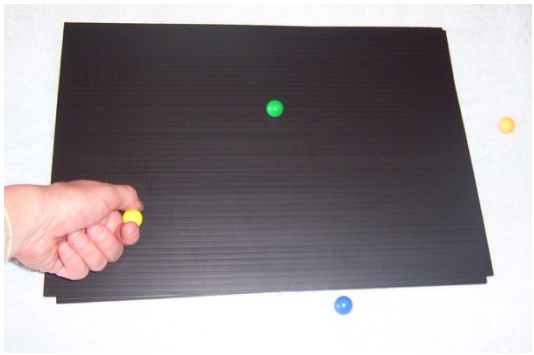
Where are the Black Holes?

How we know black holes are there?

Topics Covered

- How we know black holes are there: How scientists are finding them
- Making it real in the night sky: pointing out the locations of known black holes



Materials Needed

- 2 - 11" x 16" (28 cm x 40 cm) sheets of black signboard
- **Magnetic** marbles
- 2 small cylindrical magnets
- Optional: thin blanket or towel

About the Activity

Using magnets and magnetic marbles, demonstrate the effect black holes have on nearby stars.
You may want to use the demo as an introduction to observing of location of black holes in the night sky. You can find star maps with the locations of black holes here:
http://bit.ly/wherebh

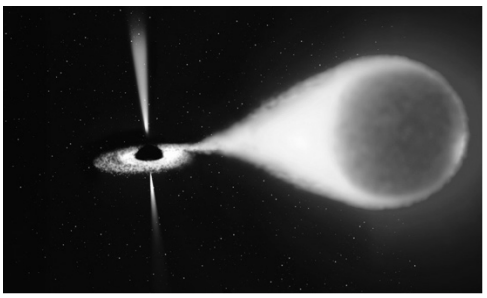
Participants

Adults, teens, families with children 6 years and up
If a school/youth group, ages 8 and higher
From one person to fifteen participants

Location and Timing

- Pre-Star Party: As an introduction to observing the locations of black holes.
- Scout troop or classroom: Form teams of 8 to 10 people and provide each team with a set of materials.
- Club Meeting, Science Fair, or Science Museum: Set up a table to do the demonstration.

Included in This Packet	Page



Set Up:

- Punch 3 or more holes in one of the signboards, about the same size as the small cylindrical magnets.

- Insert one of the small cylindrical magnets into one of the holes in the signboard sheet with the holes – you may want to place a strip of tape on the underside of the sheet under each hole so the magnets don't slip out.

- Place the other signboard sheet over the sheet with the magnet in it.

- This MUST be on a level surface. It is helpful to have a thin blanket or towel underneath it to keep the marbles from rolling too far. You might want to place the boards inside a large box lid to keep the marbles from rolling away.

- If working with children, we suggest that you use one magnetic marble and pass it from one child to the next. If working with teens or adults, each participant can have their own marble.

Detailed Activity Description

Leader's Role	**Participants' Roles**
Introduction – Search for the Black Holes	
To Say: Where are the black holes in our galaxy? How do scientists find them?	Shrugs, uncertain
To Do: (Point to the signboard sheet)	
To Say: This is space – we are surrounded by space and this is just one very small section. These are magnetic marbles and we're going to use them to explain the force of gravity. Magnetism is an invisible force, just like gravity, but they are different kinds of forces. Gravity is a force that always attracts an object toward another object. Magnets sometimes pull together and sometimes push each other apart. So we are just using magnets as a model for gravity when the marbles attract each other.	Take marble
(Place one magnetic marble somewhere on the sheet.)	Star goes into orbit Star is deflected
To Say: This is a star in space. What happens to this star when another star goes nearby?	No.
To Do: (Roll a few marbles past the star and ask how the two stars are affected. Have other participants roll their marble past the star.)	Shrugs – Black holes are black! Roll marbles!
To Say: There is another smaller, but more powerful magnet representing a black hole somewhere in this field. Can you see the black hole? Just like out in space we can't see the black hole. Why can't we see it? Black holes don't give off any light! How will we find the black hole – how will we know it is there?	

