

Black-holes

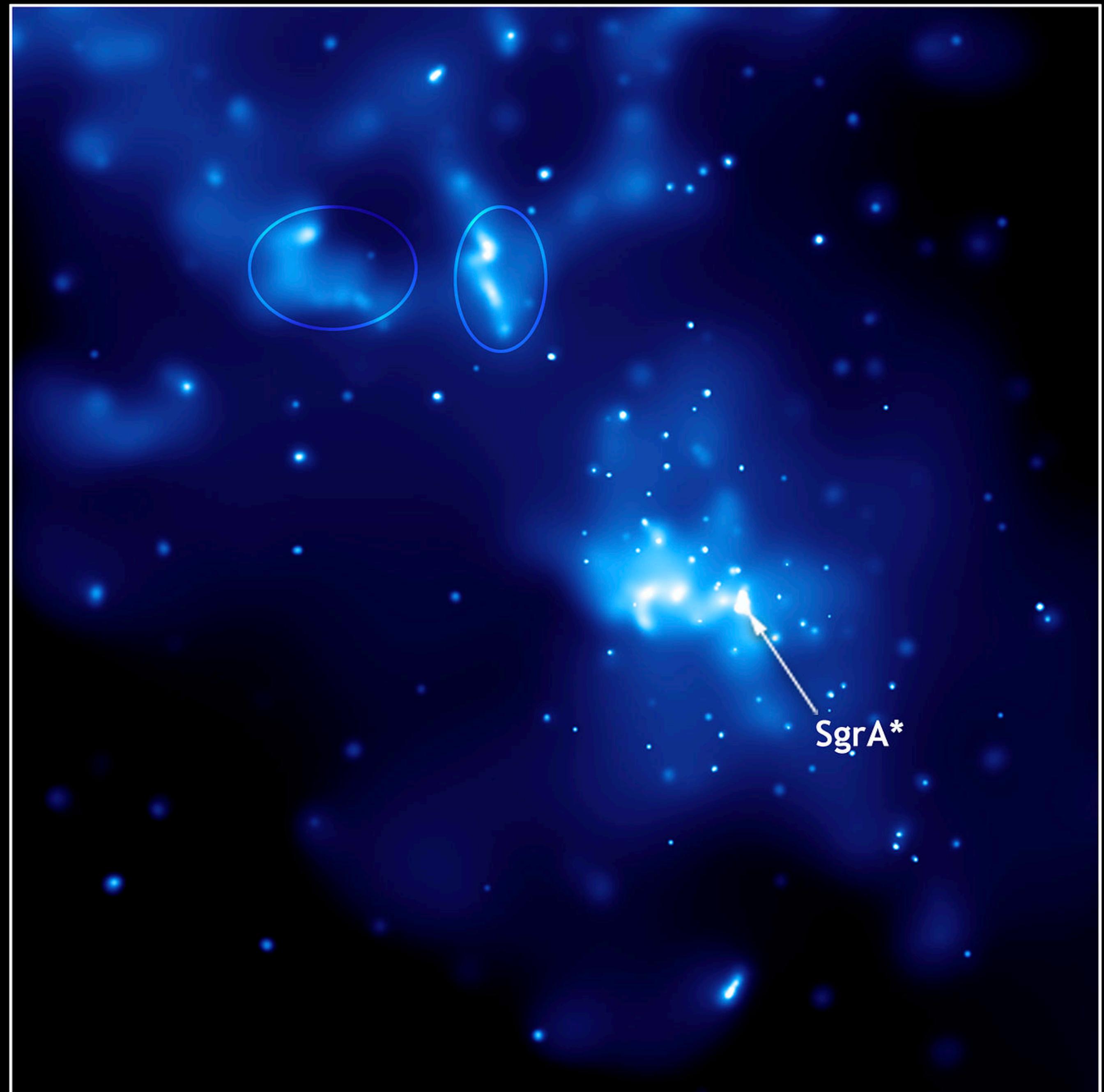
L. Vacher -



2005

2004

2002





$$\frac{1}{2}mv^2 = \frac{GMm}{r}$$

$$v = \sqrt{\frac{2GM}{r}}$$

Location	Relative to	V_e (km/s) ^[12]	Location	Relative to	V_e (km/s) ^[12]	System escape, V_{te} (km/s)
On the Sun	The Sun's gravity	617.5	At Mercury	The Sun's gravity	~ 67.7	~ 20.3
On Mercury	Mercury's gravity	4.25	At Venus	The Sun's gravity	49.5	17.8
On Venus	Venus's gravity	10.36	At Earth	The Sun's gravity	42.1	16.6
On Earth	Earth's gravity	11.186	At the Moon	The Earth's gravity	1.4	2.42
On the Moon	The Moon's gravity	2.38	At Mars	The Sun's gravity	34.1	11.2
On Mars	Mars' gravity	5.03	At Ceres	The Sun's gravity	25.3	7.4
On Ceres	Ceres's gravity	0.51	At Jupiter	The Sun's gravity	18.5	60.4
On Jupiter	Jupiter's gravity	60.20	At Io	Jupiter's gravity	24.5	7.6
On Io	Io's gravity	2.558	At Europa	Jupiter's gravity	19.4	6.0
On Europa	Europa's gravity	2.025	At Ganymede	Jupiter's gravity	15.4	5.3
On Ganymede	Ganymede's gravity	2.741	At Callisto	Jupiter's gravity	11.6	4.2
On Callisto	Callisto's gravity	2.440	At Saturn	The Sun's gravity	13.6	36.3
On Saturn	Saturn's gravity	36.09	At Titan	Saturn's gravity	7.8	3.5
On Titan	Titan's gravity	2.639	At Uranus	The Sun's gravity	9.6	21.5
On Uranus	Uranus' gravity	21.38	At Neptune	The Sun's gravity	7.7	23.7
On Neptune	Neptune's gravity	23.56	At Triton	Neptune's gravity	6.2	2.33
On Triton	Triton's gravity	1.455	At Pluto	The Sun's gravity	~ 6.6	~ 2.3
On Pluto	Pluto's gravity	1.23				
At Solar System galactic radius	The Milky Way's gravity	492–594 ^{[13][14]}				
On the event horizon	A black hole's gravity	299,792.458 (speed of light)				



$$v = \sqrt{\frac{2GM}{r}} = c$$

