ASTROEDU

Peer-reviewed Astronomy Education Activities

Star in a Box: High School

Explore the life-cycle of stars with Star in a Box activity.

Edward Gomez, LCOGT


[STAR IN A BOX]
Welcome!
You are now the proud owner of Star In A Box.
Inside this box you can animate the different stages in a star's life and see how its brightness, size, and mass change with time.
Once you've opened the box just click the play button to start animating.
< Open the Lid
[LCOGT.net]

AGE

10 - 19

LEVEL

Middle School, Secondary

TIME

30min

GROUP

Group

SUPERVISED

No

COST PER STUDENT

Low Cost

LOCATION

Small Indoor Setting (e.g. classroom)

CONTENT AREA FOCUS

Astronomy

ASTRONOMY CATEGORIES

Stars

EARTH SCIENCE KEYWORDS

Geophysics

SPACE SCIENCE KEYWORDS

Astrobiology

CORE SKILLS

Constructing explanations, Communicating information

TYPE(S) OF LEARNING ACTIVITY

Technology-based

KEYWORDS

Lifecycle of stars, Stars, Evolution, Interactive

GOALS

- To understand the differences in the lifecycle of stars with different starting masses.
- To demonstrate the use of graphing as a tool for exploring different physical aspects of a complex system.

LEARNING OBJECTIVES

- Describe the relationship between a star's mass and its life span.
- State that stars above a certain mass end their lives in a supernova.
- Name the major stages of a star's life cycle, in order, for several masses of star.
- Describe the relationship between a star's mass, its age, and its position on the Hertzsprung-Russell diagram.

EVALUATION

The accuracy of their answers to the question can form the basis of the evaluation of students' understanding. However, more detailed feedback can be obtained by talking to individual students about their understanding.
- Ask students to talk through what is happening to a 1 solar mass star as the star marker moves around the graph.
- Ask students why different initial masses of star lead different life cycles; what are the main differences and happens at the end of these stars lives?

MATERIALS

- Computer with internet
- Star in a Box worksheets

BACKGROUND INFORMATION

- Students should understand what a star is in broad terms before starting this activity.
- Students should be familiar with the concept of hydrogen burning/fusion.
- Students should be familiar with using graphs to display and discern information.
- Teachers can use the Powerpoint presentation provided to give students a full lesson about the life cycle of stars before attempting the activity (available at http://lco.global/education/starinabox).

FULL ACTIVITY DESCRIPTION

Star in a Box app is available at http://starinabox.lco.global

Secondary School Level

Step1

- Open the lid of your 'Star in a Box'.
- The graph is a Hertzsprung-Russell diagram, where a star's luminosity is plotted against its temperature.
- The information panels allow you to compare the Sun with your star. It compares the relative radius, surface temperature, brightness (luminosity) and mass of the star to the Sun.

Step2

The Sun's Evolution during its lifetime.

Click the play button below the Hertzsprung-Russell diagram to show the Sun's evolution.

- Name the three stages of the Sun's life shown on the Hertzsprung-Russell diagram.
    - Stage 1:
    - Stage 2:
    - Stage 3:

Use the table below to describe the changes the Sun will go through between stages.

- Label 'Increase', 'Decrease' or 'Stay the same' for each of the quantities in the table along with the values they change from and to.

	Radius	Luminosity	Temperature	Mass
	. . . Increase	. . . Increase	. . . Increase	. . . Increase
Stage 1 to Stage 2	From: . . . R_{sun} To: . . . R_{sun}	From: . . . L_{sun} To: . . . L_{sun}	From: . . . K To: . . . K	From: . . . M_{sun} To: . . . M_{sun}
	. . . Increase	. . . Increase	. . . Increase	. . . Increase
Stage 2 to Stage 3	From: . . . R_{sun} To: . . . R_{sun}	From: . . . L_{sun} To: . . . L_{sun}	From: . . . K To: . . . K	From: . . . M_{sun} To: . . . M_{sun}

- Look at the light bulb tab:
    - At which stage in its life cycle will the Sun be at its brightest?
    - How old will the Sun be at this point? Myr
- Look at the thermometer tab:
    - At which stage in its lifecycle will the Sun be at its hottest?
    - What is its maximum temperature? K
- Look at the pie chart tab:
    - In which stage of its life will the Sun spend most of its time?
    - How long will it spend in this stage? Myr
- Look at the mass tab:
    - What happens to the mass of the Sun as it gets older?
- What type of star will the Sun be at the end of its life?
- What is the total lifetime of the Sun?

