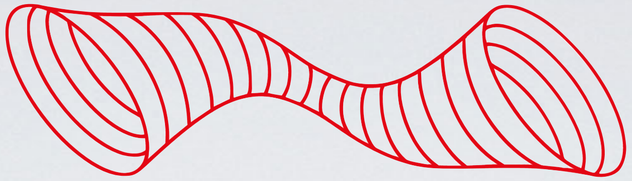

THE CENTER OF GRAVITY

WHAT IS A BLACK HOLE?

Rodrigo Panosso Macedo

Carlsberg Mindelegat

https://hyperboloid.al

WHAT ARE BLACK HOLES?

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Black holes are empty
yet massive

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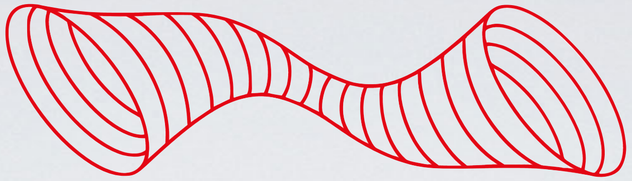
Black holes are highly curved space time

Black holes are just gravity in its most magnificent form



THE CENTER OF GRAVITY

WHAT IS A ~~BLACK HOLE~~?

GRAVITY?

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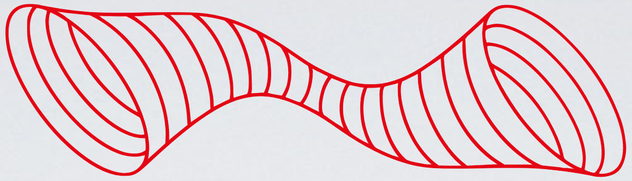

THE CENTER OF GRAVITY

~~WHAT IS A BLACK HOLE?~~

HISTORY OF GRAVITY!

Rodrigo Panosso Macedo

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Gravity affects all bodies in the exact same way


NASA
SN


NASA
SN

ESCAPE VELOCITY

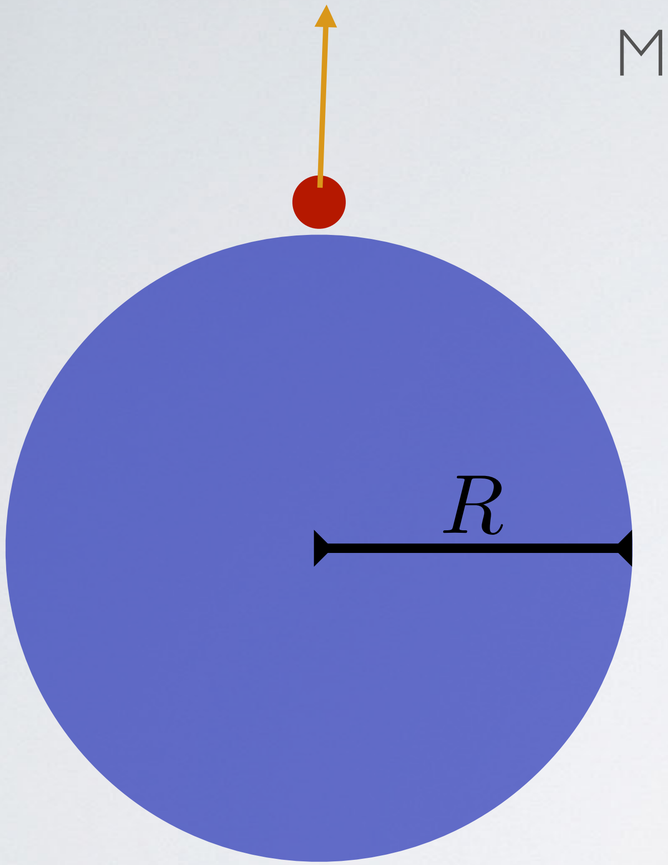
Minimum velocity to escape the gravitational field

