

Black hole explorer



Rules of the Game

Overview

You are going to build a spaceship to fly close enough to a black hole to study it, and be the first back with scientific discoveries that could win you a Nobel Prize! But travelling too close could leave you spiraling into the black hole, never (or probably never) to return!

Black Hole Explorer can be played in two ways: as a competition between missions, or as a team collaboration assembling one mission. The first is more of a race, the second pits the team against the extreme natural forces of the Black Hole.

Game Equipment

Game board; 2 dice; event cards; probe result cards; energy tokens; spaceship data sheet (one per ship); spaceship game pieces (one per ship. Use coins, tiddlywinks or customize your own); pencils, eraser.

Playing the game

The game has three parts. In Part 1 the players have to construct a spaceship based on the amount of money available (determined on a die roll). Once the spaceship is built, you can proceed to part 2: the black hole board. The board has a black hole at its center surrounded by eight circular orbits. The hazards increase as you move to smaller and smaller orbits. The outer two orbits are called the Safe Zone. You then move to the Warning Zone, and finally, close to the black hole, the Danger Zone! To move to lower orbits, you simply have to complete one orbit and then change. But to climb orbits, you need to expend energy to fight against the black hole's gravity. During your mission, events will happen. By landing on an **E** (Event) square, you turn over and read an Event card. The event may be good or bad for your mission. Once you are in the danger zone, you can launch your scientific probes, collect your results, and head for home. Part 3 of the game is when the spaceship(s) return to Earth, and the mission results are assessed, to see if you have done enough to win the Nobel Prize and the game.

Black hole explorer

Game Part 1. Spacecraft design

For this first part, you will need to complete your spaceship data sheet. Roll one die and multiply the number you roll by 10 million. This is the amount of money in dollars you have to spend. Write this number in the *Funding* box of your data sheet.

Your money needs to be spent on four items:

- Probes** How many scientific probes your spaceship will carry.
- Shielding** To protect against heat and radiation from the black hole.
- Strength** To protect against the strong gravity of the black hole
- Power** The amount of energy your spaceship will have.

Now, read the details and costs of each item before spending. Then write your purchase in the appropriate box on your data sheet.

Probes:

- 1 probe costs \$5m
- 2 probes cost \$10m
- 3 probes costs \$15m

Shielding:

- Level 1 Shielding costs \$5m. Protects against moderate temperatures
- Level 2 Shielding costs \$10m. Protects against high temperatures and weak radiation.
- Level 3 shielding costs \$15m. Protects against high temperatures and intense radiation.

Strength:

- Level 1 strength costs \$5m. Protects against tidal forces in the Safe zone.
- Level 2 strength costs \$10m. Protects against tidal forces in the Warning zone.
- Level 3 Strength costs \$15m. Protects against tidal forces in the Danger zone.

Power:

- A Single engine costs \$5m. You get 6 energy tokens.
- A Double engine costs \$10m. You get 12 energy tokens.
- A Triple engine costs \$15m. You get 18 energy tokens.

You will also collect (and lose) energy tokens during the mission.

[NOTE: In the competitive game, there is no rule stopping collaboration, especially if mission funding is poor. This way, a game of (say) three players may reduce to three collaborators and one superior spacecraft, increasing the chances of success!]

IMPORTANT. Don't forget to name your spaceship!

Black hole explorer

Game part 2. The Game Board

Moving

Start on the spaceship picture and move down the squares until you join the outer orbit. **You then move counterclockwise around the black hole.** Roll two dice to determine how far you move each turn. You always move counterclockwise, both descending to and ascending from the black hole. This is the direction the black hole and its surrounding disc of gas (the accretion disc) is spinning.

You may give yourself an extra boost by expending energy: “buy” an extra die roll for an energy token (up to a maximum of two dice = 2 energy tokens). Example: for the cost of two energy tokens, you roll effectively 4 dice. **Note:** You will still need to expend an energy token as you climb an orbit in addition to any used for the boost.

Event cards

Certain squares in an orbit are marked with an **Ⓔ**. This means that there is an event happening. These events may be good or bad, and reflect the hazards of a mission. If you land on an **Ⓔ**, take an event card from the top of the pile. Then place the card on a discard pile unless the card tells you otherwise. When the Event card pile is empty, reshuffle the discards and place them face down to make a new Event pile.

Unless otherwise stated, an event card overrides the prior status of the spaceship.

Example: if a ship had previously been ordered to stay in the same orbit, and an Event card is drawn telling it to change orbit, it must change!

To change orbits

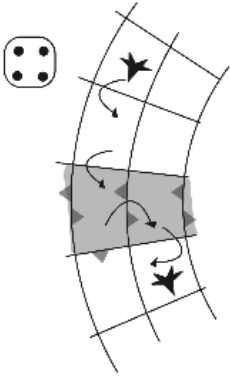
You must make at least one complete orbit before trying to change orbits. You can only change in the *CHANGE ORBIT* zone unless an event card tells you otherwise. You may only change your orbit by one unless an event card tells you otherwise. When changing orbits, move down (or up) vertically one square (see the diagrams below).

You need not change your orbit if you do not wish to (unless an event card tells you to), but... If you run out of energy tokens you automatically drop one orbit every turn (regardless of where you are in the orbit).

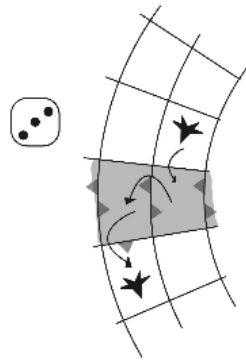
To go down: You can automatically lower your orbit when entering the *CHANGE ORBIT* zone.

To go up: You can move to a higher orbit when entering the *CHANGE ORBIT* zone, but you need to expend 1 energy token to do so (otherwise you must remain in the same orbit).

Black hole explorer



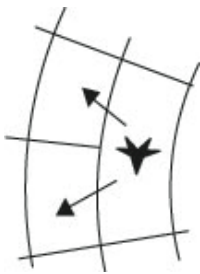
Moving Down example. On a roll of 4, your spacecraft moves into the *CHANGE ORBIT* zone, and steps down to a lower orbit.



Moving Up example. Here a roll of 3 takes you into the *CHANGE ORBIT* zone, and out into a higher orbit, but you must expend one energy token.

Forced change of orbit by an Event?

An event card may order you to change orbits immediately. If this change takes you into another Zone (say *Warning to Safe*), you will have a choice of two spaces to occupy, one of which may be an Event space. You may choose which space to enter. (This is not an issue when moving down).



Moving up by order of an Event card. You have a choice of which space to occupy.

Launching a probe

You can only (successfully) launch a probe in the *Danger Zone*. A probe can be launched at the end of your turn (that is, after you have rolled, moved and drawn an event card should you have landed on an **E**). Each probe launch costs 1 energy token.

Black hole explorer

The probe's chance of success increases the closer you are to the Black hole:

Highest orbit of Danger Zone: success with 1,2 on a die roll

Middle orbit of Danger Zone: success with 1,2,3,4 on die roll

Lowest orbit of Danger Zone: automatic success!

If your probe is successful, take a Probe Result card, read it out loud, and keep it in front of you. If your probe is unsuccessful, you do not get a Probe Result card. Note that a probe is lost and destroyed even when it is successful, as it has fallen into the black hole. A successful probe transmits its findings back to you – a failed probe (for whatever reason) does not.

What if I fall into the Black Hole?

Falling into a black hole is a one-way trip to oblivion. However, some scientists think that a black hole is a sort of gateway, or wormhole, to another part of the universe. This is very unlikely to be true, and even if it was, it is almost certainly impossible for a spaceship to journey through such a gateway. But this is only a game, so all is not lost! As soon as you fall in to the black hole, roll two dice. If you get 2 sixes, you emerge from a wormhole close to Earth and instantly win the Nobel Prize (and the game) for your discovery! If you don't, then go back and build another spaceship!

Game Part 3. Winning the game

End by returning to the “Home” Square (that is, climbing back up to the spaceship figure). You don't need to roll an exact number. If playing competitively, the first ship back home can present its results and attempt to win the Prize.

