BLACK HOLES THAT EAT STARS

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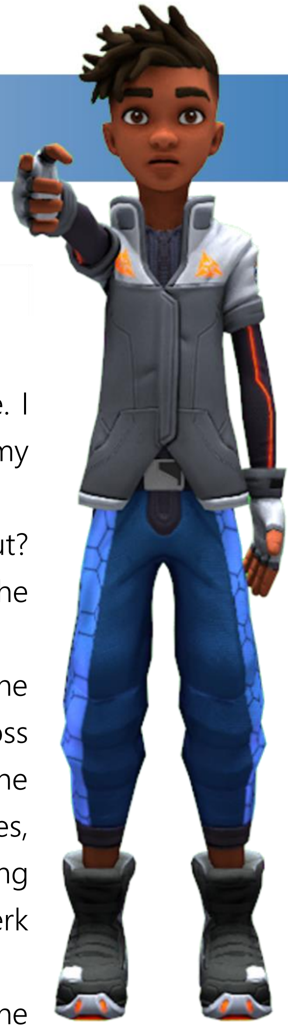
JACKSON’S STORIES

BLACK HOLES THAT EAT STARS (AS TOLD BY JACKSON)



“If I were a star,” I said, “I’d want to die of spaghettification from a black hole. I mean an out-in-space star, not a movie star. Being spaghettified would be my choice for my spectacular end of life.”

“Jack,” interrupted Johari, “what in the world are you talking about? Nobody can understand you. What is spaghettification? You need to start at the beginning.”

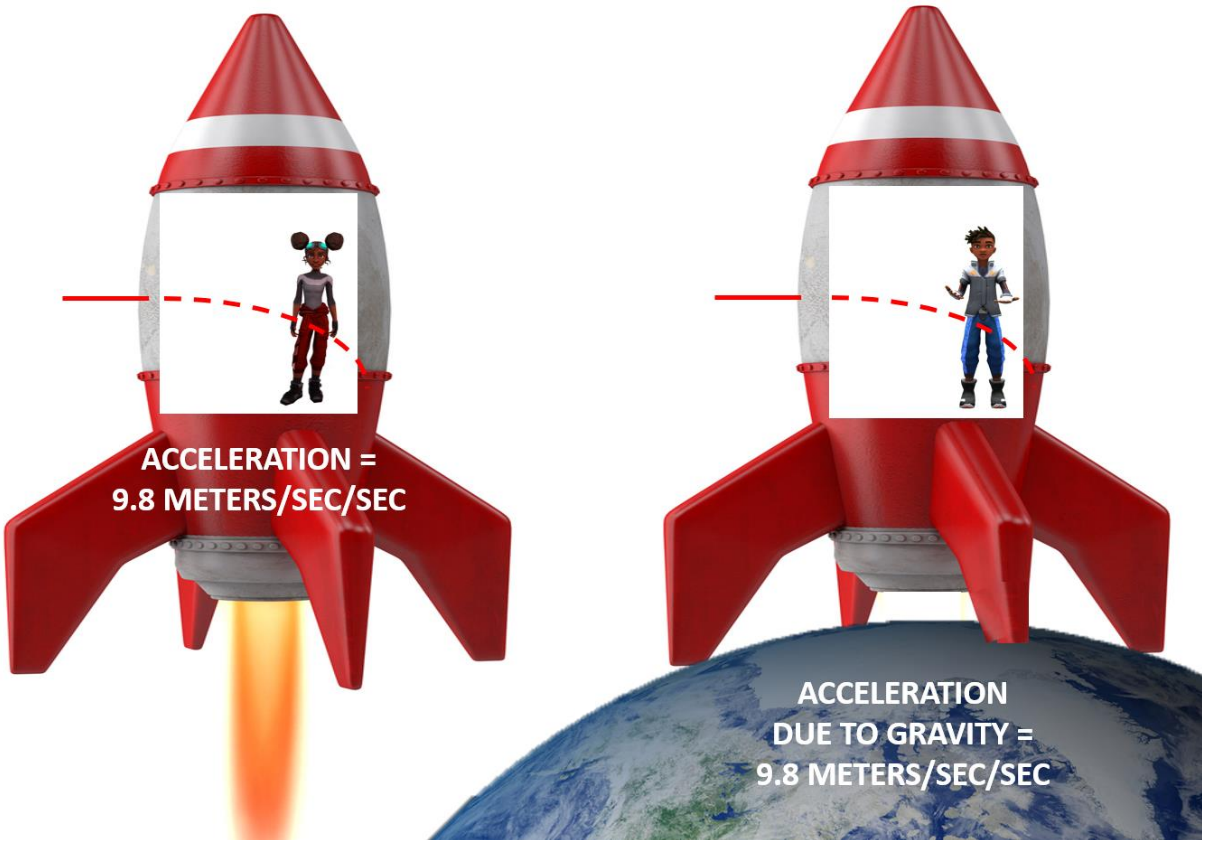
“OK,” I agreed, “you’re right. The beginnning was some time in the early 1900s. A painter fell off of a scaffolding on the outside of a building across the street from the patent office in Bern, Switzerland. A clerk who worked in the patent office saw the painter fall and had a thought. If the painter closed his eyes, the clerk imagined, he would not know whether he was accelerating, that is going faster and faster in free fall toward the ground, or floating in zero gravity. The clerk said it was t*he happiest thought of his life*.”

