STATEWIDE STAR PARTY

KINESTHETIC LIFE CYCLE OF STARS

Activity Instructions

http://www.ncsciencefestival.org/starparty

OBJECTIVE

To kinesthetically model the birth, life, and death of stars

SUGGESTED AGE RANGE

Ages 10 and up (can work with younger children if their parents are also participating)

ACTIVITY DURATION

15-40 minutes depending on length of discussion

MATERIALS

- People! A group of 8 to 12 people is ideal.
- Optional: Images of humans in different stages of life
- Optional: Images of stars in different stages of their life cycles – http://chandra.harvard.edu/edu/formal/stellar_cycle
- Optional: Life cycle of stars handout – https://nightsky.jpl.nasa.gov/docs/13lifecycleshandout.pdf

SETTING

Outdoors, or inside an empty room

CREDITS

Adapted from: Reinfeld, E. L. & Hartman, M. A. (2008). Kinesthetic Life Cycle of Stars. *Astronomy Education Review, 7(2),* 158-175. Original article available at

http://aer.noao.edu/cgi-bin/article.pl?id=287

PROCEDURE

1. Optional: Challenge your visitors to put in order images of humans in different stages of life. Encourage them to notice details of the images, and to justify their reasoning by identifying features and patterns in each stage (e.g., graying hair, smaller size in infancy). If you wish, ask them to repeat the challenge with images of stars and nebulae. They may be able to notice different details and features, but putting the images in the correct order will be more challenging. Tell your visitors that just like humans, stars change in predictable ways as they develop. This activity will explore the processes that affect a star's structure and appearance throughout its life.

2. Optional: You might provide some introductory reflection around your visitors' ideas about stars, by asking what they think will happen in the future to our star, the Sun, or by showing a picture of actual stars in the sky. The constellation Orion is a good example because it includes a star-forming nebula and stars of different types and ages.

3. Tell your visitors they will create, with their bodies, models that explain how stars live and die. Over only a few minutes, they'll act out the millions or billions of years of a star's life. Each person will represent a clump of gas and dust many times more massive than Earth. The clumps move and change only when pushed or pulled by interaction with the surrounding clumps of gas (and dust). This activity explores the ongoing interplay between two such influences—gravitational force, and gas pressure generated by fusion in the star's core. Explain that a star's mass determines its fate, so as time permits, you'll do the activity twice – once for a low-mass star, like the Sun, and once for a high-mass star.

4. Set ground rules, e.g., wait for a cue before starting any new motion, stay on your feet, no running, no aggressive behavior. You can encourage calm behavior by giving specific instructions, such as "take three steps backwards."

ADDITIONAL RESOURCES

- Annotated photos of people doing this activity: https://www.flickr.com/photos/mkiphotos/sets/72157605963324609/
- Life cycle of small star: https://www.youtube.com/watch?v=hLCo1P-_CvQ (3-min. video) https://universe.nasa.gov/au/videos/Small_Star_HTML_Transcript.html (video transcript)
- Life cycle of large star: https://www.youtube.com/watch?v=7oydVEEUGUg (3-min. video) https://universe.nasa.gov/au/videos/Large_Star_HTML_Transcript.html (video transcript)

PROCEDURE (CONTINUED)

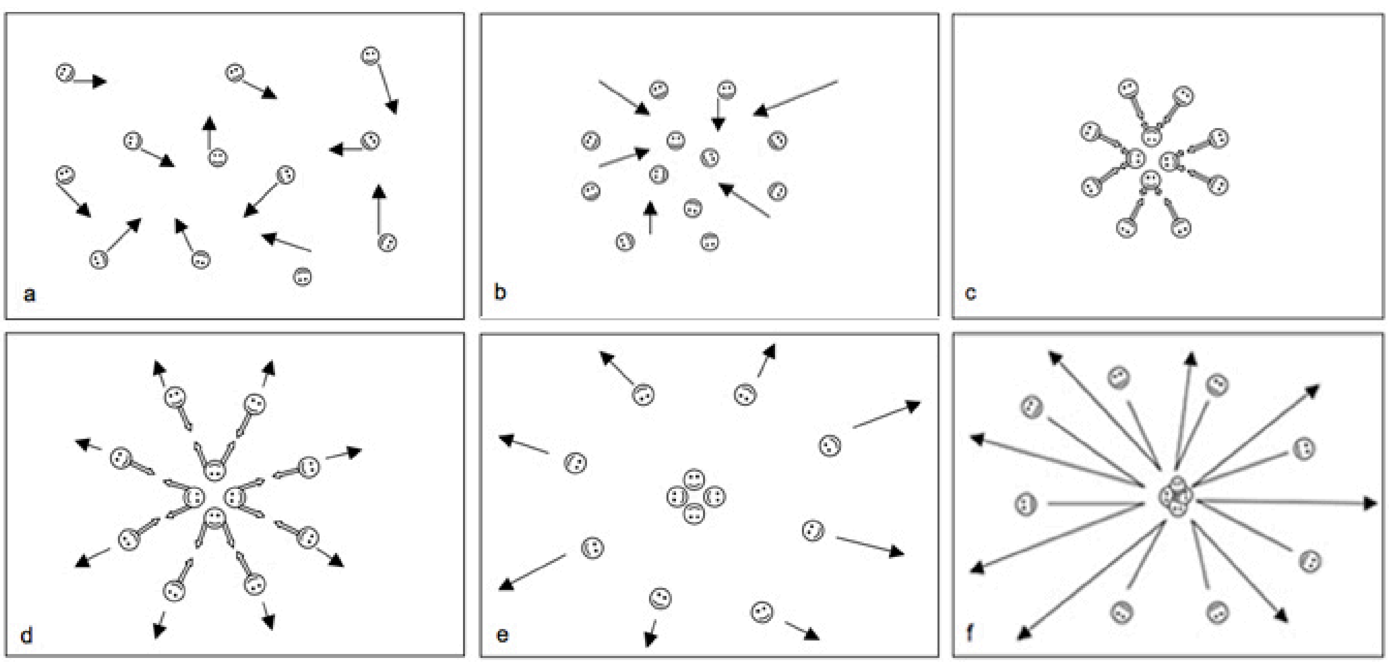
5. Refer to the table below for a summary of the stages of the life cycle of stars ("stellar evolution") and for what actions your visitors will take in each stage. The illustration shows the visitors' positions during each stage. Be sure to emphasize the interplay between the inward force of gravity that pulls the star together and the outward force that results from fusion in the core. At each stage, before you "start the clock," provide a brief narration of the science and physical actions that are about to occur. Optional: Show an illustration of the life cycle of stars.