With one probe result, you win the Prize by rolling 5 or 6 on die roll.

With two probe results, you win the Prize by rolling 3,4,5 or 6 on die roll

With three probe results, you win the Prize automatically!

Reflection

At the end of the game you may want to reflect on your experience. Here are a few thoughtful questions.

1. Has your picture of what a black hole is changed because of this game? In what way?
2. How do you think events in the game would differ from a real mission to a black hole?
3. If you had to play the game again (or plan a real mission), what would you do differently, in the design phase, and in the mission phase?

Frequently Asked Questions

Here are some questions that have come up during the playing of Black Hole Explorer.

Black hole explorer

What's the difference between the spaceship and the probes?

The spaceship is a large vessel with a crew of scientists and engineers. The probes are small robotic craft that are launched by your spaceship. The probes are equipped with cameras and an array of scientific equipment, and radio their findings back to the spaceship.

What if I roll a 1 for funding? What chance have I got?

There are several options. You could agree that a roll of one means roll again. Or it's time to arrange a collaboration. Some \$10M ships have made it through – so think of it as a challenge!

Why do I have to expend energy climbing, but not descending?

When climbing you are working against the gravity of the black hole. The Space Shuttle needs tremendous energy to fight Earth's gravity on take-off, but glides back down to Earth without power.

If I'm "bumped up" an orbit by a collision or other event, do I need to expend energy?

No, because the move is a forced on you from outside, and not a result of firing your own engines. "Climbing" an orbit does expend energy, because you are making the move under your own power.

What if I have zero shields (or strength), and an event card says I lose 1 shield (or strength)?

If you are at zero you stay at zero (you can't go negative) and be thankful that you're still in one piece!

Can I help another spaceship that is in trouble?

Yes. If you can land on an adjacent square (either side, above, below or diagonal), you can donate a probe, repair robot or energy. This act of charity will cost YOU an energy token for each service given. Example: to give another spaceship one energy point will cost you two energy tokens.

I want lasers to shoot things!

This is not really in the spirit of exploration, although we appreciate that the USS Enterprise is quite heavily armed! If you want to turn "Black Hole Explorer" into "Black Hole Buccaneer" the tools are all here – energy, shields and strength.

What if the space I land on is occupied by another ship?

Two ships can occupy the same space (a ship is a few hundred feet long, and each space is many square miles in size). You may want to add new rules to bring in chances of collision, or (dare we say) combat!

Why does the black hole spin counterclockwise?

Why not? All real black holes rotate (probably), as do all stars and planets. Whether a black hole spins clockwise or counterclockwise depends on your perspective.

Can I move my spaceship in the opposite direction (clockwise?)

The rules say no. In reality, it would be tough to orbit "retrograde." The inner accretion disc will be rotating very rapidly – we're talking 10 million mph! Fighting against this would be like white water rafting back up a mountain. Feel free to adapt the rules if you want to fight the rotation, but get ready to burn energy and shields!

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Prepare to journey to the darkest place in the Universe!

Mission Briefing Room

Welcome to the mission briefing room. Your job is to fly a spaceship to a black hole. When you are close enough to the black hole, you will launch scientific probes into the black hole to answer some of the darkest mysteries about the darkest of objects:

What happens to space near a black hole?

What happens to time near a black hole?

What happens to you near a black hole?

But a mission such as this takes a lot of planning and a lot of money! You and your team will first be given millions of dollars to build a spaceship. You will need to decide how much you can spend on parts for your spaceship, such as the number of engines it will have, how well protected it is against heat and radiation, and the number of probes it can carry. Spend wisely!

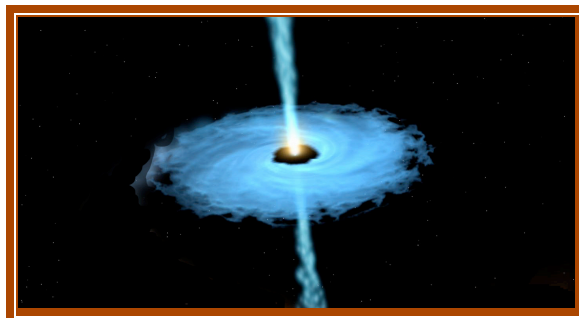
Once you have built your spaceship, your mission will begin. You will orbit closer and closer to the black hole, until you are close enough to launch the probes. But beware. Space around a black hole is swarming with hazards! On the next page, our astronomers will brief you on what you may encounter during your mission.

When your mission is complete, you can return home with your scientific results. Because your mission is the first to a black hole, your findings will be headline news. If you do well, you stand a good chance of winning a Nobel Prize, the greatest honor in the world for scientific discovery. Good luck to you all!

Science Briefing Room

Welcome to the Black Hole Science Briefing Room. Here is a photograph taken of your black hole by a recent robot probe. Doesn't look very black does it? We can't see the black hole itself (after all, it is a black hole!) but we can see the effect that a black hole has on its surroundings. If there are clouds of gas nearby, the gas will be spun, stretched and squeezed into a flat pancake. As the gas falls towards the black hole, it heats up and starts to glow. The further it falls, the hotter it gets. The temperature of this gas is something your mission will study.

Black holes like this one aren't very big compared to other objects in space such as planets and stars – think of a big black ball about the size of a city! But this is no rubber ball, this is a hole in space, and a black hole is completely, utterly black. That is because once inside nothing, not even light, can come out again. Going into a black hole is the ultimate one-way trip!



Sometimes the gas near the black hole is whipped up into such a tornado that before it has a chance to fall into the black hole, it is shot back out like the beam of a lighthouse. This jet of energy should be avoided if possible!

But the most amazing thing about black holes is that they bend and distort space and time itself! Studying the effect that a black hole has on time and space is the most important part of your mission. But remember, the black hole will bend and distort your space ship as well! And what will happen to your clocks as you close in on the black hole? Only time will tell!

You are now ready to start work on your spaceship. Don't forget to name it!

Black hole explorer

Rules Quick Reference

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The Game has three parts:

Part 1. Preparing for the Game

Construct a spaceship based on the amount of money available. Once the spaceship is built, you can proceed to the board. Turn over this sheet to begin construction!

Part 2: Playing the game.

Your aim is to orbit the black hole, and to launch a probe when in the Danger Zone. If your probe is successful, you pick up a Probe Result Card. Once you have launched all your probes, return home.

Any time you land on an **E** (Event) square, pick up an Event card and do what it says.

Moving

ALWAYS move counterclockwise when approaching and leaving the Black Hole.

Roll 2 dice to move. You can also buy extra dice rolls to move faster (one energy token per die, two dice max each turn).

You must make at least one orbit before ascending or descending in the CHANGE ORBIT zone. It costs nothing to drop an orbit, but costs one energy token when climbing an orbit.

If you run out of energy, you automatically drop one orbit every turn.

Launching a Probe

This expends 1 energy token, and is performed at the end of your turn (after moving and, if landing on an E, drawing of event card).

Outer Danger Zone orbit, probe is successful with roll of 1,2

Middle Danger Zone orbit, probe is successful with roll of 1,2,3,4

Inner Danger Zone orbit, probe is automatically successful.

Falling into the Black Hole

A roll of two sixes sends you home through a wormhole to automatically win

Any other roll and it's time to build a new spaceship!

Part 3. Winning the Game.

First spaceship back home can attempt to win the Nobel Prize. Success will depend on how many Probe Result cards you have: roll of 5,6 with one Probe Result; 3,4,5,6 with two; automatic win with three. If the first ship back fails, then the second has its chance etc.

Black hole explorer



Spacecraft Construction

You need to build a ship with available funds. To see how much money you have, roll a die and multiply by 10 million (e.g. a roll of 2 gives you \$20 million)

Your Funding is: \$ million

Now spend this money building your spaceship. Each component costs \$5 million. As with a real mission, you will need to make an educated guess as to how best to spend your money.

