



St. Louis Library Telescope Program

Serving the Greater St. Louis area since 2014



May 2017

Educators and Librarians,

We are excited that you are interested in promoting the science of astronomy in your school and/or library programs.

The SunSpotter Solar Telescope that you have just checked out is both educational and a lot of fun to use. Most telescopes allow only one person at a time to view an image. The SunSpotter Solar Telescope allows several persons to view an image at one time making it ideal for use in programs involving groups. Solar surface features such as sunspots will be displayed on any clear day and along with the progress of the Moon's shadow on the Sun during the partial eclipse phases on August 21, 2017.

In the pages that follow, you will find links to a YouTube Video on how to use the telescope that you can apply in your classroom or library program.

You can help us provide feedback to our donors by providing information about your program audience and what they learned. A program audience census along with pre and post surveys are included in the attachment. Once your program is complete, please use this forms to summarize your program information. It will only take a few minutes to submit the information to us using an online form that we have made available.

If you have questions, please reach out to us at librarytelescope@slasonline.org

#

The St. Louis Library Telescope Program has been serving the Greater St. Louis area since 2014. Our program would not be a success without the cooperation of its many partners.

Many thanks to the executives, staff and patrons of St. Louis area libraries for their enthusiastic support and to amateur astronomers and educators from the [New Hampshire Astronomical Society](#), [St. Louis Astronomical Society](#), [Astronomical Society of Eastern Missouri](#), [Southern Illinois University Edwardsville](#), [Jefferson College](#), [Eastern Missouri Dark Sky Observers](#), [River Bend Astronomy Club](#) and [Southeast Missouri State University](#) for making this program possible.

For more information about the St. Louis Library Telescope Program, visit www.slasonline.org



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RECOMMENDED STEPS

The next page outlines recommended steps to get started with your SunSpotter Solar Telescope. Links to several external websites are referenced in the recommended steps. If the website links in this document do not work, you can visit www.slasonline.org and click "Library Telescope" to get the website links from a webpage. The website links will be under the "Help for Educators" section in the right margin of the page.



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Recommended Steps

STEP 1: Print this PDF which will become a handy guide on using your Sunspotter Solar Telescope. The PDF includes blank forms for you to summarize information about your students and how their knowledge progressed as a result of this program. Reporting this information to us will provide important feedback to our donors.

STEP 2: Before your program, do your homework:

- Learn about the Sunspotter Solar Telescope by reading the instructions on the telescope or by watching our YouTube Video located at <https://youtu.be/wvCWBjMufiw>
- Practice using the Sunspotter Solar Telescope on your own – a great way to have fun!
- Read the suggested activities in the instruction manual provided with the Sunspotter Telescope. The manual includes four activity suggestions which is a great foundation to get started.
- Read the pre and post test materials included in the PDF. Study the instruction version which includes answers. Print enough copies of the student version to administer the test to your students.
- Check <http://www.spaceweather.com> to see if sunspots are present on the Sun. If you can "see" the spot(s) on that small graphic, you should be able to see them on a clear day with this Sunspotter scope. Even at solar minimum there are occasionally some spots that show up (https://en.wikipedia.org/wiki/Solar_minimum). Even if sunspots are not available, students will be fascinated by the image of the Sun and how it moves across the screen.

STEP 3: Schedule and host your program

- Schedule your program
- Before your program, give your students the pre-test provided in this PDF.
- Host your program and have fun!
- After your program, give your students the post-test provided in this PDF.

STEP 4: Provide us with feedback on your program**

- Use the blank forms provided in this PDF to summarize who participated in the program and the number of correct/incorrect responses for both the pre and post tests.
- Report your results electronically to us at:
<https://fs30.formsite.com/eclipse2017/form10/index.html>

** Twelve telescopes in this program were funded by a grant from the American Astronomical Society's National Science Foundation award to promote eclipse awareness. Our donors have asked for feedback on the audiences served by this program and what they learned. Your help in providing feedback is important and will help us make a case for future funding.



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PRE AND POST PROGRAM STUDENT QUESTIONNAIRE STUDENT VERSION

The next pages provide pre and post test program student questionnaires based on grade levels. Select the test that matches the grade level of the students that are in your program.