ESCAPE VELOCITY

Minimum velocity to escape the gravitational field

Energy associate with velocity = Energy associate with gravitational field

ESCAPE VELOCITY

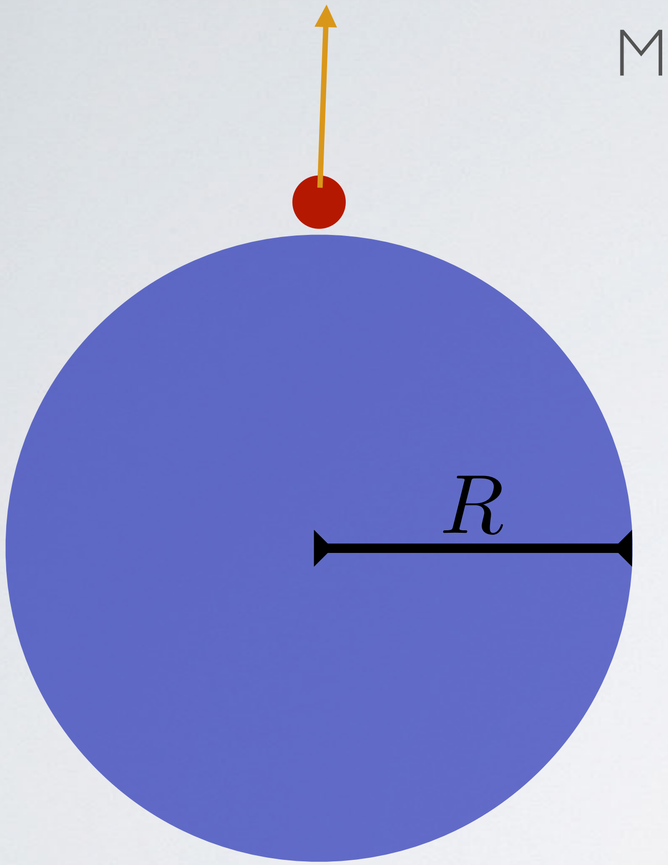


Minimum velocity to escape the gravitational field

$$\frac{m\,v^2}{2} = G\,\frac{m\;M}{R}$$

G: Newton's constant of gravity (number taking care of how strong gravity is)

ESCAPE VELOCITY



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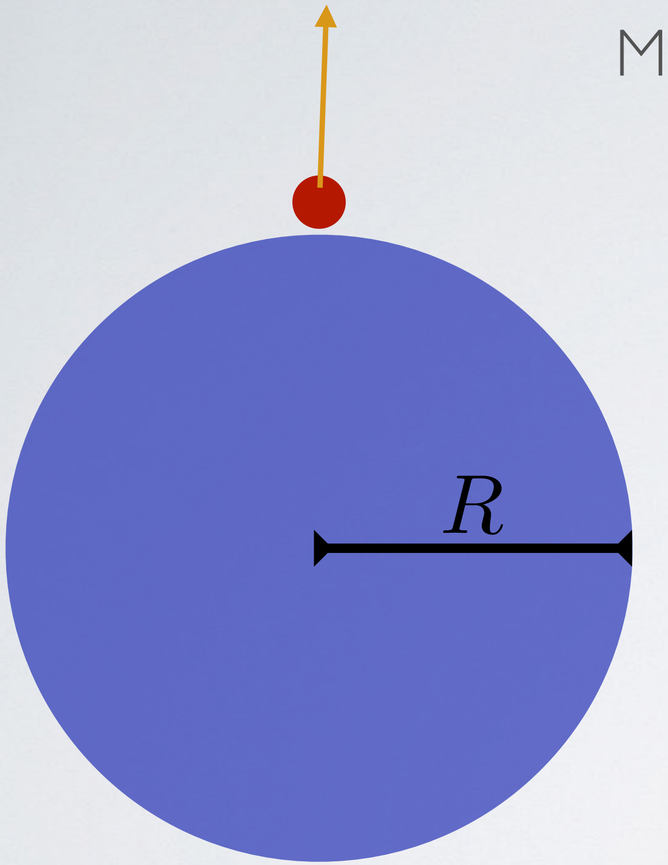
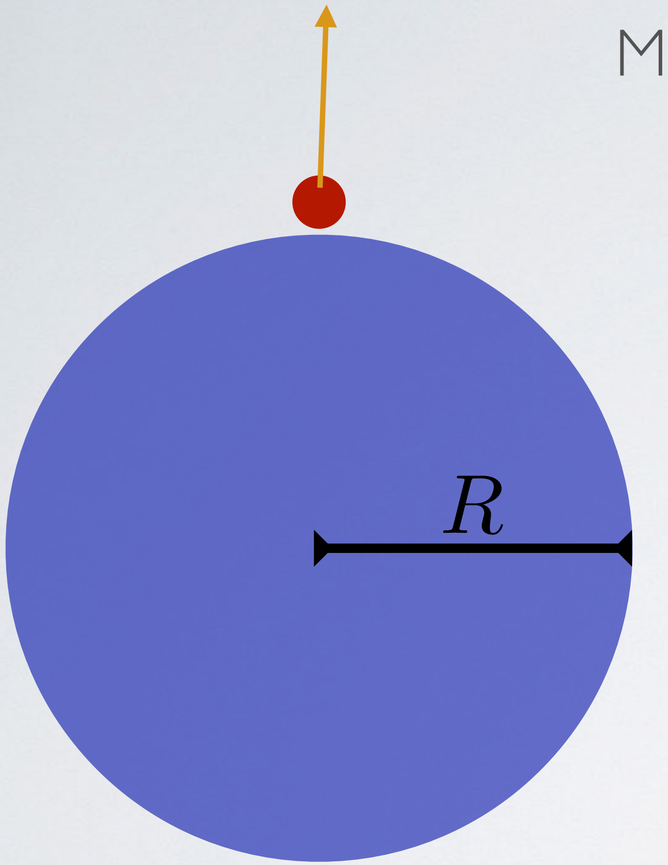