“That’s awful,” objected Johari. “The painter would surely know the difference the second he hit the ground. You’d think this guy would have called 911. That would have been a better thought.”

“OK, Jo,” I answered. “The patent clerk was Albert Einstein, and the story is probably not exactly true. But Einstein really did describe his inspiration that the force of gravity and acceleration are two different parts of one single thing. He really did say that it was *the happiest thought of his life*. And that thought was the basis for his *General Theory of Relativity*.

“There is one more part to explain before we get to spaghetti,” I continued. “It is Einstein’s thought experiment about rockets. Even a kid can understand that part of *Relativity*. If the painter couldn’t tell the difference between free falling and being in zero gravity, then the guys in the rocket can’t tell if they are on the ground on Earth, feeling the force of gravity, or in a rocket ship out in space, accelerating. Think of the ship going faster and faster, that is accelerating, at the same rate as a ball that is dropped on Earth.”

“Now think about shining a laser beam into the moving rocket ship,” I added. “Because the ship is accelerating, the laser beam would bend, following an arc to the other side of the ship. It would follow a straight line if the rocket was standing still or moving at constant speed.”



"Oh, I see," said Johari. "To the guy in the moving rocket ship, the laser beam would appear to bend. So, because Einstein predicts that the two guys should see the same thing, the beam in the rocket ship on the ground would bend too."

"Right, Jo," I answered. "And what does that mean?"

"It means that a beam of light should be bent by the force of gravity," Johari answered.

"Right again, Jo," I agreed as I gave her a pat on the head. She slapped my hand away and gave me a mean stare. "Here is the best part, Jo. Gravity bending light was actually observed in an experiment in 1919. It was during an eclipse of the sun. Just when our moon blocked the sun, the scientists could measure that light from a star was being bent by our sun, and that proved Einstein's *General Theory of Relativity*."

"So, *Boy Genius*," demanded Johari, "what in the universe does that have to do with a black hole and a star dying by spaghetti?"

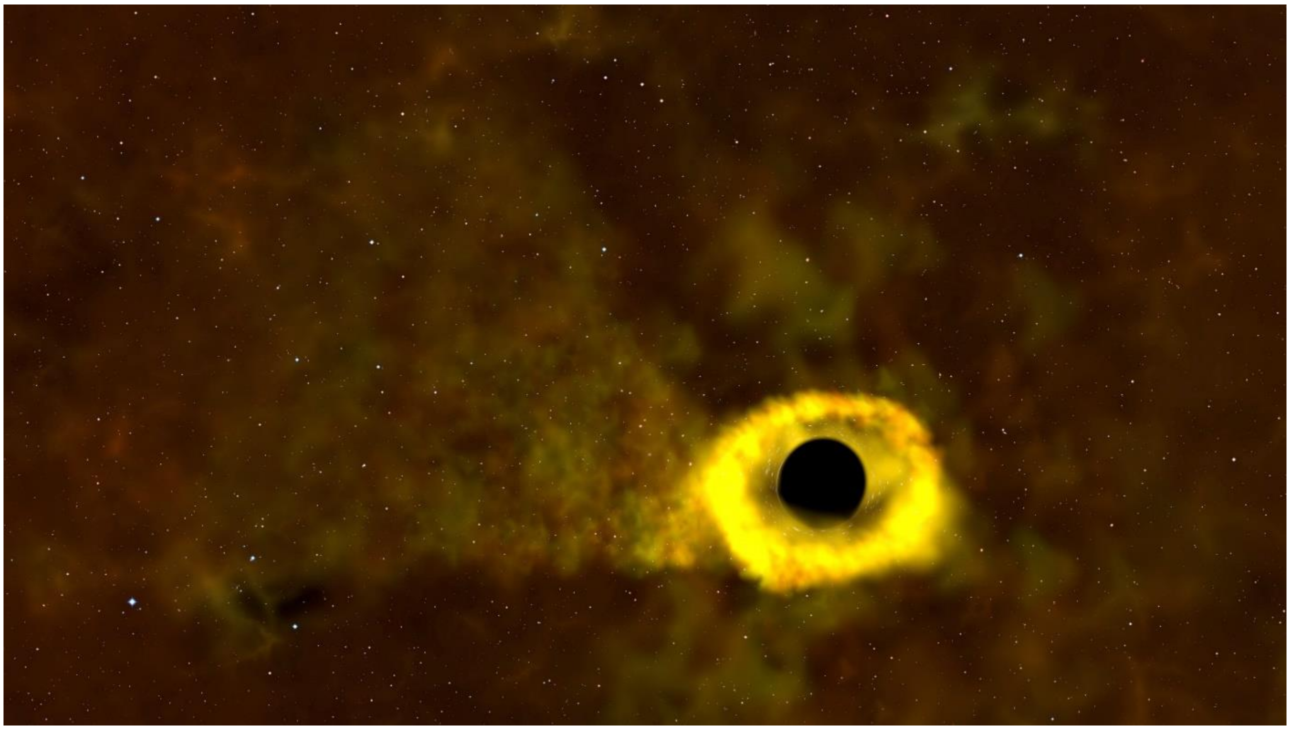
"Just stick with me a little longer," I requested. "Einstein had predicted that light would be attracted by gravity. The bending of light by our sun proved it. And the bigger the object, the bigger the attraction. A star ten times larger than our sun would have ten times the force of attraction. If the mass of an object is big enough, the force of attraction could be so large that light could never escape from the object."

