

ASTRONOMY UNIT 16

Lab Three – Schwarzschild radius

Questions

What are the largest non-diffuse objects in the universe?

Black holes are the result of stellar collapse. Is it possible that black holes are larger than stars?

Hypothesis

1. Black holes are the largest objects in the universe
2. Black holes are not the largest objects in the universe

Method

1. Get the mass of the black hole
2. Use the mass in this equation to calculate the Schwarzschild Radius

$$R_s = \frac{2GM}{c^2}$$

Where:

G is the gravitational constant

$$6.67408 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$$

M is the mass of the body

c is the speed of light

$$3 \times 10^8 \text{ m/sec}$$

R_s is the Schwarzschild Radius

3. Compare values of BH Schwarzschild Radius with the sizes of the largest celestial bodies

Object	Type	Physical Radius (m)	Physical Mass (kg)	Schwarzschild Radius (m)
UY Scuti	Star	$1.18 \cdot 10^{12}$ m	$8.00 \cdot 10^{31}$ kg	
Jupiter	Planet	$7.00 \cdot 10^7$ m	$1.91 \cdot 10^{27}$ kg	
Sun	Star	$7.00 \cdot 10^8$ m	$1.99 \cdot 10^{30}$ kg	$2.96 \cdot 10^3$ m
Cygnus X1	Black Hole		$4.22 \cdot 10^{31}$ kg	
Sagittarius A*	Black Hole		$8.16 \cdot 10^{36}$ kg	
SMBH in Andromeda	Black Hole		$4.58 \cdot 10^{38}$ kg	
SMBH in Messier 87	Black Hole		$1.30 \cdot 10^{40}$ kg	
SMBH in NGC 4889	Black Hole		$4.20 \cdot 10^{40}$ kg	
TON 618	Black Hole		$1.30 \cdot 10^{41}$ kg	

Calculate the Schwarzschild Radius for the following objects

UY Scuti (star)

$$2 \cdot (6.67 \cdot 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2} \cdot \text{_____}) / (3.00 \cdot 10^8 \text{ m/s})^2$$

Jupiter (planet)

Cygnus X1 (black hole)

Sagittarius A* (black hole)

SMBH in Andromeda (black hole)

SMBH in Messier 87 (black hole)

SMBH in NGC 4889 (black hole)

TON 618 (black hole)

Conclusion

Black holes are the largest non-diffuse objects in the universe

Black holes are not the largest non-diffuse objects in the universe