Probes at \$5million each, to launch into the black hole. Maximum of three.

Number of probes: Cost: Tick here when probes are launched:

Radiation **Shielding** to protect vital systems, each layer is \$5million, maximum of three layers.

Number of shielding layers: Cost:

Hull **Strength**, to resist the tug of gravity, each level of reinforcement costs \$5million, maximum of three levels.

Strength Level: Cost:

Engines: More engines means more energy. Each engine is \$5million, maximum of three engines.

Number of engines: Cost:

For one engine, take 6 energy tokens; Two engines take 12; Three engines take 18.

Spacecraft Name:

Now, you are ready to begin your mission! As the mission progresses, some of the information above will change – for example, you may gain hull strength, or lose an engine. Record those changes on this sheet.

black hole explorer

Standard Pre-Made Ships

These ships represent a moderate funding level. They are more or less evenly matched, but have strengths in different areas. This allows for participants to see the trade offs that of necessity arise in mission planning and building. Besides the random nature of luck, participants can experience how the relative preparedness of their ships affects their chances for success.

Ship 1. Trailblazer Class

The 'Trailblazer' is designed to carry maximum probe load, as well as maximum energy, allowing for greater data collection and maneuverability. The trade off is that the ship has fewer shields and lesser hull strength, making it more vulnerable to the dangerous conditions around the black hole.

Ship 2: Dauntless Class

The 'Dauntless' is designed to be resistant to the radiation dangers around the black hole, carrying maximum radiation shields. The trade off for the shields is that this ship has only enough room for one thick layer of hull.

Ship 3: Vanguard Class

The 'Vanguard' is designed to be very well balanced, with a good number of probes, and reasonable shielding, strength and energy, hopefully to be able to handle anything that comes. While the ship has no major weakness, neither does it have a major strength. Be flexible and ready for anything. If your probes or shields are damaged, you may want to buy more from a ship that lands next to you, but remember you have limited energy.

Print out this document or copy it using the two-sided feature of your printer or copier. Each of the ships should have a "quick rules" reference on the back. You may need to make multiple copies of each ship, depending on how many ships are in the game.

black hole explorer

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black hole explorer



Explorer Ship 'Trailblazer' Class

The 'Trailblazer' is designed to carry maximum probe load, as well as maximum energy, allowing for greater data collection and maneuverability.

NOTE: Be careful, however, the trade off is that the ship has fewer shields and lesser hull strength, making it more vulnerable to the dangerous conditions around the black hole. You might want to hang on to any repair cards for emergencies, and use your extra energy to buy shields from ships that land near you.

PROBES. No ship can have more than three.

Number of probes
to start: 3

Tick here when probes
are damaged:

Tick here when probes
are launched:

SHEILDING to protect vital systems from Radiation. No ship can have more than three shield layers.

Number of shields
to start: 1

Tick here when shields
are damaged:

HULL STRENGTH to protect the ship from gravity. No ship can have more than three reinforcement layers.

Number of layers
to start: 1

Tick here when strength
is damaged:

ENERGY to move and power the ship. Each engine provides 6 units of energy at the start of the game, to use as the game progresses. No ship can have more than three engines. One engine = 6 energy tokens; Two engines = 12; Three engines = 18.

Number of engines
to start: 3

Tick here when engines
are damaged:

Take 18 energy tokens to start.

Spacecraft Name:

Now, you are ready to begin your mission! As the mission progresses, some of the information above will change – for example, you may gain hull strength, or lose an engine. Record those changes on this sheet.

black hole explorer

Rules Quick Reference

This is the spaceship you are going to use to get close enough to a black hole to study it. Try to be the one who gets back safely with the most probe results before time runs out. But be careful! A black hole is very hazardous, and your ship might get damaged or spiral into the black hole, never (or probably never) to return!

Part 1. Preparing for the Game


Review your ship; see how many engines, probes, etc. you start with. Take the appropriate number of energy tokens from the pile. Start your ship token at the large space ship picture on the board.

Part 2: Playing the game.

Your aim is to 'orbit' the black hole, and to launch at least one probe when you get near it. Once you have launched all your probes, try to return home - back to the large picture of a space ship on the board.

Moving

ALWAYS move counterclockwise when approaching and leaving the Black Hole. Roll 2 dice to move.

Any time you land on an  (Event) square, pick up an Event card and do what it says.

Each level around the board is called an 'orbit'. You must make at least one orbit before ascending or descending in the CHANGE ORBIT zone. You can only move up or down one level at a time. You can only willingly go up and down in the CHANGE ORBIT zone (although other events like running out of energy can drop you down or bump you up anywhere.)

It costs nothing to drop an orbit, but always costs one energy point to willingly climb an orbit, because you are fighting the pull of gravity from the black hole.

If you run out of energy, you automatically drop one orbit every turn!

Launching a Probe

If you are in the last orbit (lowest level) you can launch a probe at the end of your turn. You must pay one energy point and then cross off a probe box on your sheet. The facilitator will give you a 'Probe Result Card'.

Helping Out

If you land within one space of another ship, either in your orbit or one orbit above or below, you can arrange an exchange. It costs you one energy for each thing you give them: either a probe, a shield, or even another energy point. Why do it? You might be in need yourself later in the game, or maybe you are playing in teams.

Losing your ship

The area around the black hole is very dangerous. Many ships will not make it in to launch a probe, or make it out to report their results. If your ship is destroyed before anyone else has made it back 'home', pull another ship sheet and keep trying! You may still succeed in getting in and out with a result before anyone else.

Falling into the Black Hole

If you fall into the black hole, roll two dice. A roll of two sixes sends you home through a wormhole to automatically win! Any other roll and it's time to build a new spaceship and give it another try!

Part 3. Winning the Game.

You can only report your results to the scientific community if you make it out of the black hole! Once you have launched one to three probes, and gotten your probe results, then return to the ship. The one who makes it back with the most probe results before time is up, wins the game.

black hole explorer



Explorer Ship 'Dauntless' Class

The 'Dauntless' is designed to be resistant to the radiation dangers around the black hole, carrying maximum radiation shields.

NOTE: Be careful, however, the trade off for the shields is that this ship has only enough room for one thick layer of hull. You might want to use any repair cards to keep your hull in good shape. You might want to consider using some of your energy to buy an extra probe from another ship that lands near you.

PROBES. No ship can have more than three.

Number of probes
to start: 2

Tick here when probes
are damaged:

Tick here when probes
are launched:

SHEILDING to protect vital systems from Radiation. No ship can have more than three shield layers.

Number of shields
to start: 3

Tick here when shields
are damaged:

HULL STRENGTH to protect the ship from gravity. No ship can have more than three reinforcement layers.

Number of layers
to start: 1

Tick here when strength
is damaged:

ENERGY to move and power the ship. Each engine provides 6 units of energy at the start of the game, to use as the game progresses. No ship can have more than three engines. One engine = 6 energy tokens; Two engines = 12; Three engines = 18.

Number of engines
to start: 2

Tick here when engines
are damaged:

Take 12 energy tokens to start.

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black hole explorer

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black hole explorer



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Number of engines
to start: 2

Tick here when engines
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black hole explorer

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Each level around the board is called an 'orbit'. You must make at least one orbit before ascending or descending in the CHANGE ORBIT zone. You can only move up or down one level at a time. You can only willingly go up and down in the CHANGE ORBIT zone (although other events like running out of energy can drop you down or bump you up anywhere.)

It costs nothing to drop an orbit, but always costs one energy point to willingly climb an orbit, because you are fighting the pull of gravity from the black hole.

If you run out of energy, you automatically drop one orbit every turn!

Launching a Probe

If you are in the last orbit (lowest level) you can launch a probe at the end of your turn. You must pay one energy point and then cross off a probe box on your sheet. The facilitator will give you a 'Probe Result Card'.

Helping Out

If you land within one space of another ship, either in your orbit or one orbit above or below, you can arrange an exchange. It costs you one energy for each thing you give them: either a probe, a shield, or even another energy point. Why do it? You might be in need yourself later in the game, or maybe you are playing in teams.

