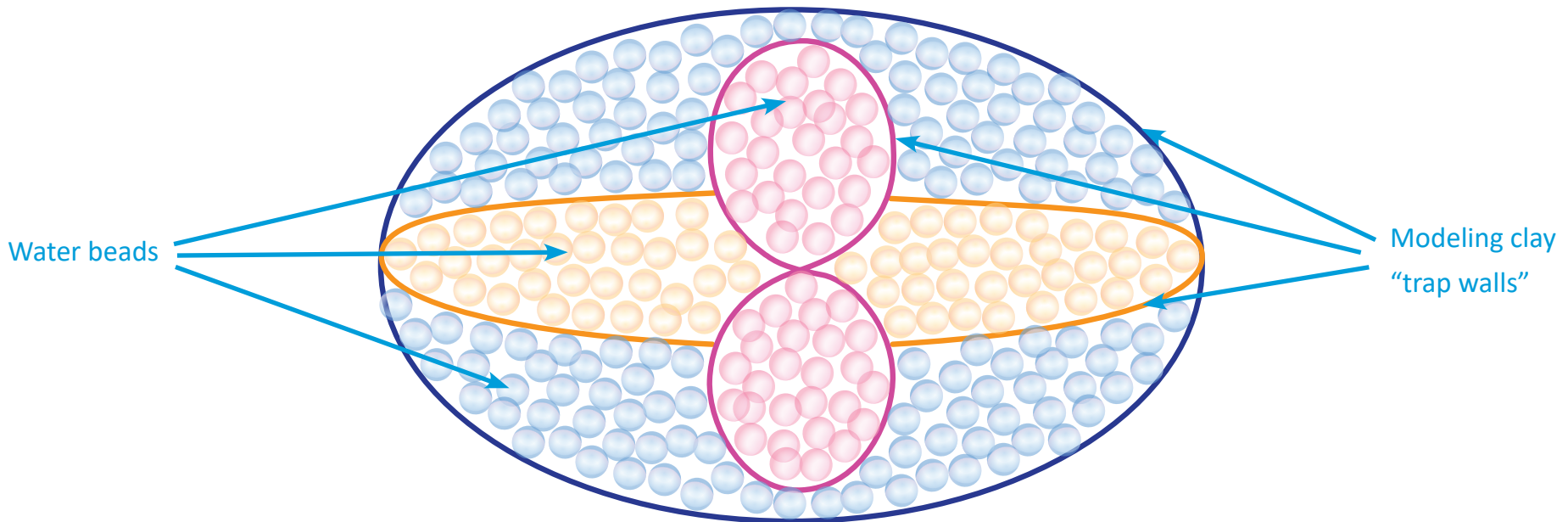
Prepare ahead of time: The beads will need to soak for at least 4 hours before this activity. Letting the beads soak overnight is best. Have a variety of colors available for the best results. Color matching the beads based on the map guide could be used as an additional skill.