Minimum velocity to escape the gravitational field

$$v^2 = \frac{2\,G\,M}{R}$$

G: Newton's constant of gravity (number taking care of how strong gravity is)

ESCAPE VELOCITY



Minimum velocity to escape the gravitational field

$$v^2 = \frac{2\,G\,M}{R}$$

Body	Mass (kg)	Radius (m)	Escape velocity (km/s)
Earth	5.97×10^{24}	6.37×10^{6}	11.2
Moon	7.34×10^{22}	1.74×10^{6}	2.38
Sun	1.99×10^{30}	6.96×10^{8}	617.7

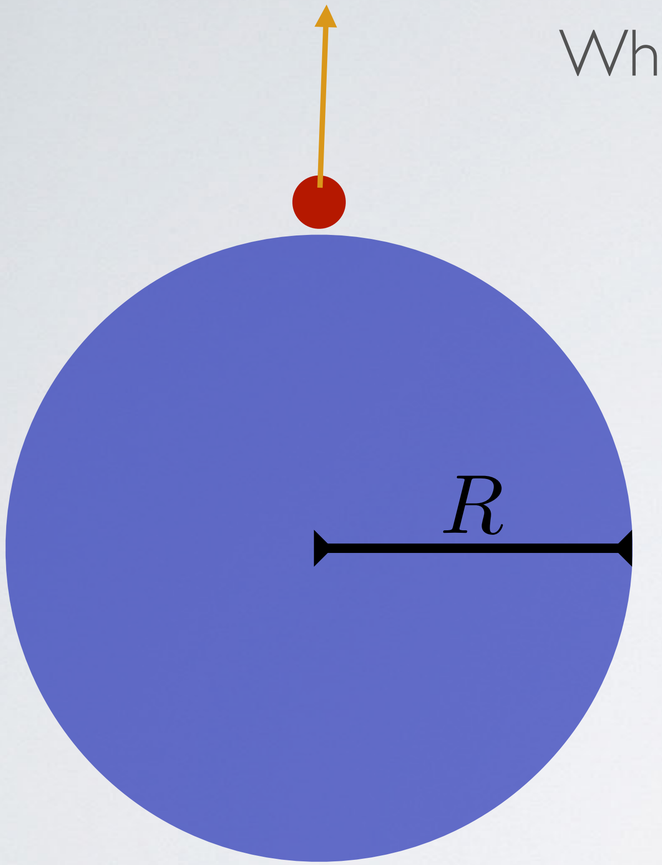
G: Newton's constant of gravity (number taking care of how strong gravity is)

$$G = 6.6743 \times 10^{-11}\,\frac{\mathrm{m}^3}{\mathrm{kg\,s}^2}$$

Gravity affects all bodies in the exact same way

HOW ABOUT LIGHT?