Losing your ship

The area around the black hole is very dangerous. Many ships will not make it in to launch a probe, or make it out to report their results. If your ship is destroyed before anyone else has made it back 'home', pull another ship sheet and keep trying! You may still succeed in getting in and out with a result before anyone else.

Falling into the Black Hole

If you fall into the black hole, roll two dice. A roll of two sixes sends you home through a wormhole to automatically win! Any other roll and it's time to build a new spaceship and give it another try!

Part 3. Winning the Game.

You can only report your results to the scientific community if you make it out of the black hole! Once you have launched one to three probes, and gotten your probe results, then return to the ship. The one who makes it back with the most probe results before time is up, wins the game.

black hole explorer

Extreme Pre-Made Ships

These ships represent the extremes of the funding spectrum. The Behemoth is fully funded, with full resources in all categories. The Atomic has minimum funding with only one resource in each category. Playing these ships will not result in a 'fair' game. The Behemoth clearly has the advantage over all other ships. Instead, playing these ships allows for participants to explore the range of experiences that come up related to how well prepared, or not, ships are for the trip. This relates directly to funding. Play these ships alone or with others to increase the participants' appreciation of how funding affects ship success, and to encourage more creative solutions and teamwork.

Print out this document or copy it using the two-sided feature of your printer or copier. Each of the ships should have a "quick rules" reference on the back. You may need to make multiple copies of each ship, depending on how many ships are in the game.

black hole explorer

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black hole explorer



Explorer Ship “Atomic” Class

The ‘Atomic’ is designed for maximum economy; hoping to learn about a black hole on a very small budget.

NOTE: Built with the minimum number of all resources, you’ll have to be both smart and lucky to get the Atomic near the black hole, launch your probe, and return safely. But if you do, you’ll have saved millions of dollars. Your major issue will probably be energy, since you do not even start the game with enough to get away from the black hole. You’ll need to find other sources.

PROBES. No ship can have more than three.

Number of probes
to start: |

Tick here when probes
are damaged:

Tick here when probes
are launched:

SHEILDING to protect vital systems from Radiation. No ship can have more than three shield layers.

Number of shields
to start: |

Tick here when shields
are damaged:

HULL STRENGTH to protect the ship from gravity. No ship can have more than three reinforcement layers.

Number of layers
to start: |

Tick here when strength
is damaged:

ENERGY to move and power the ship. Each engine provides 6 units of energy at the start of the game, to use as the game progresses. No ship can have more than three engines. One engine = 6 energy tokens; Two engines = 12; Three engines = 18.

Number of engines
to start: |

Tick here when engines
are damaged:

Take 6 energy tokens to start.

Spacecraft Name:

Now, you are ready to begin your mission! As the mission progresses, some of the information above will change – for example, you may gain hull strength, or lose an engine. Record those changes on this sheet.

black hole explorer

Rules Quick Reference

This is the spaceship you are going to use to get close enough to a black hole to study it. Try to be the one who gets back safely with the most probe results before time runs out. But be careful! A black hole is very hazardous, and your ship might get damaged or spiral into the black hole, never (or probably never) to return!

Part 1. Preparing for the Game


Review your ship; see how many engines, probes, etc. you start with. Take the appropriate number of energy tokens from the pile. Start your ship token at the large space ship picture on the board.

Part 2: Playing the game.

Your aim is to 'orbit' the black hole, and to launch at least one probe when you get near it. Once you have launched all your probes, try to return home - back to the large picture of a space ship on the board.

Moving

ALWAYS move counterclockwise when approaching and leaving the Black Hole. Roll 2 dice to move.

Any time you land on an  (Event) square, pick up an Event card and do what it says.

Each level around the board is called an 'orbit'. You must make at least one orbit before ascending or descending in the CHANGE ORBIT zone. You can only move up or down one level at a time. You can only willingly go up and down in the CHANGE ORBIT zone (although other events like running out of energy can drop you down or bump you up anywhere.)

It costs nothing to drop an orbit, but always costs one energy point to willingly climb an orbit, because you are fighting the pull of gravity from the black hole.

If you run out of energy, you automatically drop one orbit every turn!

Launching a Probe

If you are in the last orbit (lowest level) you can launch a probe at the end of your turn. You must pay one energy point and then cross off a probe box on your sheet. The facilitator will give you a 'Probe Result Card'.

Helping Out

If you land within one space of another ship, either in your orbit or one orbit above or below, you can arrange an exchange. It costs you one energy for each thing you give them: either a probe, a shield, or even another energy point. Why do it? You might be in need yourself later in the game, or maybe you are playing in teams.

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The area around the black hole is very dangerous. Many ships will not make it in to launch a probe, or make it out to report their results. If your ship is destroyed before anyone else has made it back 'home', pull another ship sheet and keep trying! You may still succeed in getting in and out with a result before anyone else.

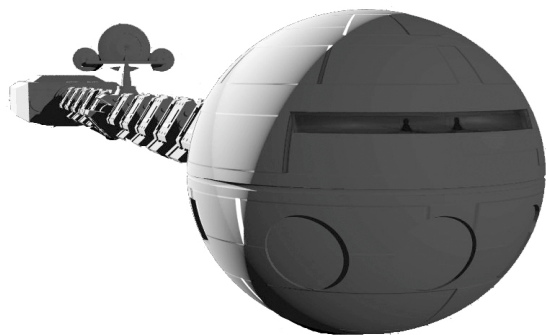
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black hole explorer



Explorer Ship 'Behemoth' Class

With maximum resources, the 'Behemoth' has a good chance of making key discoveries about black holes.

NOTE: But be cautious, even the most well built and well-funded ship can still have problems, especially in the 'Danger Zone'. Generosity shown early on might come in handy if problems arise later, and you help.

PROBES. No ship can have more than three.

Number of probes
to start: 3

Tick here when probes
are damaged:

Tick here when probes
are launched:

SHEILDING to protect vital systems from Radiation. No ship can have more than three shield layers.

Number of shields
to start: 3

Tick here when shields
are damaged:

HULL STRENGTH to protect the ship from gravity. No ship can have more than three reinforcement layers.

Number of layers
to start: 3

Tick here when strength
is damaged:

ENERGY to move and power the ship. Each engine provides 6 units of energy at the start of the game, to use as the game progresses. No ship can have more than three engines. One engine = 6 energy tokens; Two engines = 12; Three engines = 18.

Number of engines
to start: 3

Tick here when engines
are damaged:

Take 18 energy tokens to start.

Spacecraft Name:

Now, you are ready to begin your mission! As the mission progresses, some of the information above will change – for example, you may gain hull strength, or lose an engine. Record those changes on this sheet.

black hole explorer

Rules Quick Reference

This is the spaceship you are going to use to get close enough to a black hole to study it. Try to be the one who gets back safely with the most probe results before time runs out. But be careful! A black hole is very hazardous, and your ship might get damaged or spiral into the black hole, never (or probably never) to return!