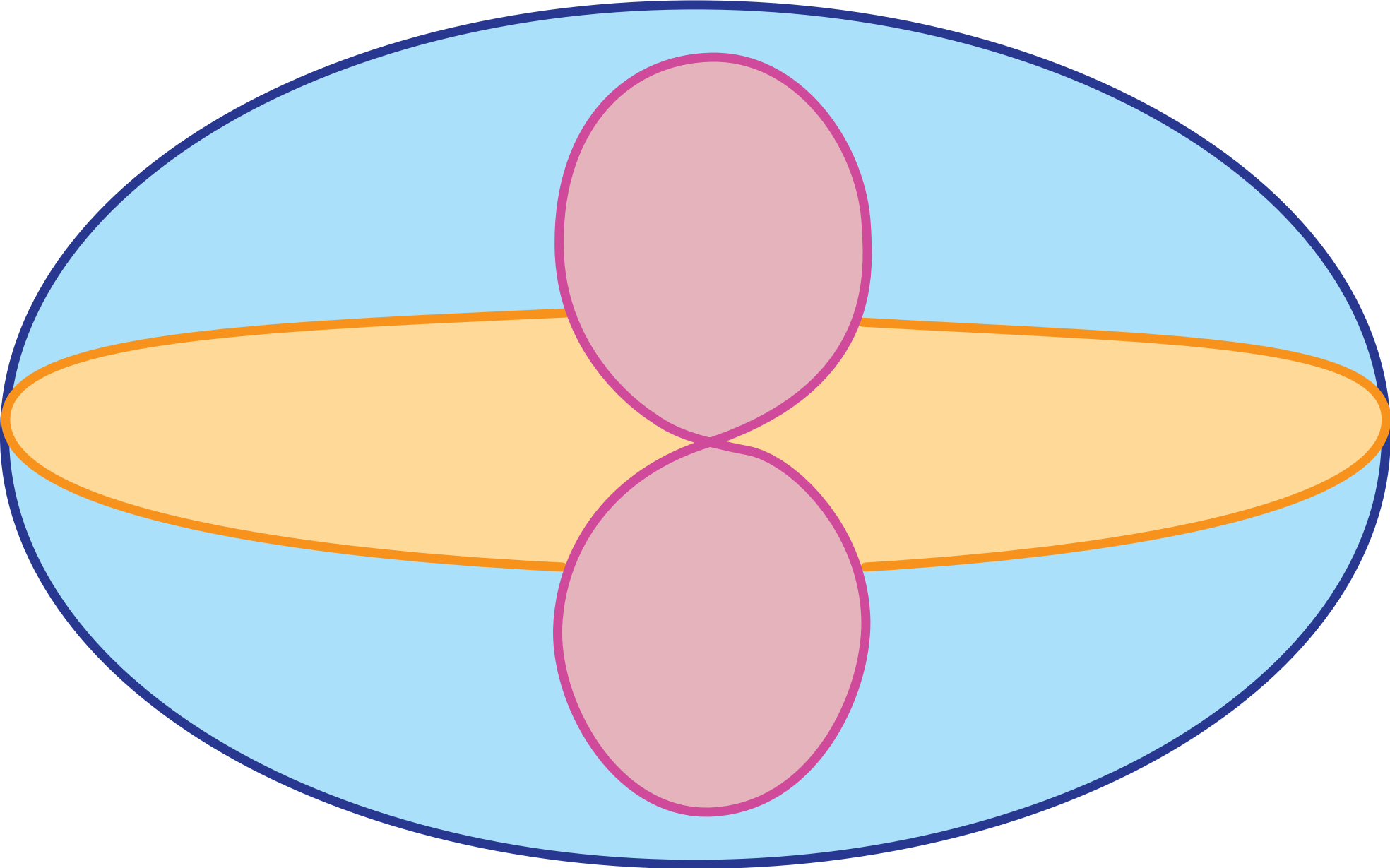
1. Copy or print the “Skymap Trap Guide” on p.25.
2. Depending on the participant’s abilities and time available:
 - a. Prep in advance by applying a 1/4 inch layer of modeling clay along the lines of the guide map to create “trap walls” for the water beads.
 - b. Or have the participant create the traps as an extra skill activity.
3. Have the participant use tweezers or their fingers to place water beads within the trap. As an extra challenge, have them place beads of corresponding colors in each trap!

What You Need:

- A set of pre-soaked colored water beads in a container. Three different colors would be best.
- A sorting instrument such as tweezers if not using fingers
- Water
- Modeling clay (any color)
- A printed Trap Guide Map (p. 25)

[Note: it is strongly recommended that this activity be supervised to prevent potentially dangerous misuse of materials.]