DARK STAR

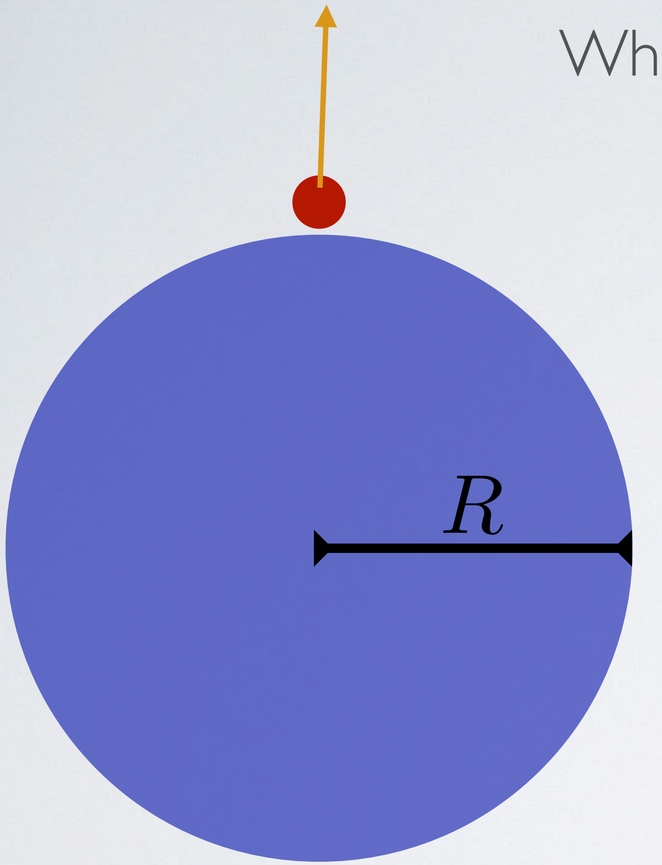


What if the escape velocity equals the speed of light?

$$v^2 = \frac{2\,G\,M}{R}$$

G: Newton's constant of gravity (number taking care of how strong gravity is)

DARK STAR



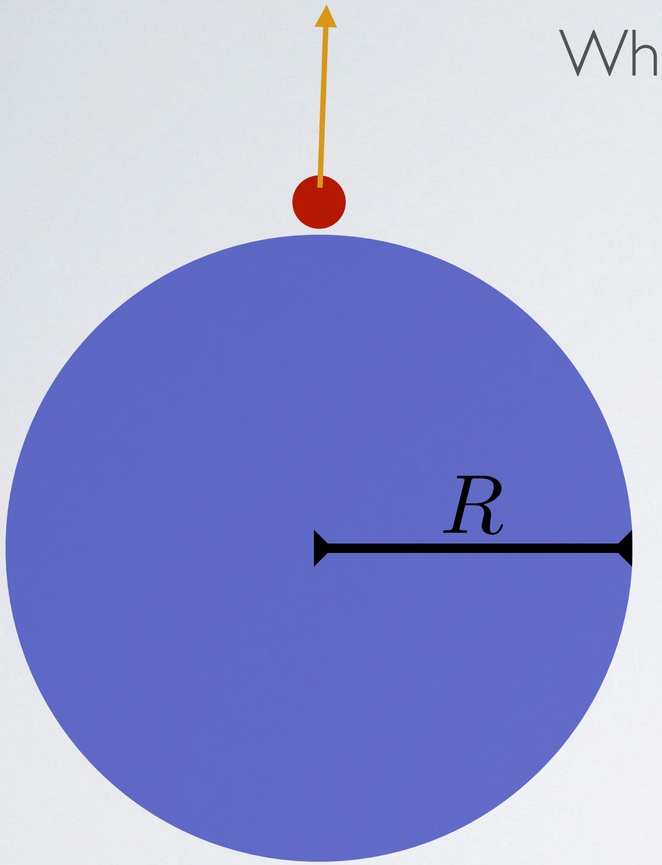
What if the escape velocity equals the speed of light?