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Losing your ship

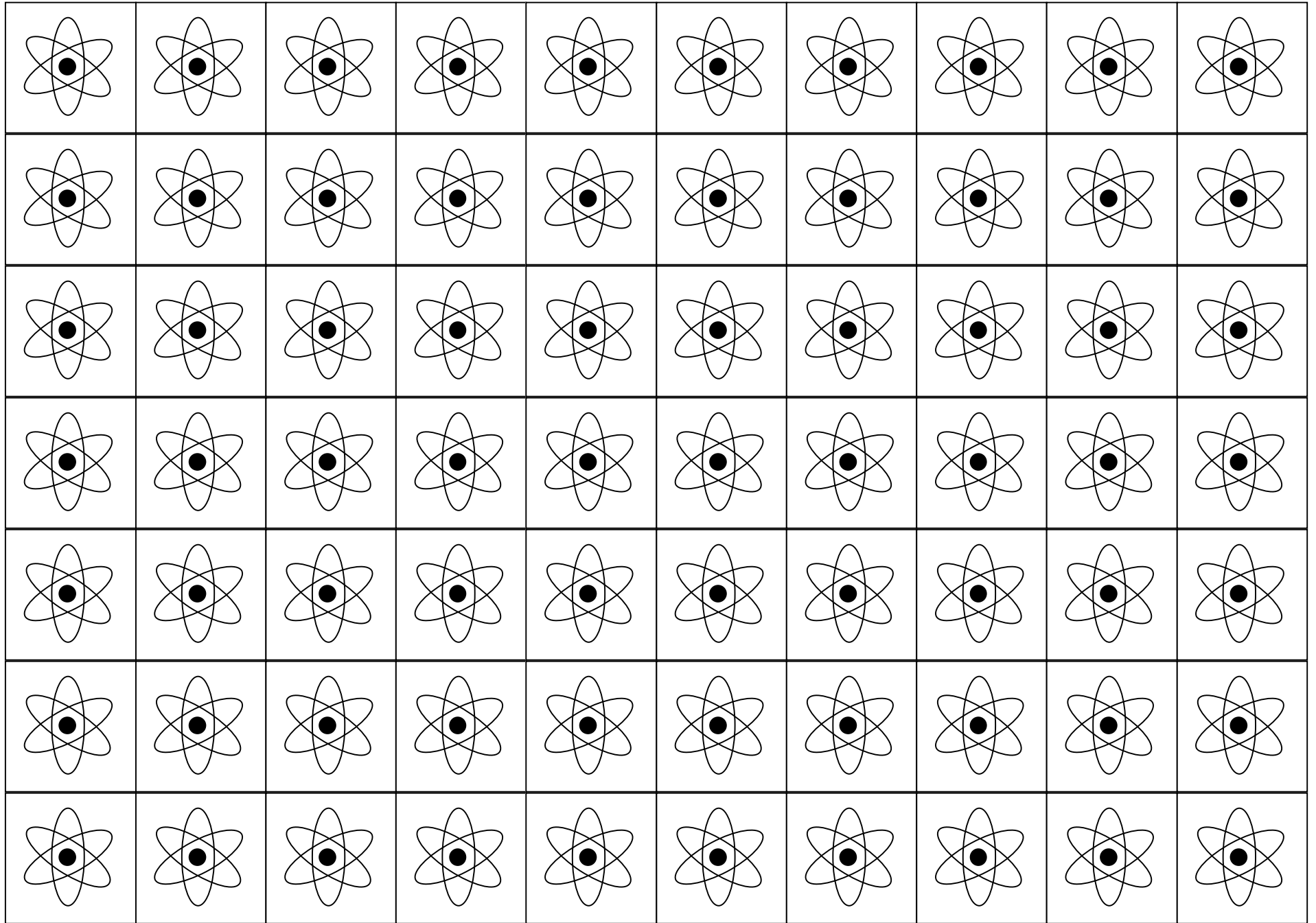
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EVENT

EVENT

EVENT

EVENT

<p>Maneuver your spacecraft to convert some of the black hole's spin energy into spacecraft power. Roll a die to see how much energy you gain.</p> <p style="text-align: center;">Safe Zone</p> <p>1,2,3 for 1 energy token 4,5,6 for 2 energy tokens</p> <p style="text-align: center;">Warning Zone</p> <p>1,2 for 1 energy token 3,4 for 2 energy tokens 5,6 for 3 energy tokens</p> <p style="text-align: center;">Danger Zone</p> <p>1,2,3 for 3 energy tokens 4,5 for 4 energy tokens 6 lose control of your ship! lose 1 strength, 1 shield and drop of 1 orbit!</p>	<p style="text-align: center;"><u>Repair Card</u></p> <p>Mission Control activates your onboard repair robot.</p> <p style="text-align: center;">All Zones</p> <p>Expend 1 energy token for your robot to fix any damage to your ship or to your probes. This repair also raises your shield strength by 1. (You cannot play this card if you have zero energy)</p> <p>This card may be kept and played when needed, then discarded.</p>
<p>A passing European Space Agency (ESA) mission offers you help.</p> <p style="text-align: center;">Safe Zone</p> <p>Fuel transfer gives you 2 extra energy tokens.</p> <p style="text-align: center;">Warning Zone</p> <p>The ESA mission offers you an extra probe. You may accept 1 probe over your design limit.</p> <p style="text-align: center;">Danger Zone</p> <p>Roll a die. 1-5, transfer 2 energy tokens from the ESA ship, but a roll of 6 and you collide, knocking you down one orbit!</p>	<p>Your orbital path takes you through a jet of energy generated by the Black Hole.</p> <p style="text-align: center;">Safe Zone</p> <p>The radiation from the jet lowers your shield strength by 1.</p> <p style="text-align: center;">Warning Zone</p> <p>The radiation from the jet lowers your shield strength by 2.</p> <p style="text-align: center;">Danger Zone</p> <p>The radiation from the jet lowers your shield strength by 2 and the blast knocks you up one orbit.</p> <p>If your shields are at zero, Maintain your orbit for three turns to repair shields up to a value of 1. Or, fix now with repair card.</p>

<p>An orbiting European Space Agency (ESA) mission assists you with its servicing robot.</p> <p style="text-align: center;">All Zones</p> <p>Repair one probe (if you currently have one that is damaged) and increase your shield value by 1.</p> <p>This card is to be played now, and cannot be retained.</p>	<p>X-radiation fries your probe launch computer!</p> <p style="text-align: center;">All Zones</p> <p>You cannot launch a probe until this problem is fixed!</p> <p>Retain this card until you collect a repair card. (If you have a repair card, you may play it to fix the computer now, or wait until you need to launch your probes in the Danger zone).</p>
<p>Computer error causes a probe rocket to fire! Roll a die.</p> <p style="text-align: center;">All Zones</p> <p>Roll 1-3 The probe rocket causes your spaceship to veer off course and dive 1 orbit.</p> <p>Roll 4-6 Maintain your orbit, but damage reduces shields by 1. If your shields go to zero, use a repair card or stay in this orbit for two turns to return your shields to 1.</p> <p>This misfire fortunately does not damage your probe! Ignore this card if you have no working probes aboard.</p>	<p>Your engineers find out that one of your probes is broken.</p> <p style="text-align: center;">All Zones</p> <p>Decrease number of probes by one. Your Mission is cancelled if you only had one. Head for home, but remember that there are Event opportunities to regain or repair probes.</p> <p>Ignore your engineers if you have already launched your probes!</p>

<p>Use ultra-violet radiation from the hot gas swirling around the black hole to recharge your energy cells.</p> <p style="text-align: center;">Safe Zone</p> <p>Gain 1 energy token</p> <p style="text-align: center;">Warning Zone</p> <p>Gain 2 energy tokens</p> <p style="text-align: center;">Danger Zone</p> <p>Gain 3 energy tokens</p>	<p>Engineers have discovered problems with the design of your spaceship while running computer simulations of your mission.</p> <p style="text-align: center;">Safe & Warning Zones</p> <p>Reduce shielding and strength values 1 token each (if value already at zero, stay at zero). Play a repair card to add 1 to strength and 1 to shield value.</p> <p style="text-align: center;">Danger Zone</p> <p>If strength and shields at zero, your whole spacecraft is destroyed unless you can play a repair card <u>NOW</u>. If either stays above zero, stay in orbit 3 turns to correct problems and return to former strength/shield levels.</p>
<p>Engineers discover that your spaceship's engines are working better than expected!</p> <p style="text-align: center;">All Zones</p> <p>Increase your energy by 2 tokens per engine.</p>	<p>Gravitational squeezing and tugging on your spacecraft is becoming dangerous.</p> <p>Throw a die and add your shield value. (Example: a roll of 4 and shield value of 1 gives you a total of 5)</p> <p style="text-align: center;">Safe & Warning Zone</p> <p>If total is 1,2 or 3: Climb 2 orbits immediately!</p> <p style="text-align: center;">Danger Zone</p> <p>If total is 1-4: Climb 2 orbits immediately!</p> <p><u>Remember</u>: climbing orbits expends energy! You may resume your regular descent (or ascent) next round. No energy? Hold tight, roll 5,6 to stay in current orbit, or drop one orbit per turn.</p>