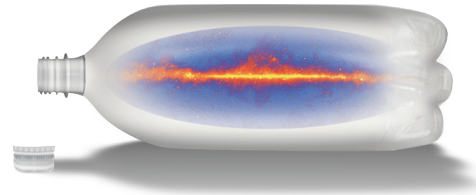




Watch Me

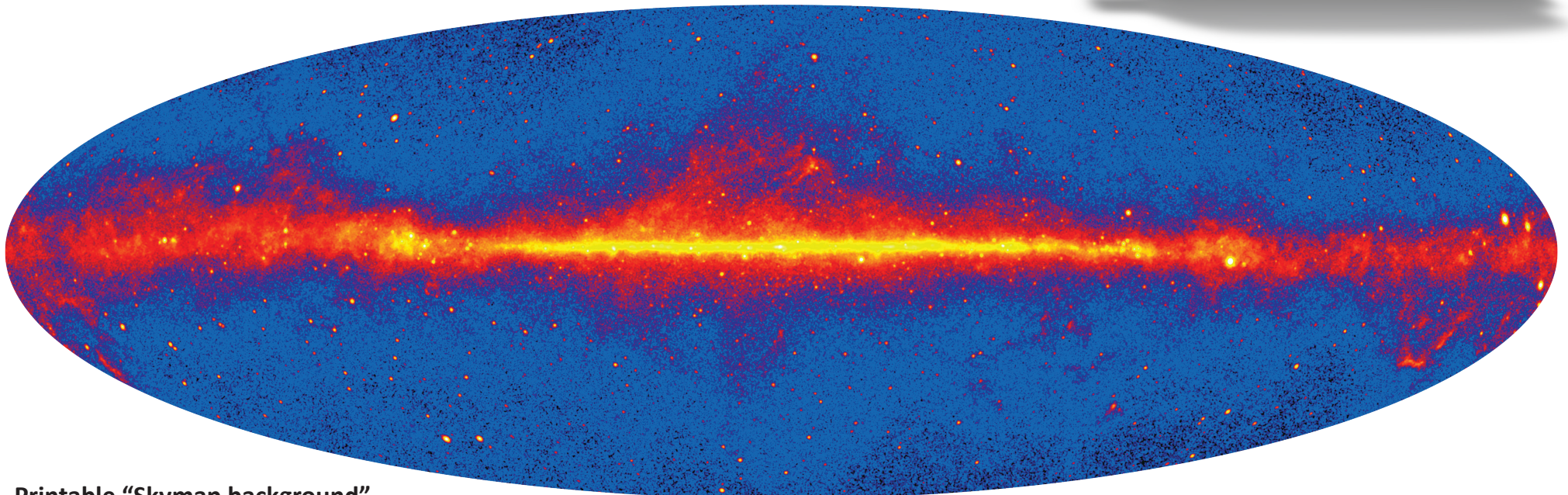
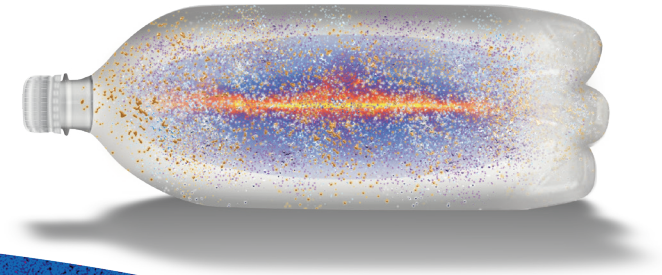
Instructions: Create a mesmerizing Gamma-ray sky!

1. Copy or print the “Skymap background” below.
2. Glue or tape the SkyMap on the outside of the bottle.
 - Hold the bottle sideways.
 - Align the Skymap width with the top and bottom of the bottle.
 - The colors should face toward the inside of the bottle, so the map is visible when looking through.
3. Tilt the bottle back upright and fill it up half way with water (Optional: Add 1-2 drops of blue dye if you wish).
4. Add glitter, sequins, water beads and any other fun items you wish.
5. Fill the remainder of the bottle with glycerin. Leave a bit of space at the top to make it easier for contents to mix.
6. Close the bottle cap, shake well and be mesmerized!



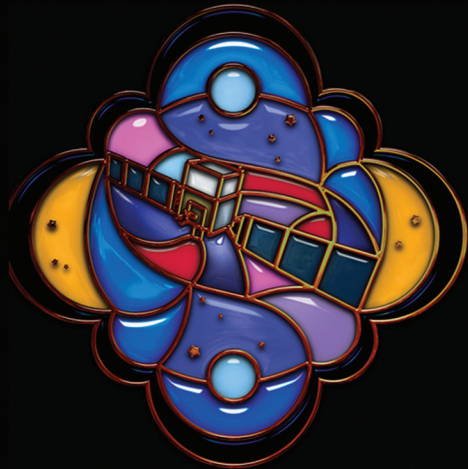
What You Need:

- 1 liter empty clear plastic bottle
- Glycerin
- Glitter of different colors
- Sequins (Optional: other fun items such as water beads)
- Water
- Blue dye (optional)



Printable “Skymap background”

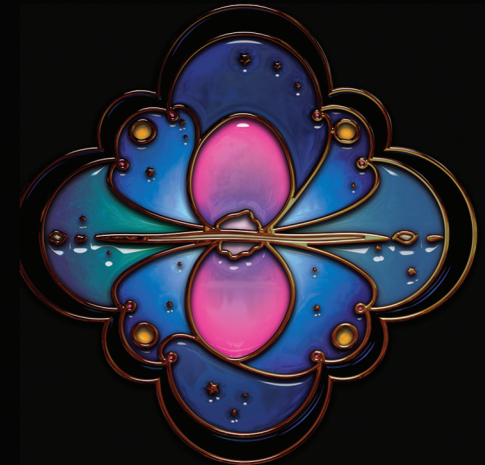
Stained-glass" Illustrations of Fermi objects used in activities



Fermi Satellite



Fermi Skymap



Fermi Bubbles



Active Galaxy



Supernova Remnant



Binary Neutron Stars