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PRE AND POST PROGRAM STUDENT QUESTIONNAIRE Grades K – 3

1. What is the name of the closest star to the Earth?
2. Which is bigger – the Earth or the Sun?
3. Whichever is bigger: is it a little bit bigger, a whole bunch bigger, or a humongous amount bigger?
4. What are the dark patches on the Sun's surface called? Could you see any with the telescope?
5. What is an eclipse?
6. What kind of eclipse will happen on August 21, 2017?
7. Name one thing that will happen in the sky during a total eclipse of the Sun.
8. Is it safe to look directly at the Sun with just your eyes during a total solar eclipse?
9. Is it safe to look directly at the Sun with just your eyes during a partial solar eclipse – the time when part of the bright surface of the Sun is visible?
10. Did the Sun stay in view through the telescope? If it moved, why did it move?



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PRE AND POST PROGRAM STUDENT QUESTIONNAIRE

Grades 4 – 6

1. What is the closest star to the Earth?
2. When does a total eclipse of the Sun happen?
3. When does a total eclipse of the Moon happen?
4. Does an eclipse happen every month? If not, why not?
5. The Sun is really much bigger than the Moon. Then why can the Moon cover up the Sun in the sky?
6. Could you see anything on the surface of the Sun when you were using the telescope? If so, what things did you see?
7. Why is the August total solar eclipse visible from some parts of Missouri, but not visible in other parts?
8. Is it safe to look directly at the Sun with just your eyes during a total solar eclipse?
9. Is it safe to look directly at the Sun with just your eyes during a partial solar eclipse – the time when part of the bright surface of the Sun is visible?
10. Did the Sun stay in view through the telescope? If it moved, why did it move?



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PRE AND POST PROGRAM STUDENT QUESTIONNAIRE Middle School

1. What part of the Sun can you see, using just your eyes, only during a total eclipse of the Sun?
2. That outer part of the Sun is much hotter than the surface of the Sun – so why is it so much fainter than the surface. (Hotter objects in the sky are usually brighter than cooler objects.)
3. What phase is the Moon during a solar eclipse?
4. Why doesn't an eclipse happen every month, when the Moon is in that phase?
5. Most people have seen at least one total lunar eclipse. Why have fewer people ever seen a total solar eclipse?
6. Sometimes the Moon lines up with the Sun and the Earth, but the Moon's shadow is too small to cover the entire Sun. What is that kind of eclipse called? Why is the Moon's shadow smaller during that kind of eclipse than it is during a total solar eclipse?
7. Could you see any of the Sun's surface features with the telescope? If so, what were they?
8. Is it safe to look directly at the Sun with just your eyes during a total solar eclipse?
9. Is it safe to look directly at the Sun with just your eyes during a partial solar eclipse – the time when part of the bright surface of the Sun is visible?
10. Did the Sun stay in view through the telescope? If it moved, why did it move?



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PRE AND POST PROGRAM STUDENT QUESTIONNAIRE High School

1. Why does a sunspot look black?
2. Does a sunspot stay in the same position, as seen through the telescope, from one day to the next? Why?
3. What makes the Sun shine – where does it get its energy from?
4. If the Moon's shadow will be traveling at about 1400 miles per hour through Missouri during the total eclipse of the Sun in August, and if the shadow will be about 65 miles wide, how long will the total phase of the eclipse last, as seen from the ground at the center line of the eclipse?
5. Why doesn't an eclipse of the Sun occur every month?
6. The August 21 solar eclipse will be the first total solar eclipse visible from St. Louis in
 - a. 25 years
 - b. 52 years
 - c. 76 years
 - d. 148 years
 - e. Over 500 years
7. Why does the image of the Sun seen with the solar telescope drift out of view in just a few minutes?
8. Is it safe to look directly at the Sun with just your eyes during a total solar eclipse?
9. Is it safe to look directly at the Sun with just your eyes during a partial solar eclipse – the time when part of the bright surface of the Sun is visible?
10. The Moon is slowly moving away from the Earth (about 1.5 inches per year). Tens of millions of years in the future, will total solar eclipses be more frequent or less frequent? Why?