Leader's Role	**Participants' Roles**
To Say: Some marbles will "orbit" and be captured and some will roll by the black hole but be deflected. This is one way scientists find them – by seeing the effects on a star or stars in the vicinity of a black hole. You noticed how some of the stars whirled around the black hole. Gas whirling around a black hole heats up to very high temperatures, and gives off hot x-ray radiation. As the material orbits closer and closer, it moves faster and faster, heating up to millions of degrees. Sometimes fast-moving jets of material are streaming off the black hole. – Telescopes in space, like NASA's Chandra X-Ray telescope, can detect these high temperature X-rays emanating from a small area of space. Future NASA missions are being developed to look for more black holes and to try to determine why these jets occur, what happens to that material that falls into a black hole, and what actually happens to space – and time – very near a black hole.	Continue to roll marbles to find the black hole
Transitioning from the activity to observing locations of black holes in the night sky: <u>*To Say:*</u> Here is a star map that shows the locations of known black holes. Let's place the black hole location on the star map over the location of the black hole in space here. (Place the star map on the top board, centering one of the black holes over one of the strong magnets). Now let's roll one of the marbles toward this black hole. Yes, sure enough – there is a black hole there! *(Optional)* Let's see where that is in the sky….	Roll marble to find the black hole

Helpful Hints

Demonstrate to your visitors how to roll the marbles across "space" – give the marble enough of a push to roll across the sheet. If your visitors roll the marbles too slowly, they will wobble around due to the magnet in the middle.

If you are working with children under the age of 14, we recommend that you only use one or two magnetic marbles and pass them from child to child, instead of giving everyone a marble. This way, you are more likely to keep their attention and less likely to lose your marbles.

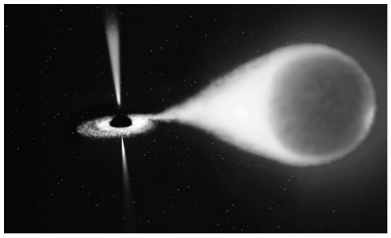
CAUTION! Small children are likely to mistake the marbles for candy and try to put them in their mouths.

Background Information

There will be nothing to see at the locations of black holes in the sky. Their companion stars and parent galaxies are too dim to see with the unaided eye. But seeing the location in a constellation makes the existence of black holes real to your visitors.

As for telescope viewing of black hole locations, the parent galaxies of the supermassive black holes are certainly visible in the telescope (under the right skies). And, if it is July through December, the globular cluster M15, which harbors a mid-mass black hole, is visible in the scope. Cygnus X-1's companion star (visible in the evening June through mid-December) is really the only one visible in backyard telescopes, at a visual magnitude of 9.

BLACK HOLE FAQ's



1. **What is a black hole?** A black hole is a region of space that has so much mass concentrated in it that there is no way for a nearby object to escape its gravitational pull. There are three kinds of black hole that we have strong evidence for:
    a. Stellar-mass black holes are the remaining cores of massive stars after they die in a supernova explosion.
    b. Mid-mass black hole in the centers of dense star clusters
    c. Supermassive black holes are found in the centers of many (and maybe all) galaxies.
2. **Can a black hole appear anywhere?** No, you need an amount of matter more than 3 times the mass of the Sun before it can collapse to create a black hole.
3. **If a star dies, does it always turn into a black hole?** No, smaller stars like our Sun end their lives as dense hot stars called white dwarfs. Much more massive stars end their lives in a supernova explosion. The remaining cores of only the *most* massive stars will form black holes.
4. **Will black holes suck up all the matter in the universe?** No. A black hole has a very small region around it from which you can't escape, called the "event horizon". If you (or other matter) cross the horizon, you will be pulled in. But as long as you stay outside of the horizon, you can avoid getting pulled in if you are orbiting fast enough.
5. **What happens when a spaceship you are riding in falls into a black hole?** Your spaceship, along with you, would be squeezed and stretched until it was torn completely apart as it approached the center of the black hole.
6. **What if the Sun became a black hole without gaining or losing any mass?** The Sun can't turn into a black hole, but if it did, the Earth would get very dark and very cold. The Earth and the other planets would not get sucked into the black hole; they would keep on orbiting in exactly the same paths they follow right now.
7. **Is a black hole a portal ("wormhole") to another part of the universe?** In some science fiction shows, people sometimes travel through wormholes. This leads many people to think black holes are wormholes and therefore lead to other places. There is no evidence that wormholes exist.
8. **Can I see a black hole?** No. The light produced or reflected by objects makes them visible. Since no light can escape from a black hole, we can't see it. Instead, we observe black holes indirectly by their effects on material around them.
9. **What evidence is there that black holes exist?** Fast-moving stars orbiting "unseen" objects and strong X-rays emitted from a very small area of space. NASA missions and projects are in the process of discovering more about black holes.

For more info: http://cfa-www.harvard.edu/seuforum/blackholelanding.htm