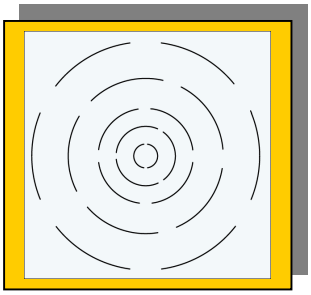
The Sun and Solar Wind: A Search for the Beginning

Photons in the Radiative Zone: Which Way is Out? An A-Maz-ing Model

TEACHER GUIDE

BACKGROUND INFORMATION



Students try to work their way out of a circular maze, thereby modeling the movement of a photon as it travels through the **radiative zone** of the sun. Classroom discussion after they complete the activity is focused on the Standard Solar Model and its importance in further scientific studies of the sun.

STANDARDS ADDRESSED

Grades 5-8

Science As Inquiry
- Understandings about scientific inquiry

Science and Technology
- Understandings about science and technology

Physical Science
- Properties and changes of properties in matter
- Transfer of energy

History and Nature of Science
- Science as a human endeavor
- Nature of science and scientific knowledge
- History of science and historical perspectives

Grades 9-12

Science As Inquiry
- Understandings about scientific inquiry

Science and Technology
- Understandings about science and technology

Earth and Space Science
- The origin and evolution of the Earth system

Physical Science
- Properties and changes of properties in matter
- Transfer of energy

History and Nature of Science
- Science as a human endeavor
- Nature of science and scientific knowledge
- History of science and historical perspectives

MATERIALS

For each student (or pair of students)
- Copy of Student Activity "Photons in the Radiative Zone: Which Way is Out?"
- A protractor
- A straight edge
- Copy of "Standard Model of the Sun"
- Copy of Student Text "Models in Science"

PROCEDURE

1. Before class, make copies of the Student Activity, "Photons in the Radiative Zone: Which Way is Out?" If you have not already done so, makes copies of the Handout "Standard Model of the Sun" and Student Text, "Models in Science".

2. Group the class into pairs. Hand the first two pages (the instructions and the maze) of Student Activity "Photons in the Radiative Zone: Which Way is Out?" to each student or each pair of students. Instruct them to complete the maze in pencil, since they may wish to make more than one try at the problem.

   Tell them to follow the instructions at the top of the page. They should draw only straight lines until they run into a barrier. At this point, they should use a protractor to determine the angle at which the line away from the barrier should be drawn. The angle of reflection should equal the angle of incidence. Again, the line of reflection should be drawn using a straight edge. The goal of the assignment is to find a way out of the maze.

Alternative Strategy Tips

Prepare "black boxes" for each group of students by placing a small, unbreakable object in a box and sealing it. Using their senses, students observe the object, determining whether or not:
- a) it is heavy,
- b) it rolls or slides,
- c) it has an odor, etc.

They must decide what is in the box on the basis of their observations.

Electric circuit black boxes can also be constructed with light bulbs mounted on top. Students are challenged to determine the types of circuits connecting the bulbs.

3. Ask one student in each group to record the problem-solving processes they used to work their way out of the maze. They should record whether or not the process was successful and why it was or was not.

   They may begin to wonder whether or not it is possible to work their way out of the maze. Assure them that there are a number of ways to do this.

4. When they have worked their way out of the maze (or you have called time), bring them back together for a general class discussion. Have each group report to the class the successful and unsuccessful problem-solving processes they tried as they completed the assignment.

5. Tell students to review the Student Text "Modeling the Sun" before the next class period.

6. Review the characteristics and the purpose of a good scientific model from the previous class discussion on models and follow this with questions similar to the following:
   a. In the maze model that you worked on
      i. What do the holes model?
      ii. What do the lines model?
      iii. Why is the maze circular?
      iv. In what way(s) is the maze a good model for the path of a photon in the radiative zone of the sun?
      v. In what way(s) is this model not accurate?

Alternative Strategy Tips

Have students do the following calculations:

1. How long would it take a photon, starting at the center of the sun's core and traveling at the speed of light, to reach the sun's surface, a distance of 7×10^5 Km, if it did not collide with electrons or any other particles?

2. Using a ratio, compare the length of time a proton *actually* stays in the sun compared to the direct route time you calculated in #1 above.

b. Critique this model of the sun's radiative zone. Was it a good model, an adequate model, or a poor model? Defend your rating of the model.

c. Based on the students' list of criteria, devise a list of criteria for a good model of photon movement in the sun's radiative zone.

d. Divide the class into teams of four students to design another, perhaps better, model for the path of a photon in the radiative zone of the sun.

e. Have each team make an illustrated oral presentation of its model. The presentations can be evaluated either by other class members or by you, using the criteria developed by the class.