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PRE AND POST PROGRAM STUDENT QUESTIONNAIRE ANSWER SHEET AND COMMENTS

The next pages provide pre and post test program student questionnaires with the answer sheet and comments. Answers are provided in larger type. Additional comments and information in italics.



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ANSWER SHEET AND COMMENTS

Grades K – 3

1. What is the name of the closest star to the Earth?
the Sun. *The Sun looks much bigger and feels much hotter than stars in the night sky only because the night stars are so far away.*
2. Which is bigger – the Earth or the Sun?
the Sun
3. Whichever is bigger: is it a little bit bigger, a whole bunch bigger, or a humongous amount bigger?
humongous amount. *The Sun has more than a million times the volume of the Earth. So more than a million Earths would fit inside the Sun.*
4. What are the dark patches on the Sun's surface called? Could you see any with the telescope?
Sunspots. Sunspots are often visible with the telescope, but not always. *It depends upon both whether there are large spots on the side that faces Earth and whether the Earth's air is clear and steady enough. The sunspots themselves last for weeks, but they could be visible one day and not the next.*
5. What is an eclipse?
An eclipse happens when one large body in the sky lines up with another large body, as seen from Earth. An eclipse of the Sun happens when the Sun, Moon and Earth are in a straight (or nearly straight) line. An eclipse of the Moon happens when the Sun, Earth, and Moon are in a straight (or very nearly straight) line. When the Moon moves into the Earth's shadow, there is a lunar eclipse until the Moon moves out of the Earth's shadow.
6. What kind of eclipse will happen on August 21, 2017?
A solar eclipse will be visible from North and South America. It will be a partial solar eclipse as seen from most of these continents. It will be a total solar eclipse as seen from a path only about 65 miles wide. *The total eclipse begins in the Pacific Ocean, hits the land in Oregon, and passes through twelve states, including Missouri, before it moves into the Atlantic Ocean. So the eclipse path is very long but very narrow.*
7. Name one thing that will happen in the sky during a total eclipse of the Sun.
Some answers: the black disk of the Moon will cover up the bright surface of the Sun. The corona (outer atmosphere) of the Sun will appear.



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The sky will get dark (like a deep twilight). Planets and bright stars will appear.
The air will get cooler. Wind may change direction.
Animals will think that night is coming because the sky gets dark.

8. Is it safe to look directly at the Sun with just your eyes during a total solar eclipse?

Yes! But only during the total eclipse – when the Moon has completely covered up the bright visible surface of the Sun.

9. Is it safe to look directly at the Sun with just your eyes during a partial solar eclipse – the time when part of the bright surface of the Sun is visible?

No! It will hurt your eyes if you look directly at any part of the bright surface of the Sun. During the partial phase of the eclipse, part of the bright surface still shines. You can hurt your eyes looking at the Sun, even if you do not feel any pain. *There are invisible rays (infrared and ultra-violet) that can scar the retina of the eye. Because there are no nerve cells in the retina, there is no pain, but there is damage to the retina.*

10. Did the Sun stay in view through the telescope? If it moved, why did it move?

The Sun moved out of view in just two minutes or so. That happens because the Earth is turning – once around per 24 hour day. *As the Earth turns west to east, it looks to us as if the Sun is moving east to west. The Earth is so big and the motion is so slow that we do not feel it move.*