<p>Communications Antenna destroyed by collision with orbiting debris!</p> <p>You may play a repair card to fix the antenna now or:</p> <p style="text-align: center;">Safety Zone</p> <p>Remain in this orbit for your next turn to repair</p> <p style="text-align: center;">Warning Zone</p> <p>Remain in this orbit for your next two turns to repair.</p> <p style="text-align: center;">Danger Zone</p> <p>Remain in this orbit for your next 3 turns to repair. You cannot launch a probe until this is problem is fixed!</p>	<p>Convert the heat being given off from the accretion disc (the hot gas spiraling into the black hole) into energy for your engines.</p> <p style="text-align: center;">Safe Zone</p> <p>Warm accretion disc gives you 1 energy token</p> <p style="text-align: center;">Warning Zone</p> <p>Hot accretion disc gives you 2 energy tokens</p> <p style="text-align: center;">Danger Zone</p> <p>Incredibly hot accretion disc gives you 3 energy tokens</p>
<p>Mission controllers change the speed of your spacecraft remotely but enter the numbers in <i>miles per second</i> instead of <i>meters per second</i> by mistake!</p> <p style="text-align: center;">All Zones</p> <p>Expend 2 energy tokens correcting Mission Control's error!</p> <p>No energy tokens? You can't change your speed without energy, so this command is ignored.</p>	<p>Public interest in mission gets you the headline on CNN.</p> <p>This doesn't affect your mission, but give yourselves a pat on the back!</p>

<p>Pass through a cloud super-hot gas!</p> <p>Safe & Warning Zones Lose 1 level of shielding. If shielding at zero remain in this orbit 2 turns working to bring shielding up to 1. You may also play a repair card.</p> <p>Danger Zone Lose 1 token of shielding. If your shielding is at zero you need to move out of the Danger Zone and make repairs. This takes 2 turns and returns your shield value to 1. You may play a repair card to fix your shields now.</p>	<p>Collision course with a Russian spacecraft!</p> <p>Roll a die:</p> <p>All Zones</p> <p>Roll 1-4. Close, but you safely miss each other.</p> <p>Roll 5-6. Too close! expend 2 energy tokens altering course and avoiding collision.</p> <p>No energy? If you rolled 5-6 roll again. 1-3 and you collide, destroying both spaceships. 4-6 and you shoot past, losing nothing but a bit of paintwork!</p>
<p>The spinning black hole drags space itself around with it. This gives your spacecraft a free ride.</p> <p>Safe + Warning Zone Move forward 10 spaces. If you reach the Change Orbit square, you may choose to move up or down.</p> <p>Danger Zone Roll a die. 1-4 Move forward to the Change Orbit square now.</p> <p>5-6 Tidal forces tear at your spaceship. Lose 2 strength points. If you are at zero strength, your ship is ripped apart and destroyed.</p>	<p>The hot gas in the accretion disc is becoming increasingly turbulent.</p> <p>Safe Zone Lower Strength value by 1. If this takes you to zero strength, stay in this orbit for 2 turns, then return to strength of 1.</p> <p>Warning Zone Lower Strength value by 2. If this takes you to zero strength, stay in this orbit for 2 turns, then return to strength of 2.</p> <p>Danger Zone Lower Strength value by 2. If this takes you to zero strength, stay in this orbit for 2 turns, then return to strength of 1</p>

<p style="text-align: center;"><u>Repair Card</u></p> <p>Activate your onboard repair robot.</p> <p style="text-align: center;">All Zones</p> <p>Expend 1 energy token for your robot to fix any damage to your ship or to your probes. This repair also raises your shield strength by 1. (You cannot play this card if you have zero energy)</p> <p>This card may be kept and played when needed, then discarded.</p>	<p>X-radiation fries your guidance computer. Computer is back online next turn, but in the meantime, roll a die.</p> <p style="text-align: center;"><u>Repair Cards cannot be used</u></p> <p style="text-align: center;">Safe Zone</p> <p>Roll 1-3: fall two orbits. Roll 4-6 stay in same orbit, but jump ahead 6 squares (if you cross the change orbit zone, don't change orbit!)</p> <p style="text-align: center;">Warning Zone</p> <p>Roll 1-3: fall two orbits Roll 4-6 climb two orbits, expending 2 energy cards.</p> <p style="text-align: center;">Danger Zone</p> <p>Roll 1-2: fall one orbit. Roll 3-6: climb 3 orbits, expending 3 energy tokens.</p>
<p>Engineers discover that one of your probes has a programming error.</p> <p style="text-align: center;">Safe and Warning Zones</p> <p>Your probe will explode in its launch bay when you enter the Danger Zone unless repaired by a Repair Card. Retain this card until problem is fixed.</p> <p style="text-align: center;">Danger Zone</p> <p>Roll a die. 1-4 A serious probe error is fixed by engineers. Roll 5-6: One Probe explodes in its launch bay. Lose probe, 2 shields drop 1 strength level. If strength and shields at zero, your whole spacecraft is destroyed. If either stays above zero, stay in orbit 3 turns to return to former strength/shield levels. Play a repair card to fix now. (You cannot recover your probe)</p>	<p>Gravity around black hole affects the flow of time. You need to recalibrate your clocks.</p> <p style="text-align: center;">Safe Zone</p> <p>Stay in current orbit for one turn, even if you enter the change orbit zone.</p> <p style="text-align: center;">Warning Zone</p> <p>Stay in current orbit for two turns, even if you enter the change orbit zone.</p> <p style="text-align: center;">Danger Zone</p> <p>Stay in current orbit for three turns, even if you enter the change orbit zone. You cannot launch a probe while recalibrating.</p>

<p style="text-align: center;"><u>Repair Card</u></p> <p>Mission Control activates your onboard repair robot.</p> <p style="text-align: center;">All Zones</p> <p>Expend 1 energy token for your robot to fix any damage to your ship or to your probes. This repair also raises your shield value by 1 (You cannot play this card if you have zero energy)</p> <p>This card may be kept and played when needed, then discarded.</p>	<p style="text-align: center;"><u>Repair Card</u></p> <p>Mission Control activates your onboard repair robot.</p> <p style="text-align: center;">All Zones</p> <p>Expend 1 energy token for your robot to fix any damage to your ship or to your probes. This repair also raises your shield value by 1 (You cannot play this card if you have zero energy)</p> <p>This card may be kept and played when needed, then discarded.</p>
<p>X-radiation is stronger than scientists anticipated.</p> <p style="text-align: center;">Safe Zone</p> <p>Lose 1 shielding level. If at zero shields you cannot enter the warning zone until you have repaired your shields with a repair card</p> <p style="text-align: center;">Warning Zone</p> <p>Lose 2 shielding levels. If at zero shielding you cannot enter the danger Zone until shields are fixed with repair card</p> <p style="text-align: center;">Danger Zone</p> <p>Lose 2 shielding levels. If at zero shielding your crew abandons ship in escape pods because of radiation. Mission over!</p>	<p>Heat from accretion disc burns hole in hull!</p> <p style="text-align: center;">Safe and Warning Zone</p> <p>Drop one strength level. If at zero strength, do not enter Danger Zone until Strength level restored using a repair card.</p> <p style="text-align: center;">Danger Zone</p> <p>Drop 2 Strength levels. If at Zero Strength play a repair card NOW!</p> <p>If you cannot, climb to Warning Zone and stay there for two turns to bring your Strength back up to 1.</p> <p>If no energy tokens to climb, your spacecraft burns up!</p>

Science Result!

Warning and Danger Zones Only

An onboard scientific experiment gets you your first results without launching a probe.

Take a Probe Result Card now. This does not affect the status of your probes.

