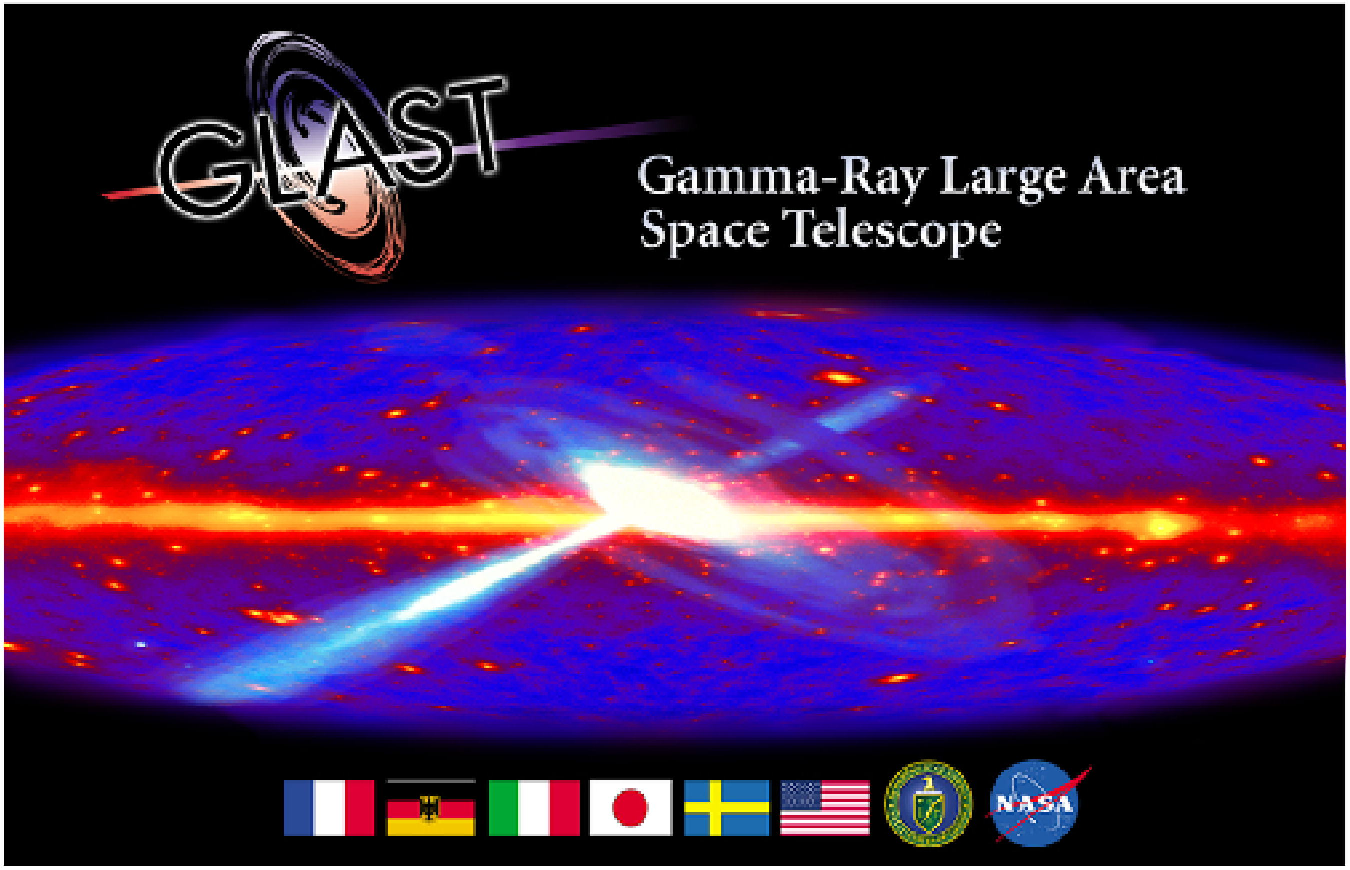


Mission

The Gamma-ray Large Area Space Telescope (GLAST) is an international satellite mission dedicated to understanding the most powerful particle accelerators in the Universe. It will begin a new epoch in space-based physics investigation.

GLAST will:

- explore the extreme environments of super massive black holes, neutron stars, and gamma-ray bursts.
- explore the era of star formation in the universe, the physics of dark matter and the creation and evolution of galaxies.
- be launched in 2006.

Education & Public Outreach Program

Gamma-ray astronomy is an exciting field for the public as well as the researcher. Both young and old can be engaged by the exotic concepts of black holes and violent explosions seen across the Universe. Here's what you can expect from us in the near future:

• GLAST Ambassadors Program
- -work with us for the entire mission lifetime
- - selected via nation-wide application process
- - applications due 8/1/01

• development of cutting edge curriculum materials for the Grades 9-12 classroom
- - download materials free from the Web
- - inquiry-driven, interactive Web explorations
- - request printed copies

• educator workshops presented by GLAST scientists
- - every year at NSTA and NCTM