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ANSWER SHEET AND COMMENTS

Grades 4 – 6

1. What is the closest star to the Earth?
the Sun
2. When does a total eclipse of the Sun happen?
A total eclipse of the Sun happens when the Sun, the Moon, and the Earth are in a straight (or almost straight) line as seen from outer space.
3. When does a total eclipse of the Moon happen?
A total eclipse of the Moon happens when the Sun, the Earth, and the Moon are in a straight (or almost straight) line, as seen from outer space.
4. Does an eclipse happen every month? If not, why not?
No. The Moon's path around the Earth is slanted a little bit from the Earth's path around the Sun. The slant can cause the Moon to be a little bit above or a little bit below the Sun-to-Earth line. *If the Moon is above or below the line, its shadow misses the Earth for a solar eclipse. If the Moon goes above or below the Earth's shadow, there is no lunar eclipse.*
5. The Sun is really much bigger than the Moon. Then why can the Moon cover up the Sun in the sky?
Because the Moon is much closer to Earth than the Sun is. The farther away something is, the smaller it looks. *The Moon is pretty far away – usually about 240,000 miles. But the Sun is much farther – about 93 million miles. About 400 times the Moon's distance.*
6. Could you see anything on the surface of the Sun when you were using the telescope? If so, what things did you see?
You may have been able to see dark places on the Sun's surface. They are called sunspots. *They are places on the Sun that are a little cooler which makes them darker.*
7. Why is the August total solar eclipse visible from some parts of Missouri, but not visible in other parts?
The total eclipse is visible only where the Moon's dark shadow touches the ground. For this eclipse, the shadow is only about 65 miles wide. If you are outside the shadow path, you will see only a partial eclipse – part of the Sun will still be visible.
8. Is it safe to look directly at the Sun with just your eyes during a total solar eclipse?



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Yes! But only during the total eclipse – when the Moon has completely covered up the bright visible surface of the Sun.

9. Is it safe to look directly at the Sun with just your eyes during a partial solar eclipse – the time when part of the bright surface of the Sun is visible?

No! It will hurt your eyes if you look directly at any part of the bright surface of the Sun. During the partial phase of the eclipse, part of the bright surface still shines. You can hurt your eyes looking at the Sun, even if you do not feel any pain. *There are invisible rays (infrared and ultra-violet) that can scar the retina of the eye. Because there are no nerve cells in the retina, there is no pain, but there is damage to the retina.*

10. Did the Sun stay in view through the telescope? If it moved, why did it move?

The Sun moved out of view in just two minutes or so. That happens because the Earth is turning – once around per 24 hour day. *As the Earth turns west to east, it looks to us as if the Sun is moving east to west. The Earth is so big and the motion is so slow that we do not feel it move.*



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ANSWER SHEET AND COMMENTS

Middle School

1. What part of the Sun can you see with just your eyes only during a total eclipse of the Sun?
The corona – the outer atmosphere of the Sun.
2. That part of the Sun is much hotter than the surface of the Sun – so why is it so much fainter than the surface. (Hotter objects in the sky are usually brighter than cooler objects.)
The corona is made of very hot but very thin (*low density – very few particles compared to the surface*) gas particles. (*The particles are ions – atoms with electrons removed.*) The corona is dim because there are so few particles present.
3. What phase is the Moon during a solar eclipse?
new moon
4. Why doesn't an eclipse happen every month, when the Moon is in that phase?
The Moon's path around the Earth is slanted a little bit from the Earth's path around the Sun. The slant can cause the Moon to be a little bit above or a little bit below the Sun-to-Earth line. If the Moon is above or below the line, its shadow misses the Earth for a solar eclipse. If the Moon goes above or below the Earth's shadow, there is no lunar eclipse.
5. Most people have seen at least one total lunar eclipse. Why have fewer people ever seen a total solar eclipse?
When a lunar eclipse occurs, it can be seen by anyone who can see the Moon – anyone on the night side of the Earth. *This is because the Earth's shadow is very large – much wider than the surface of the Moon- so the whole Moon fits easily into the Earth's shadow.* The Moon's shadow is much smaller, because the Moon is much smaller. When it reaches the Earth's surface, it is always less than two hundred miles wide. A total solar eclipse can only be seen from within that narrow Moon shadow. From any spot on Earth, on average, the Moon's shadow will only pass over about once every 375 years.
6. Sometimes the Moon lines up with the Sun and the Earth, but the Moon's shadow is too small to cover the entire Sun. What is that kind of eclipse called?
an annular solar eclipse
Why is the Moon's shadow smaller during that kind of eclipse than it is during a total solar eclipse?