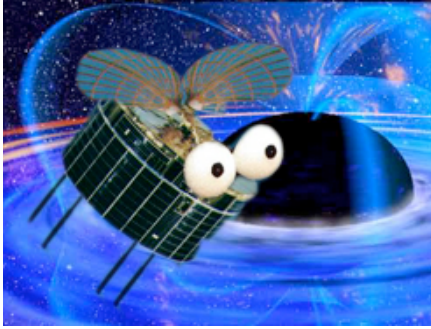
Science Result!

Warning and Danger Zones Only

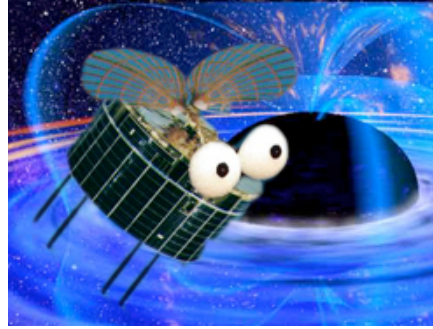
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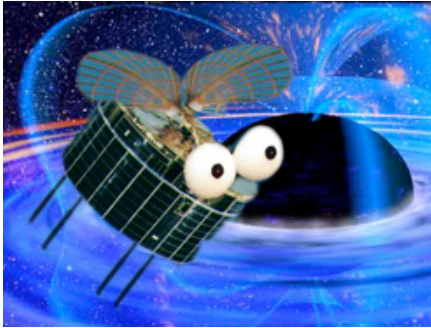
Probe Result



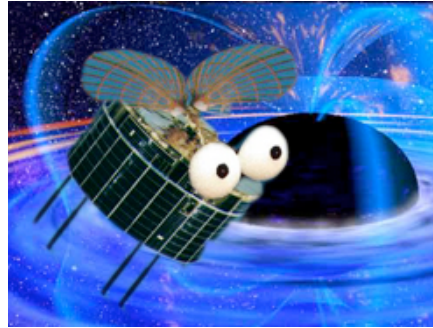
Probe Result



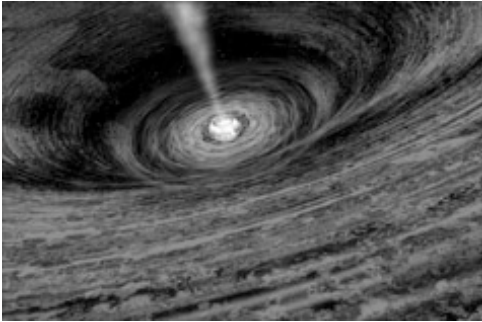
Probe Result



Probe Result

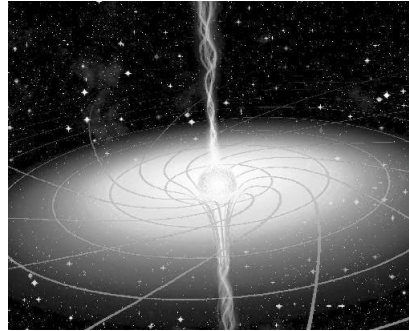


Probe Result



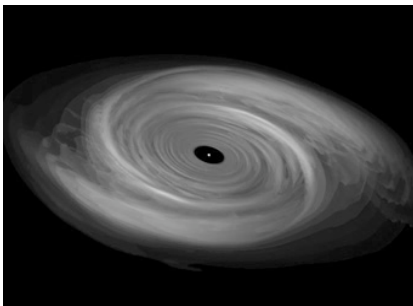
The temperature of the disc of gas that spirals into a black hole can reach millions of degrees. At these temperatures, a gas isn't red hot, or white hot, but X-ray hot! One important way to discover black holes is to look for the glow of X-rays using an X-ray space telescope.

Probe Result



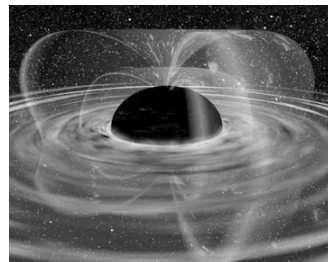
From your spaceship above the Black Hole, the clock on board the probe appears to slow down and actually freezes at the moment the probe enters the black hole. From the probe's point of view however, its clock ticks by normally, but looking back up it sees your spaceship clock whizzing round faster and faster!

Probe Result



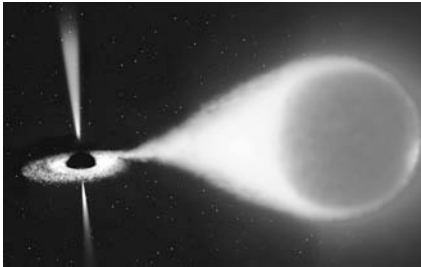
Because a black hole warps space, it will also warp anything in that space. As the probe moves towards the black hole, the stretching and squeezing gets worse and worse. In the end, the probe is stretched and squeezed to destruction.

Probe Result



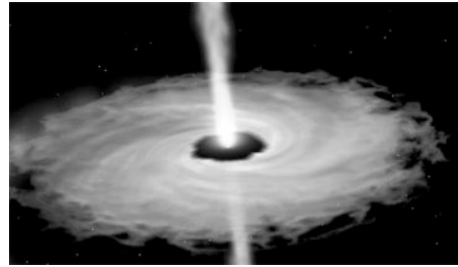
Despite having the mass of nearly ten Suns, this black hole is no larger than an average city, about 60 km side to side. Black holes are very compact objects, concentrating a lot of mass into a very small volume. The disc of gas that has given your ship such a rough ride is about 100 times bigger – a pancake about as wide as the United States.

Probe Result



We can't see the black hole itself but we can see the effect that a black hole has on its surroundings. Our black hole is in an orbital dance with a companion star. Simply by watching the companion star, we could tell that something was tugging it around. The motions of stars we can see gives us clues to the whereabouts of things – such as black holes – that are invisible to us.

Probe Result



Sometimes the gas near the black hole is whipped up into such a tornado that before it has a chance to fall into the black hole, it is shot back out into space in two jets like the beams of a lighthouse.

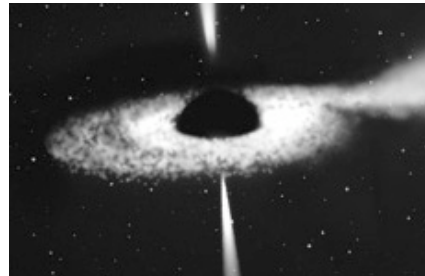
Although the jets look as though they are emerging from the black hole, they actually start just outside it.

Probe Result



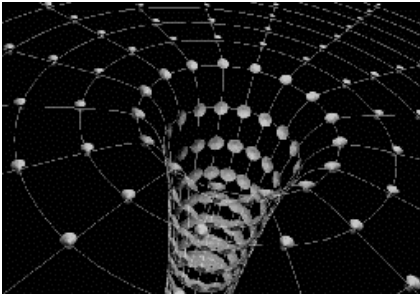
This black hole began its life as an ordinary, but very large star. When the star had used up all its nuclear fuel, its core collapsed to form this black hole. The outer part of the star was blown out into space in a huge explosion called a supernova.

Probe Result



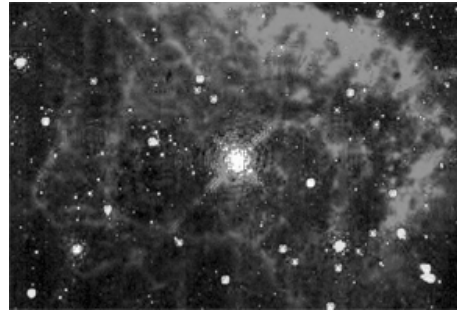
The black hole doesn't have a surface – you can't land on it. The black ball you see is simply a boundary – like an open doorway into a pitch black room. Your probe does not notice anything strange as it passes through the boundary, except that it cannot ever turn around and come back out.