6. Once the action begins for a specific stage, provide more detailed instructions or guidance to individual visitors as needed.

7. After visitors complete the action of a stage, have them stop moving while you summarize the process and begin to narrate the next segment. Optional: Show an image of a star in that stage of life, e.g., Orion Nebula for star-forming region; Sun for main sequence; Aldebaran for red giant, or Betelgeuse for red supergiant; Ring Nebula for planetary nebula, or Crab Nebula for supernova remnant.

8. Have your visitors act out all the stages for the low-mass star life cycle. Then repeat for the high-mass star life cycle, by rewinding the clock back to the original star-forming nebula.

STAGES OF STELLAR EVOLUTION



a. Star-Forming Nebula (random motion)
b. Protostar (clumping, motion toward the center, core and envelope start to differentiate)
c. Main Sequence (core and envelope pushing in balance)
d. Red giant (core pushing harder, motion outward)
e. Planetary Nebula (core compacted, all other motion outward)
f. Supernova (core compacted, motion inward then outward)

STAGES OF STELLAR EVOLUTION

Stage	Description	Action
Star-Forming Nebula [Gravity rules.]	A cloud of gas and dust forms many stars. A single star is created when clumps of this material (mostly hydrogen gas) are pulled together by the force of gravity.	Students, scattered randomly throughout the room, point in the direction where “the most other clumps” are, and slowly make their way to that point.
Birth of the Star (Protostar) [Gravity rules. Fusion begins.]	As a region of the cloud collapses, gravity pulls the clumps of gas together. The gas in the center becomes hot enough and dense enough to begin fusion. Hydrogen atoms inside the clumps smash into each other, combining to create helium and releasing light and heat. The star begins to shine.	Students clump together, forming a large ball. Those on the outside (“envelope”) continue to move toward the center. When students on the inside (“core”) start bumping into each other, they face outward.
Life of the Star (Main Sequence) [Gravity and thermal pressure from fusion in balance.]	Fusion in the core generates an outward gas and radiation pressure to balance the inward gravitational force from the outer layers.	Core students, arms slightly bent, and envelope students, arms extended, gently push against each other, palm-to-palm, balancing.
Red Giant [Fusion overtakes gravity.]	As the core nears the end of its fuel supply, the outer layers continue to push inward, increasing the temperature in the core. This produces a new series of fusion reactions that produce enough outward force to overpower the inward gravitational force and expand the star.	Core students fully extend their arms, pushing the envelope students backwards, expanding the star.
Death of a Low-Mass Star (Planetary Nebula with White Dwarf) [Fusion ends; gravity wins.]	As the core runs out of fuel for fusion, it emits one last push outward, ejecting the star’s outer layers, which drift away into space. The core then contracts under its own gravity, forming a white dwarf.	Core students push the envelope outward then move together into a tight blob at the center. The envelope students, in a ring-like shape, drift away from the core.
Death of a High-Mass Star (Supernova, with Neutron Star or Black Hole) [Fusion ends; gravity wins.]	The massive core continues to fuse elements and expands the star so it is even larger. Once the core runs out of fuel, it collapses to form a neutron star. The outer layers then collapse as well. As material falls toward the star’s center, it bounces off the core and explodes outward through the star. This explosion is called a supernova. In the most massive stars, the collapsed core will become a black hole.	Core students extend their arms, expanding the star. Then, they stop pushing and scrunch together at the star’s center. Envelope students rush inward, and bounce off the packed-together students in the core, exploding outward dramatically, revealing the collapsed core.

NORTH CAROLINA space grant

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