$$c^2 = \frac{2\,G\,M}{R}$$

G: Newton's constant of gravity (number taking care of how strong gravity is)

c : Speed of light

DARK STAR



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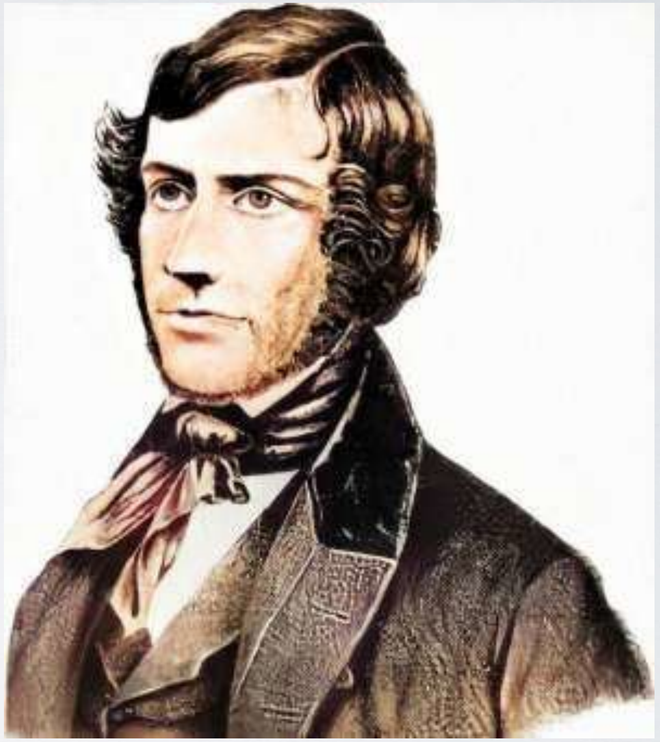
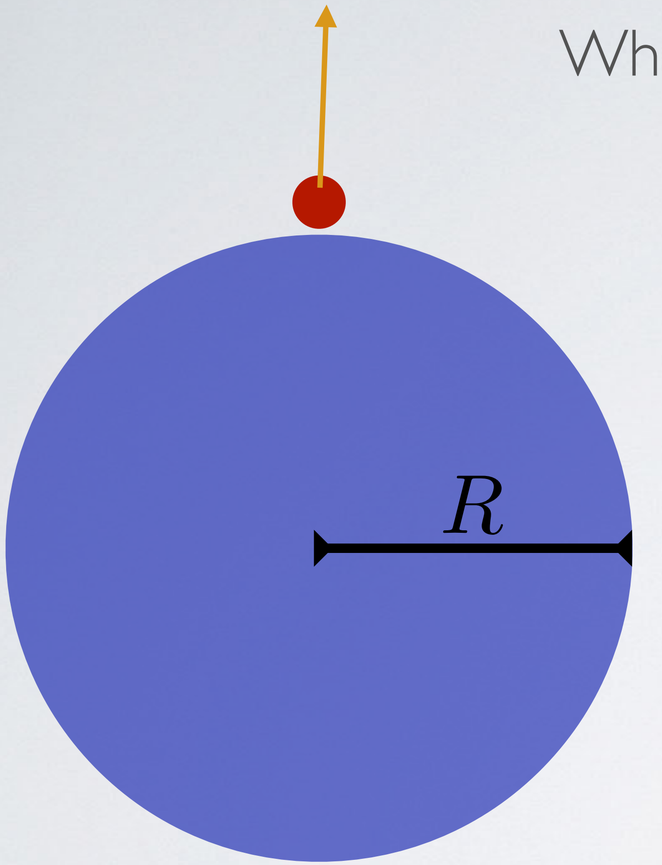


John Michell (1724-1793)