Probe Result



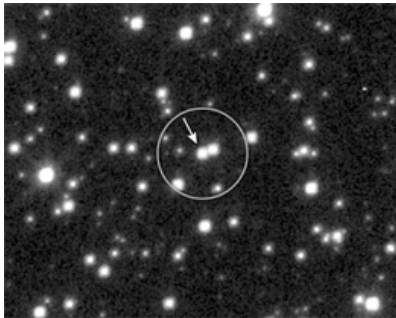
Once inside the black hole the probe is lost to us. Even if it survives the intense gravity as it enters the hole it will never be able to communicate with us on the outside. Ultimately, as the probe reaches the very center of the black hole, not even the atoms that the probe is made of will be able to resist the stretching and squeezing of the gravity.

Probe Result



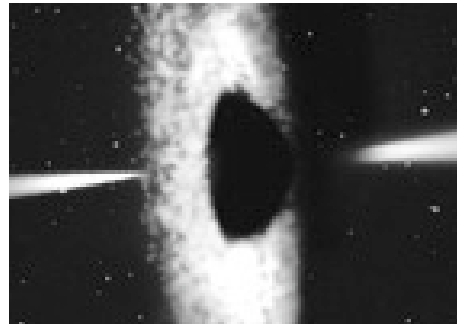
Black holes are formed when the biggest and brightest stars die. The Sun, although a very impressive star, is not big enough to form a black hole when it dies. This black hole, with a mass of about ten Suns, began its life as a huge star with a mass of a hundred Suns.

Probe Result



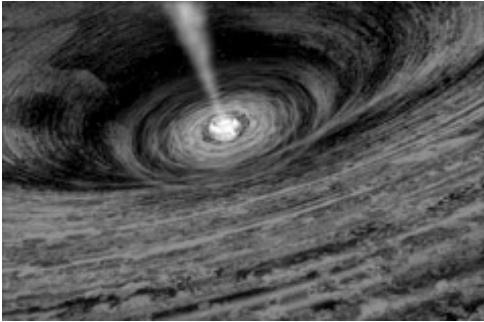
This black hole is one of about a million in our Milky Way galaxy. This sounds dangerous, but the Milky Way is a big place. It took our ultra-fast spaceship a very long time to reach even this nearby black hole and, as we are finding out, we needed to get pretty close before things got really risky!

Probe Result



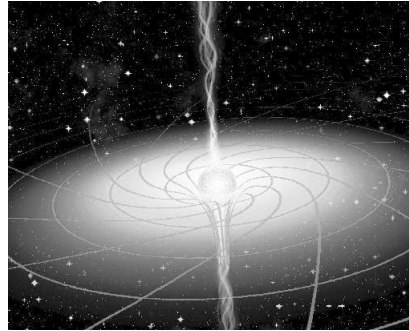
We can watch the probe reach the black hole but will never see it enter. Because of the effect gravity has on time, the probe will appear to move slower and slower and then freeze at the moment it “touches” the black hole. Its frozen image will just keep getting fainter and redder for the rest of time.

Probe Result



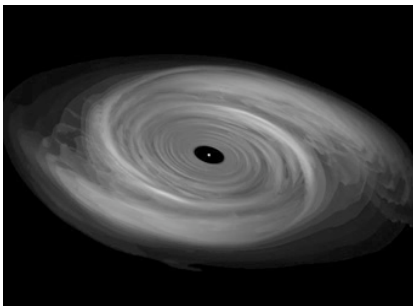
Our probe is interested in the hot gas spiraling around the black hole. The gas reaches millions of degrees. At these temperatures, a gas isn't red hot, or white hot, but X-ray hot!

Probe Result



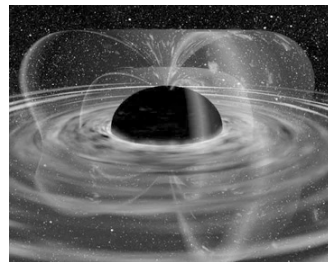
Our probe says that this is only the twelfth black hole to be discovered in our galaxy, but there may be another million waiting to be found, so we need to hurry up!

Probe Result



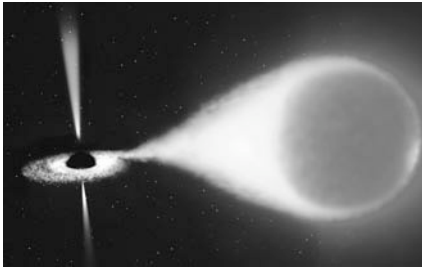
Our probe found out that the black hole is very very dense. Our probe also told us that we could make the Earth into a black hole too, if we squeezed it down to the size of a marble!

Probe Result



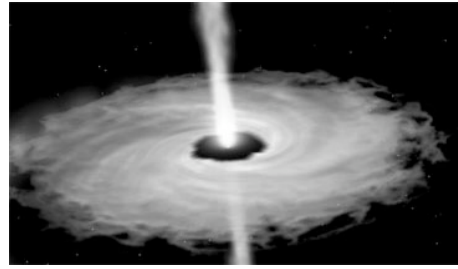
Our probe has just weighed the black hole. It has calculated that the black hole has more mass than ten Suns put together, all squeezed into a volume the size of a city!

Probe Result



Our probe says we were lucky to have found this black hole. If it weren't for the supply of gas from the companion star feeding the black hole, there would be no glowing disc, nor any jets. The black hole would be invisible.

Probe Result



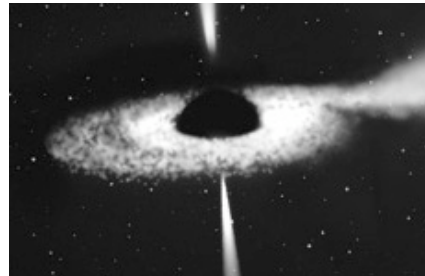
Our space probe refuses to fly into the black hole. It says the laws of physics don't work at the center of a black hole, and it will probably be crushed out of existence!

Probe Result



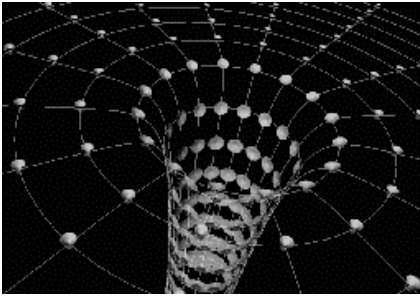
Our probe confirms that this black hole was made millions of years ago, and is all that is left of a giant star that died in a huge explosion called a supernova.

Probe Result



Our probe has just told us that the black hole is like the ghost of a star. In fact, a black hole isn't made of anything except gravity!

Probe Result



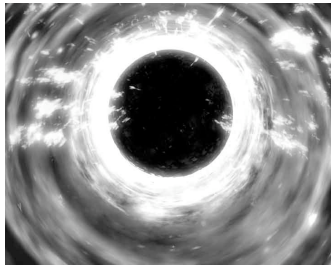
Our probe thinks this black hole may be a gateway, or wormhole, into another part of our universe, or even to a different universe altogether. It says we can risk the journey, if we don't mind being torn, melted and squashed out of existence.

Probe Result



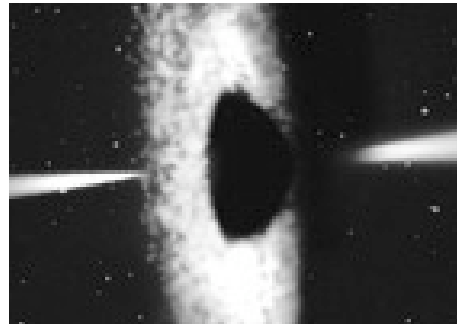
Our probe says that the black hole doesn't have a surface – you can't land on it. The black ball we see is simply a boundary – like an open doorway into a pitch black room. But once the probe enters the black hole, it cannot ever turn around and come back out!

Probe Result



We watched our probe reach the black hole but we'll never see it enter. Because gravity slows time, our probe appeared to move slower and slower and then froze at the moment it touched the black hole. Its frozen image will just keep getting fainter and redder for the rest of time!

Probe Result



Our probe has studied the powerful jets of gas shooting away from the black hole at almost the speed of light! They are generated just outside the black hole by the huge magnetic fields.

BLACK HOLE EXPLORER

