



## The “Hole” Shebang About Black Holes By Judy Chinitz



“Black holes are where God divided by zero,” said Albert Einstein. (For those who are not math geeks, a number cannot be divided by zero and thus, this is considered “undefined”...which is a great way of describing a black hole!) In spite of its name describing a vast EMPTINESS, according to NASA (the National AERONAUTICS and Space Administration), “...a black hole is anything but empty space. Rather, it is a great amount of matter packed into a very small area.” In fact, the prevailing belief, that they are created by the collapse of a star, was predicted by none other than Albert Einstein himself. While scientists can’t actually see black holes, because they do not emit any kind of ELECTROMAGNETIC radiation which can be seen by telescopes, they can INFER [guess at or deduce] their existence by observing the environment surrounding them. As stars, planets, COSMIC dust, and so forth near a black hole, they are drawn in, in a process called ACCRETION, and as this debris gets closer and closer to the black hole it heats up, emitting x-rays into space...which scientists *can* detect.

**SPELL:** AERONAUTICS

EMPTINESS

COSMIC

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The drawing of space matter into a black hole is called what?

ACCRETION

What do we call the result of dividing a number by zero?

UNDEFINED

What does space debris emit as it gets closer to a black hole and heats up? X-RAYS

What kind of radiation can be detected by telescopes?

ELECTROMAGNETIC

What does NASA stand for? NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

During accretion, what gets drawn into a black hole? STARS, PLANETS, COSMIC DUST

First a little on the history of these cosmic MONSTROSITIES. The first scientist to propose the modern version of what we now call black holes was the German physicist KARL SCHWARZSCHILD, in 1915. Based upon Dr. Einstein's Theory of General RELATIVITY, he realized that matter could be squeezed into an INFINITELY small point. (It's incredibly hard to imagine that before the Big Bang, everything in the entire universe once fit into a ball about the size of a baseball!) Thus, physicists came to realize that a black hole, formed when a giant star collapses, has gravity so intense that not even light can escape...and thus, appears as a black hole in space. The rim of the black hole, where that intense gravity slides into oblivion ending in its infinitely dense core (the SINGULARITY) is called the EVENT HORIZON – the point of no return. Once you hit the event horizon, nothing can pull you away...you are going into the black hole. The distance between the event horizon and the singularity is called the Schwarzschild Radius, named after this brilliant man. You hit that event horizon...you'll eventually find out just what that singularity looks like!

SPELL: MONSTROSITIES    VERSION    INFINITELY

What scientist proposed that matter can fit into an infinitely small point (full name)? KARL SCHWARZSCHILD

What word means to guess or deduce? INFER

What is the infinitely dense core of a black hole? SINGULARITY

What is the rim of the black hole called? EVENT HORIZON

What is the distance between the event horizon and the singularity

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called? SCHWARZSCHILD RADIUS

What was the name of Dr. Einstein's famous theory: THE THEORY OF GENERAL RELATIVITY, GENERAL RELATIVITY

Name another famous scientist? Marie Curie, Galileo, Copernicus, Charles Darwin, Nikola Tesla, Carl Sagan, Louis Pasteur, Michael Faraday, etc.

In what year did Karl Schwarzschild propose the modern version of black holes? 1915

So many amazing people have contributed to science in so many ways. Is there any scientific invention or discovery that particularly fascinates you?



VAKT: Dr. Karl Schwarzschild – The Father of Black Hole Science

Here are fun facts about black holes, some of which are really hard to wrap your head around. Firstly, did you know that the GRAVITATIONAL pull of a black hole is so immense that it actually DISTORTS space and time? You can't make this stuff up! Time actually runs slower the closer you get to a black hole. Dr. STEPHEN HAWKING, the brilliant THEORETICAL physicist, devoted much of his life to the study of black holes, and his work radically changed the world of COSMOLOGY (the study of the origin and development of the universe). Essentially, what Dr. Hawking's research has DEMONSTRATED is that the universe started with the Big Bang and will end in a black hole. (Some scientists believe that, in fact, a new

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universe will restart with a black hole...believe it or not!)