G: Newton's constant of gravity (number taking care of how strong gravity is)

c : Speed of light

DARK STAR



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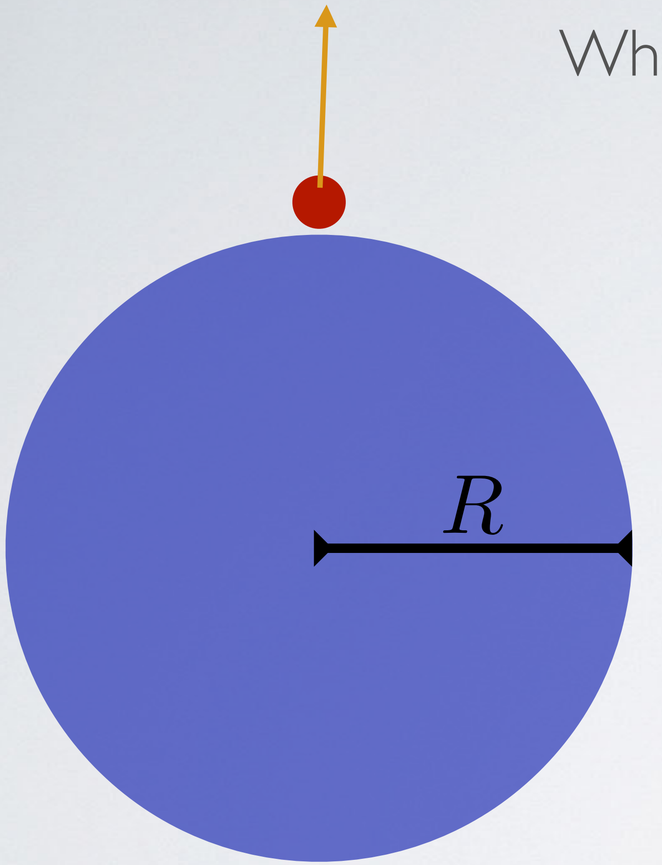

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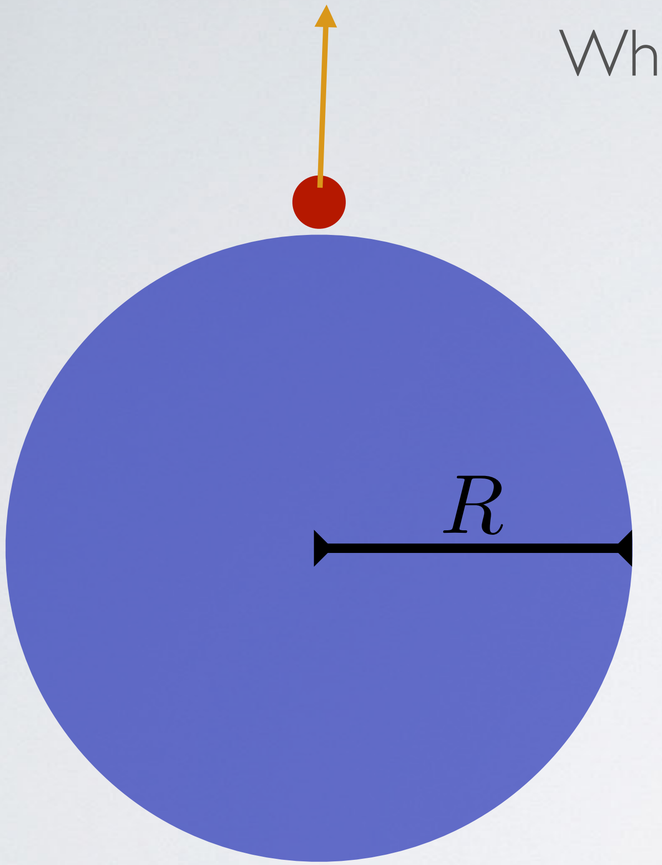

What if the escape velocity equals the speed of light?

$$R = \frac{2\,G\,M}{c^2}$$

Body	Mass (kg)	Radius (m)	Dark Star radius
Earth	5.97×10^{24}	6.37×10^{6}	8.87 mm
Moon	7.34×10^{22}	1.74×10^{6}	0.109 mm
Sun	1.99×10^{30}	6.96×10^{8}	2.95 km

G: Newton's constant of gravity (number taking care of how strong gravity is)

c : Speed of light

DARK STARS VERSUS BLACK HOLES

DARK STARS VERSUS BLACK HOLES

Light doesn't escape

Light doesn't escape

DARK STARS VERSUS BLACK HOLES

Light doesn't escape

Objects orbiting a dark spot

Light doesn't escape

Objects orbiting a dark spot

DARK STARS VERSUS BLACK HOLES

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Light orbiting a dark spot

DARK STARS VERSUS BLACK HOLES

DARK STARS	BLACK HOLES
Light doesn't escape	Light doesn't escape
Objects orbiting a dark spot	Objects orbiting a dark spot
Light orbiting a dark spot	Light orbiting a dark spot
Information may escape (construct a rocket to overcome gravity pull)	Information doesn't (nothing escape)