Step3

Using the 'Star Properties' banner, explore the evolution of stars with different starting masses.

- Select a different starting mass for your star in the 'Star Properties' banner.
- Using the Hertzsprung-Russell diagram tab, click play to watch your new stars evolution.
- Try out a few different masses then answer the following questions.
- Using the Hertzsprung-Russell diagram:
- Where on the main sequence do the lower mass stars start?
- Where on the main sequence do the higher mass stars start?
- There are three possible outcomes for the final stage of a stars life depending on its initial mass. Name these 3 possible final stages.

Step4

Follow the evolution of five stars of different masses.

Complete the table below, filling in a row for each of the different masses.
Hint: You may find it easier to use the data table on the 'Star in a Box' to find the exact values.

Mass of Star (M_{sun})	Maximum Radius (R_{sun})	Maximum Luminosity (L_{sun}) (Brightness)	Maximum Temperature (K)	Name of Final Stage	Total Lifespan (Myr)
0.2					
1					
6					
20					
40					

Step5

Study the data for the different stars in your table above.

- Comparing the temperatures:
    - Which mass star reaches the highest temperature?
    - At what stage in its life does the star reach this temperature?
- Comparing the luminosities:
    - Which mass star gets the most luminous (brightest)?
    - Is this the same mass of star that reaches the highest temperature?

Step6

Multiple choice questions. Choose the correct answer.

- What type of star will the Sun become after it leaves the Main Sequence?
    - Neutron Star
    - Red Dwarf
    - Red Giant
    - Red Supergiant
- What main factor determines the stages a star will follow after the main sequence?
    - Mass
    - Luminosity
    - Temperature
    - Radius
- The mass of the star Betelgeuse is much greater than the mass of the Sun; therefore, its total lifetime will be:
    - Greater than the Sun
    - The same as the Sun
    - Less than the Sun
- Compared to when it joins the Main Sequence, a star's mass at the end of its life will:
    - Be greater
    - Be the same
    - Be less
    - Depend on the type of star
- The Sun will spend most of its life in what stage?
    - Main Sequence
    - Red Giant

- Red Dwarf
- White Dwarf

(solutions at: http://goo.gl/tlaEH1)

CURRICULUM

Country	Level	Subject	Exam Board	Section
UK	GCSE	Physics	AQA Science A	Not in current curriculum
UK	GCSE	Physics	Edexcel	P1.3: 11, 12, 13
UK	GCSE	Physics	OCR A	P7.3.8; P7.4: 22-28
UK	GCSE	Physics	OCR B	P2h
UK	GCSE	Physics	WJEC	Physics 3.5: b, c, d, g, j
UK	GCSE	Astrophysics	Edexcel	Unit 1.3: 3o-q, 4a, 4c
UK	A level	Physics	AQA	3.9.2.5
UK	A level	Physics	Edexcel	Topic 10: 159, 160
UK	A level	Physics	OCR A	5.5.1: c, e, g
UK	A level	Physics	OCR B	5.1.3: b, c
UK	A level	Physics	WJEC	Unit 1 6d)
UK	KS3	Physics	-	Space Physics: Our Sun as a Star
UK	KS2: Year 5	Science	-	Earth and Space

ADDITIONAL INFORMATION

- If you would like to know more about how stars evolve, take a look at our SpaceBook pages about the life cycle of stars. http://lco.global/book/life-cycle-stars
- You can also learn more about Hertzsprung-Russell diagram on SpaceBook http://lco.global/book/h-r-diagram
- Questions in the exercise workbook could be made into a multiple choice quiz using a website or an app such as Socrative https://itunes.apple.com/au/app/teacher-clicker-socrative/id477620120?mt=8.

Language version:

The Spanish version of “Star in a Box: High School” translated by Mariana Lanzara, proofread by Pau Ramos and reviewed by Dr. Amelia Ortiz-Gil for the Astronomy Translation Network project. Download the files: http://astroedu.iau.org/media/files/Spanish_Star_in_a_Box_Highschool.zip

CONCLUSION

The activity finishes when the students have completed the worksheets. The teacher should discuss the range of answers the students had for some of the later questions on each worksheet.

CITATION

Gomez, E., 2013, *Star in a Box: High School*, astroEDU, doi:10.11588/astroedu.2013.1.81141