**SPELL: DISTORTS THEORETICAL DEMONSTRATED**

What kind of force exerted by a black hole distorts space and time?

**GRAVITATIONAL**

As you get closer to a black hole, time runs \_\_\_\_.

**SLOWER**  
What science is the study of the origin and development of the universe?

**COSMOLOGY**  
What was Dr. Hawking's branch of science?

**PHYSICS**  
What did the universe start with?

**BIG BANG**  
What scientist devoted much of his life to the study of black holes?

**DR. STEPHEN HAWKING, DR. HAWKING**  
During the Big Bang, all matter in the universe was thought to fit into a ball the size of what?

**BASEBALL, SMALL BALL**  
  
The CRUX of Dr. Hawking's work: while we cannot yet measure it, black holes actually emit a form of radiation called HAWKING RADIATION and once that is used up (EVAPORATED), they will explode and vanish. So, you ask, how long until a black hole uses up its energy and dies? Well...let's just say, a really, really long time! Longer than the age of the current universe! A black hole with the same mass as our sun (which in reality is too small to form a black hole when it finally collapses in several billion years), would still take  $2 \times 10^{67}$  (that is a 2 with 67 zeroes after it) years to evaporate. And how about this fun fact? Pretend that you have a super tiny black hole the size of a blue whale. Even being that small, when it explodes, it will emit the EQUIVALENT of 5 million MEGATONS of TNT. Exploding black holes pack a WALLOP!

**Spell: MEGATONS EVAPORATED EQUIVALENT**

What kind of energy does a black hole emit?

**HAWKING RADIATION**  
What word in this paragraph means the heart or essence of?

**CRUX**  
How many zeros are in the number  $1 \times 10^{110}$ ?

**110**  
With the equivalent of how many megatons of TNT would our sun, as a black hole, explode?

**5 MILLION**  
Stars are actually what?

**SUNS**

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But think about this now. All that cosmic material is ORBITING the event horizon, getting closer and closer to the black hole, speeding up as it does so. It heats up to billions of degrees FAHRENHEIT – so hot that mass from the material transforms into energy. Some scientists hope that someday, we could HARNESS this energy to power spaceships. There is, after all, a supermassive black hole at the center of every galaxy, including ours, holding our galaxy together by its immense gravitational pull. Our personal black hole is called SAGITTARIUS A, and it is a million times more massive than our sun.

**SPELL: ORBITING                      FAHRENHEIT                      HARNESS**  
What does the superheated material orbiting a black hole transform into?  
**ENERGY**  
What is the name of the black hole in the center of our galaxy?  
**SAGITTARIUS A**  
What is the name of our galaxy? **MILKY WAY**  
What is the name of the galaxy closest to ours? **ANDROMEDA**  
What is another measure of temperature besides Fahrenheit?  
**CELCIUS, CENTIGRADE, KELVIN**

Just when you think we can't have more fun with black holes...there's so much more. Some scientists believe that there may be a second type of black hole, called a PRIMORDIAL black hole. These were formed, or so the theory states when the VACUUM of the early universe EXPANDED rapidly after the Big Bang (an event known as INFLATION) causing highly dense REGIONS of exploding matter to COLLAPSE. Scientists believe these black holes would be smaller – no bigger than a jelly bean. Baby black holes! Blackholets?