"I got it," said Johari. "If I throw a ball in the air, it comes back to Earth because the force of gravity pulls it back. If I shine a light upward, gravity will pull on it but not with enough force to bring it back. But if our planet were super big, it could pull the light back. Is that a *black hole*—an object that is so massive that no light can escape it?"

"Right, Jo," I answered. "And the force of gravity of a *black hole* can be so large that it can attract a star to it and gobble it up. Most galaxies have a huge black hole in their centers. Some have eaten so many stars that they have a mass that is millions or even billions of times bigger than our sun.

"So," I continued, "it's in the eating of stars where the spaghetti comes in. Sometimes as the star gets drawn to the *black hole*, it can get stretched and stretched. It can get shredded into long strands as it's being eaten. Astronomers have named that event spaghettification. Such an event 215 light years away was recorded by a team of astronomers at the European Southern Observatory."

Another event was observed in January 2019 by NASA's planet-hunting Transiting Exoplanet Survey Satellite (TESS). TESS and other observatories watched a black hole rip apart a star in what was described as "*a cataclysmic phenomenon*." The event can be seen on a NASA TESS YouTube video.



Johari, the *Cosmic Exploreres*, and I nominate black holes eating stars and getting bigger and bigger as number three of *The Five Most Unusual Things in the Universe*.

GRANDPA'S GLOSSARY

Virtual World: Virtual worlds, also known as virtual environments, use computer technology to create a simulated world that a user can explore and interact with, while creating a feeling as if he or she were in that world. The representation of the user in that world is called an avatar. The user can even wear goggles to make it appear that he or she is surrounded by the 3-D virtual world. That is called virtual reality.

Force of Gravity: Gravity is the weakest of the four fundamental forces of nature. It is a force by which all things with mass (including ordinary objects, atoms, planets, stars, and galaxies) are attracted to one another. On Earth, gravity's pull on an object gives it weight. Gravity has an infinite range, although its effects become increasingly weaker as objects get further away. First Galileo and then Sir Isaac Newton predicted the inverse-square law of gravitation (the force is proportional to 1 divided by the distance between them squared). Newton proposed the following equation:

$$F = G*m(1)*m(2)/r^2,$$

where F is the force between two masses, m(1) and m(2); r is the distance between the centers of the masses; and G is the gravitational constant.

Gravity is more accurately described by the General Theory of Relativity proposed by Albert Einstein. Even light is affected by gravity in Einstein's theory.

Acceleration due to Gravity: Gravity is a force of attraction between all physical objects. If an object on Earth is dropped or thrown, the force of gravity between Planet Earth and the object will cause it to accelerate toward Earth. On Earth, the acceleration (rate of change of velocity) due to this gravitational force is 9.8 meters per second per second. That means that the velocity changes by 9.8 meters per second every second. The acceleration due to gravity on the moon is one sixth the value on Earth. The value depends on the mass and radius of the Earth or moon.

Black Holes: Black holes are super-dense masses that, thanks to their enormous gravitational pulls, suck everything into them like enormous monster vacuums. Their gravity is so strong that even light can't escape. That's why it's black. Black holes were predicted by Einstein's General Theory of Relativity. There is a supermassive black hole at the center of our Milky Way galaxy. The biggest black hole is believed to have a mass of over six billion times the mass of our sun.

General Theory of Relativity: General relativity is the geometrical theory of gravitation published by Albert Einstein in 1915. When Einstein became aware that feeling weightless in the absence of gravity, or in free fall acceleration because of it, were equivalent and something extremely fundamental, he called it the "happiest thought of my life." This observation guided him in the development of the theory in which gravity is a geometric property of space. In Einstein's theory, mass tells space how to curve, and the curvature of space tells mass how to move. The General Theory of relativity has important predictions. Georges Lemaître's solution of Einstein's equations for an expanding universe led to his Big Bang theory. The bending of light by gravity can lead to the phenomenon of gravitational lensing, in which multiple images of the same distant astronomical object are visible in the sky. The attraction of light by mass leads to the prediction of black holes, whose mass is so large that no light can escape. The theory predicts that cosmic events can produce gravitational wave distortions of space itself that travel at the speed of light. The first observation of gravitational waves was made by LIGO in 2015. The theory predicts the Twin Paradox described in chapter 18. The predictions of general relativity have been confirmed in all observations and experiments to date.

NASA TESS YouTube video: https://youtu.be/85tdoDt1Qh0, TESS Catches its First Star-Destroying Black Hole.

THE STARDUST MYSTERY PROJECT

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