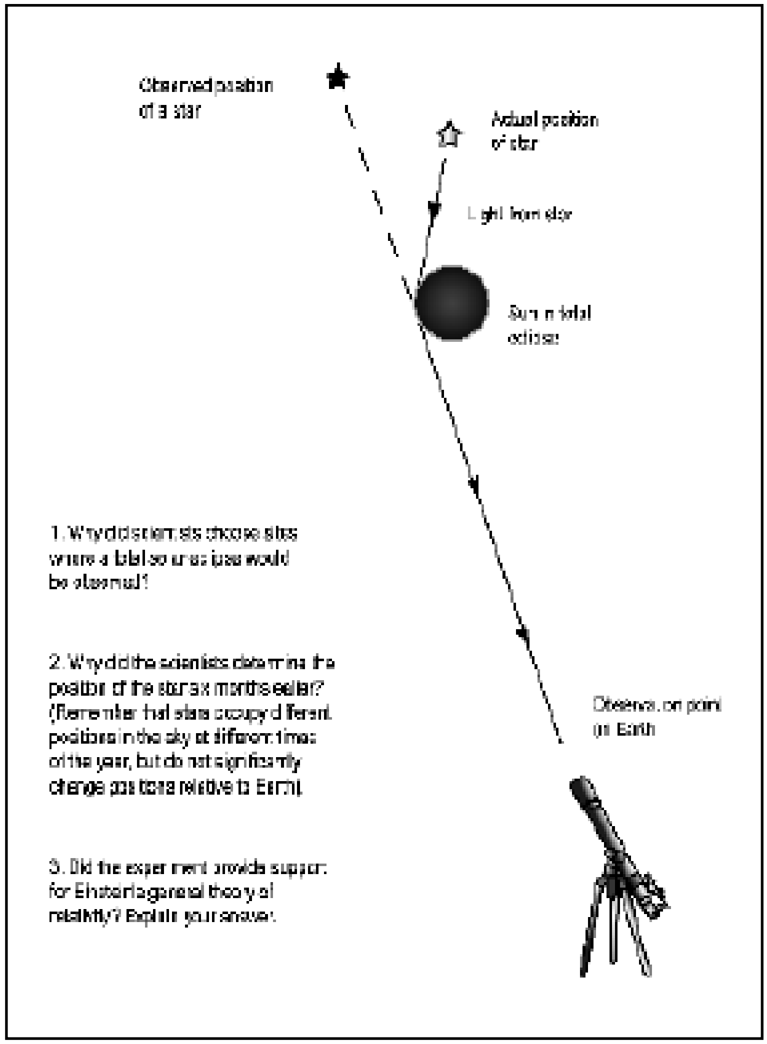
• low-cost, hands-on curriculum modules created by TOPS, Inc.

• PBS program on gamma-ray bursts, birth of black holes, and powerful jet formation in the Universe

Keep track of all this and find the materials at
http://www-glast.sonoma.edu

Inquiry-Based Science... circa 1919?

In 1915, Albert Einstein published an article in which he outlined his general theory of relativity. Amongst its many predictions was that light should be deflected by a gravitational field. This idea, certainly radical at the time, seemed impossible to detect. However, scientists at the Royal Astronomical Society of London soon proposed an experiment that they believed would test Einstein's prediction. The experiment was performed on March 29, 1919 at two separate locations: in northern Brazil and on an island off the west coast of Africa. On that day, at those sites, a total eclipse of the Sun was observed. The drawing to the right shows the position of the star as seen during the eclipse and the actual position of the star as had been established six months earlier. Study the drawing (exaggerated for clarity) and then answer the questions shown.



Answers:
1. During a total eclipse the sky would be dark and the stars could be observed. The light from some of the visible stars would pass close to the Sun.
2. If the star was visible in the sky during the day in March, six months earlier it was visible in the night sky. Since the position of stars relative to Earth remains essentially constant, determining the position of the star during the night (six months earlier) provided the scientists with valid data about the star's actual position.

So, You Want to be a Black Hole?

In theory, any object can become a black hole - as long as it can get small enough! For example, a person weighing 70 kg can become a black hole... if that person had the same mass, but was much, much smaller than the size of a hydrogen atom! The equation (Schwarzschild equation) that defines this relationship of the event horizon radius to the mass of the black hole is

$$R = 2GM/c^2$$

(Where R= radius, M=Mass, G= Gravitational constant and c= speed of light).

Using this equation, and substituting 70 kg for the mass of a person, we calculate $R=2*(6.67\times10^{-11})*70/((3\times10^8)^2)=1.04 \times 10^{-25}$ meters as the radius for an average-sized person to become a black hole.

Compare this to the size of a hydrogen atom: 1×10^{-11} meters!

1. What would be the size of the event horizon for the mass of the Sun? Or the mass of the Earth? ____________________________

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2. How much mass would an object the size of a basketball have to have in order to be a black hole? Assume its diameter to be 35 cm.

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Answers: In the following exercises, we need to know that: $G=6.67\times10^{-11}$ m^3/kg-sec^2 and $c = 3\times10^8$ m/sec

1. Using the Schwarzschild equation, we input the mass of Jupiter (1.9×10^{27} kg) to see that the radius of a Jupiter-mass black hole would occur at 2.82 meters. Substituting the mass of Earth (5.97×10^{24} kg) we calculate the radius of an Earth-mass black hole to be 8.8×10^{-3} meters.
2. We would solve for M in the Schwarzschild equation to find $M = c^2 R/2G$. If the radius of the basketball is 17.5 cm, the necessary mass to be a black hole is 1.18×10^{26} kg. This is approximately the mass of Neptune!