**SPELL: VACUUM                      REGIONS                      EXPANDED**  
What are little black holes called? **PRIMORDIAL**  
What was the name for the rapid expansion of the universe after the Big Bang? **INFLATION**  
How big are primordial black holes? **SIZE OF JELLY BEAN, JELLY BEAN**

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How would you define the word primordial? ANCIENT, PREHISTORIC, PRIMEVAL, PRIMITIVE, EARLIEST

Now one last bit of black hole INSANITY. As you approach the event horizon and the gravitational pull gets stronger and stronger, the part of you nearest the black hole will be stretched more than the bit that is further away in a process called SPAGHETTIFICATION. That is, you get stretched longer and longer, like a piece of spaghetti! As you dive feet first into the black hole, your feet start to get stretched by gravity (faster than your head will)...they will move faster, the closer they get. To sum up, you very rapidly won't be looking your best. In fact, you'll be very dead. But on the bright side, if you believe you can never be too thin well...you'll end up being 1 atom in WIDTH. If your mind isn't yet completely blown, think about this: stand up for a second. Now your feet are closer to the center of the Earth than your head and therefore, are more strongly ATTRACTED to the earth's center. That means time is moving slower for your feet than your head! This has actually been MEASURED on Earth. For those who live at the top of a mountain, time moves faster than for those at sea level. How crazy is that?!



**VAKT: SPAGHETTIFICATION: THE PROCESS OF TURNING PEOPLE INTO PASTA!**

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**SPELL: ATTRACTED           INSANITY           WIDTH**

What is the process by which something entering a black hole is stretched called? **SPAGHETTIFICATION**

You'd be as thin as one what if you entered a black hole? **ATOM**

Standing on the top of Mount Everest, time moves what as compared to standing on a beach? **FASTER**

Take a guess as to what astronomers see as space material hits the event horizon. **TIME MOVES SO SLOWLY THAT THEY NEVER ACTUALLY SEE THE MATERIAL MOVE INTO THE BLACK HOLE**

To sum up, there is more we don't know about black holes than we do at this point. No one actually knows what a singularity actually is, what it will look like, and since you'd die in a hurry trying to find out, there have been no **VOLUNTEERS** to check out the scene. Besides, even **TRAVELING** at the speed of light (which also isn't happening anytime soon as it is 186,000 miles per second...a little faster than we are now capable of going!), it would take you 30,000 years to get to Sagittarius A. So if you are volunteering, you better think about leaving **IMMEDIATELY!**

**SPELL: VOLUNTEERS           TRAVELING           IMMEDIATELY**

How long will it take to get to Sagittarius A traveling at the speed of light? **30,000 YEARS**

How fast is the speed of light? **186,000 miles per second**

How long does it take light to get from the sun to Earth? **7 minutes**

**CREATIVE WRITING: Imagine you could travel into a black hole. Write a short story about what you think might happen or what you'd find there.**

**What do you think the singularity might look like?!**

**CREATIVE WRITING: Write a short story that involves time moving at different rates in different places.**

**VAKT: Here is a great video about how gravity affects time! How Neil deGrasse Tyson Explains How Gravity Affects Time:**

**<https://www.youtube.com/watch?v=BRw6ox3dGcA>**

**VAKT: Here is a great video about black holes!**

**Black Holes Explained – From Birth to Death**

**<https://www.youtube.com/watch?v=e-P5IFTqB98>**

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**Judy Chinitz, MS, MS** is the Director of Hand to Mouth Therapy. She is a New York State Licensed, Special Educator, and Certified S2C Practitioner. Judy has been actively involved in the world of autism, both biomedically and educationally, since her son, Alex was diagnosed 26 years ago. With a Master's degree in nutrition, she has worked with many of the top physicians in the field, authoring numerous book chapters, articles, and her own book on diet (*We Band of Mothers: Autism, My Son and the Specific Carbohydrate Diet*) and other biomedical treatments. In July 2019, when she was introduced to Spelling to Communicate (S2C), everything changed for both Judy and Alex. He went on to pass the GED exam with distinction and was recently accepted to the State University of New York, Purchase. Once she saw what spelling/typing for communication could do, Judy changed her entire career path, and in May of 2020, opened up the Mouth to Hand Learning Center, where she teaches many other nonspeaking students.

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