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The Moon is slightly farther away during an annular eclipse than it is during a total eclipse. *This happens primarily because the Moon's orbit around the Earth is not a perfect circle – it is somewhat elliptical. During an annular eclipse, the Moon is in the more distant part of its orbit.*

7. Could you see any of the Sun's surface features with the telescope? If so, what were they?

You may have been able to see dark places on the Sun's surface. They are called sunspots. They are places on the Sun that are cooler than the rest and that makes them look darker.

8. Is it safe to look directly at the Sun with just your eyes during a total solar eclipse?

Yes! But only during the total eclipse – when the Moon has completely covered up the bright visible surface of the Sun.

9. Is it safe to look directly at the Sun with just your eyes during a partial solar eclipse – the time when part of the bright surface of the Sun is visible?

No! It will hurt your eyes if you look directly at any part of the bright surface of the Sun. During the partial phase of the eclipse, part of the bright surface still shines. You can hurt your eyes looking at the Sun, even if you do not feel any pain. *There are invisible rays (infrared and ultra-violet) that can scar the retina of the eye. Because there are no nerve cells in the retina, there is no pain, but there is damage to the retina.*

10. Did the Sun stay in view through the telescope? If it moved, why did it move?

The Sun moved out of view in just two minutes or so. That happens because the Earth is turning – once around per 24 hour day. As the Earth turns west to east, it looks to us as if the Sun is moving east to west. *The Earth is so big and the motion is so slow that we do not feel it move.*



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ANSWER SHEET AND COMMENTS

High School

1. Why does a sunspot look black?

A sunspot is a slightly cooler region of the Sun's surface. It is usually about 8,000°F rather than 11,000°F. In general, the hotter the gas, the brighter the gas. So the cooler region is comparatively dimmer than the rest of the surface – and it appears to be dark by contrast. *If a sunspot could be placed in the night sky, it would outshine the Moon.*

2. Does a sunspot stay in the same position, as seen through the telescope, from one day to the next? Why?

A sunspot will move slightly from day to day, because the Sun is slowly turning. The Sun takes about 25 days for its equatorial region to rotate once. *At the highest latitudes, at which sunspots can sometimes appear, it takes the Sun about 31 days to spin once. The differing rates can happen because the Sun is a gas, not a solid body.*

3. What makes the Sun shine – where does it get its energy from?

The Sun's energy source, now and for most of its life cycle, is the nuclear fusion of hydrogen into helium in the Sun's core. *In a series of steps, four hydrogen ions are converted into one helium ion. The helium ion is slightly less massive than the four hydrogen ions. The "missing" mass has been converted to energy, as described by Einstein's $E=mc^2$ equation. A small amount of mass is converted into a large amount of energy. Each second, 600 million tons of hydrogen fuses into 596 million tons of helium. 4 million tons of matter are converted to energy. That energy heats up the rest of the Sun, and makes the Sun shine.*

4. If the Moon's shadow will be traveling at about 1400 miles per hour through Missouri during the total eclipse of the Sun in August, and if the shadow will be about 65 miles wide, how long will the total phase of the eclipse last, as seen from the ground at the center line of the eclipse?

About 2.8 minutes, by this rough calculation.

The eclipse is total at any spot while any part of the Moon's dark shadow is on the ground. So the eclipse duration will be the time it takes the width of the shadow to pass over the spot.

Distance = rate x time. So time = distance/rate. 65 miles (distance from one edge of the Moon's shadow to the opposite edge) divided by 1400 mph = 0.046 hour x 60 minutes per



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hour = 2.8 minutes or 2 minutes 48 seconds. (The “real” duration is 2 minutes 40 seconds.)