DARK STARS VERSUS BLACK HOLES

DARK STARS	BLACK HOLES
Light doesn't escape	Light doesn't escape
Objects orbiting a dark spot	Objects orbiting a dark spot
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It is made of matter	It is just spacetime

DARK STARS VERSUS BLACK HOLES

DARK STARS	BLACK HOLES
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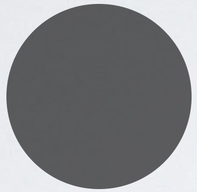
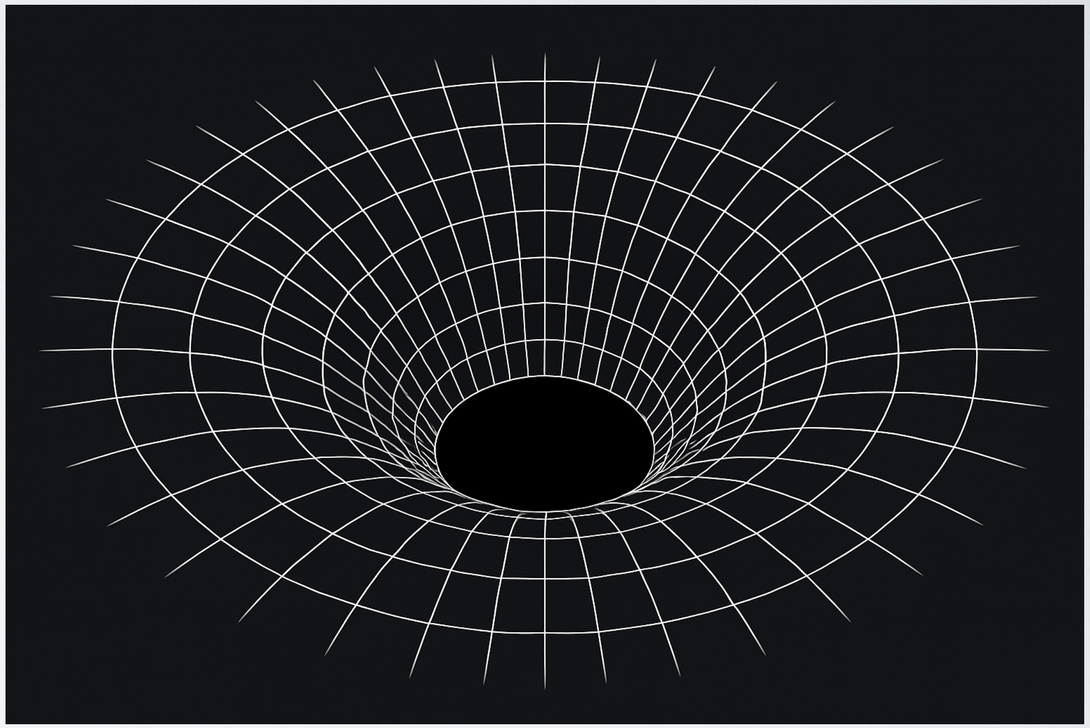
Objects orbiting a dark spot	Objects orbiting a dark spot
Light orbiting a dark spot	Light orbiting a dark spot
Information may escape (construct a rocket to overcome gravity pull)	Information doesn't (nothing escape)
It is made of matter	It is just spacetime
It has a surface	It has a no surface

DARK STARS	VERSUS	BLACK HOLES
Light doesn't escape		Light doesn't escape
Objects orbiting a dark spot		Objects orbiting a dark spot
Light orbiting a dark spot		Light orbiting a dark spot
Information may escape (construct a rocket to overcome gravity pull)		Information doesn't (nothing escape)
It is made of matter		It is just spacetime
It has a surface		It has a no surface
Does not exist in nature		Exists in nature

DARK STARS ARE NOT BLACK HOLES





Newton's Theory of Gravity:
Classical Mechanics

Einstein's Theory of Gravity:
General Relativity