5. Why doesn't an eclipse of the Sun occur every month?

The Moon's path around the Earth is tilted by about a 5° angle from the Earth's path around the Sun. The 5° slant can cause the Moon to be a little bit above or a little bit below the Sun-to-Earth plane. If the Moon is above or below the plane, its shadow misses the Earth for a solar eclipse. *If the Moon goes above or below the Earth's shadow, there is no lunar eclipse.*

6. The August 21 solar eclipse will be the first total solar eclipse visible from St. Louis in

(a) 25 years (b) 52 years (c) 76 years (d) 148 years (e) over 500 years

(e) over 500 years. *The last one visible from what is now the city of St. Louis occurred on July 7, 1442.*

7. Why does the image of the Sun seen with the solar telescope drift out of view in just a few minutes?

The drift is caused by the rotation of the Earth. The Earth turns from west to east. This makes the Sun appear to move through the sky from the east to the west. The Earth is so large and the motion is so slow – once per 24 hours – that we do not feel the Earth moving. It looks to us like the Sun is moving. The telescope not only magnifies the image of the Sun, but it also magnifies the Earth's rotation. So the Sun drifts out of the telescope's field of view because the Earth is slowly turning, pointing in a direction slightly east of where it pointed before.

8. Is it safe to look directly at the Sun with just your eyes during a total solar eclipse?

Yes! But only during the total eclipse – when the Moon has completely covered up the bright visible surface of the Sun.

9. Is it safe to look directly at the Sun with just your eyes during a partial solar eclipse – the time when part of the bright surface of the Sun is visible?

No! It will hurt your eyes if you look directly at any part of the bright surface of the Sun. During the partial phase of the eclipse, part of the bright surface still shines. You can hurt your eyes looking at the Sun, even if you do not feel any pain. *There are invisible rays (infrared and ultra-violet) that can scar the retina of the eye. Because there are no nerve cells in the retina, there is no pain, but there is damage to the retina.*



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10. The Moon is slowly moving away from the Earth (about 1.5 inches per year). Tens of millions of years in the future, will total solar eclipses be more frequent or less frequent? Why?

Less frequent. The Moon's average distance from the earth will increase. Consequently, its shadow on the surface of the Earth will be smaller. *Total eclipses will be able to occur only when the Moon is somewhat nearer to its closest point to the Earth (called "perigee") than is the case now. More annular eclipses will occur.*



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DATA COLLECTION FORM

The next pages provide forms that where you can summarize information about your program including information about:

- Your school
- Your library (where you checked out the telescope)
- Your class or program audience
- Your count of student correct/incorrectly responses to each question for both the pre and post tests.
- Your feedback on the program

We really appreciate your cooperation in providing this data to us. It provides important feedback to our donors.



St. Louis Library Telescope Program

The information requested below is intended to improve the program and to supply information stipulated in the American Astronomical Society/National Science Foundation grant proposal. The grant supported purchase of the telescope and other educational materials.

We greatly appreciate your cooperation in completing this survey!

The St. Louis Library Telescope Program

Validation Code:

Please enter the validation code that you found on the telescope. The validation code helps us verify that you checked out a telescope to complete this program. *

Information on your school:

School: *

Street Address *

Address Line 2

City *

State *

▼

Zip Code *

Information about your library

Please tell us the library location where you checked out the telescope: *

Information about your class or program audience:

Grade levels *

- K 1 2 3 4 5 6
 7 8 9 10 11 12

The number of students participating in the program: *

Students

Total	<input type="text"/>
Girls	<input type="text"/>
Boys	<input type="text"/>
African-American	<input type="text"/>
Hispanic	<input type="text"/>
Native American	<input type="text"/>
Disability	<input type="text"/>

Pre and Post Test Analysis

Please tell us how many students responded correctly/incorrectly to each question for both the pre-test and post-test: *

5. Students were interested in using the telescope						
6. Use of the telescope fit into the curriculum or extended the curriculum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Activities provided were useful	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. The checkout and return processes were quick	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. The length of time for the telescope loan was sufficient	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. I would recommend the Solar Telescope Program to my colleagues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If you have comments about the program, and particularly suggestions for changes and improvements, please indicate them here:

Additional information and activities (optional):

If you would like to receive additional information and activities as they become available, please provide an e-mail address. It will not be used for other purposes or for communications other than those related to Saint Louis Astronomical Society education programs. These are planned to be very low volume communications. Your Email address (optional):

Submit

You can find information related to the August 21, 2017 total solar eclipse at: www.stlouiseclipse2017.org

You can contact us directly with questions or comments at: publicity@slasonline.org or info@stlouiseclipse2017.org

Thank you for your participation in the Solar Telescope Library Program.