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

Object	Mass M	Schwarzschild radius $\frac{2GM}{c^2}$	Actual radius r	Schwarzschild density $\frac{3c^6}{32\pi G^3 M^2}$ or $\frac{3c^2}{8\pi Gr^2}$
Observable universe	8.8×10^{52} kg	1.3×10^{26} m (13.7 billion ly)	4.4×10^{26} m (46.5 billion ly)	9.5×10^{-27} kg/m ³
Milky Way	1.6×10^{42} kg	2.4×10^{15} m (0.25 ly)	5×10^{20} m (52.9 thousand ly)	0.000029 kg/m ³
TON 618 (largest known black hole)	1.3×10^{41} kg	1.9×10^{14} m (~1300 AU)		0.0045 kg/m ³
SMBH in NGC 4889	4.2×10^{40} kg	6.2×10^{13} m (~410 AU)		0.042 kg/m ³
SMBH in Messier 87 ^[9]	1.3×10^{40} kg	1.9×10^{13} m (~130 AU)		0.44 kg/m ³
SMBH in Andromeda Galaxy ^[10]	3.4×10^{38} kg	5.0×10^{11} m (3.3 AU)		640 kg/m ³
Sagittarius A* (SMBH in Milky Way) ^[11]	8.2×10^{36} kg	1.2×10^{10} m (0.08 AU)		1.1×10^6 kg/m ³
Sun	1.99×10^{30} kg	2.95×10^3 m	7.0×10^8 m	1.84×10^{19} kg/m ³
Jupiter	1.90×10^{27} kg	2.82 m	7.0×10^7 m	2.02×10^{25} kg/m ³
Earth	5.97×10^{24} kg	8.87×10^{-3} m	6.37×10^6 m	2.04×10^{30} kg/m ³
Moon	7.35×10^{22} kg	1.09×10^{-4} m	1.74×10^6 m	1.35×10^{34} kg/m ³
Saturn	5.683×10^{26} kg	8.42×10^{-1} m	6.03×10^7 m	2.27×10^{26} kg/m ³
Uranus	8.681×10^{25} kg	1.29×10^{-1} m	2.56×10^7 m	9.68×10^{27} kg/m ³
Neptune	1.024×10^{26} kg	1.52×10^{-1} m	2.47×10^7 m	6.97×10^{27} kg/m ³
Mercury	3.285×10^{23} kg	4.87×10^{-4} m	2.44×10^6 m	6.79×10^{32} kg/m ³
Venus	4.867×10^{24} kg	7.21×10^{-3} m	6.05×10^6 m	3.10×10^{30} kg/m ³
Mars	6.39×10^{23} kg	9.47×10^{-4} m	3.39×10^6 m	1.80×10^{32} kg/m ³
Human	70 kg	1.04×10^{-25} m	$\sim 5 \times 10^{-1}$ m	1.49×10^{76} kg/m ³
Planck mass	2.18×10^{-8} kg	3.23×10^{-35} m	(twice the Planck length)	1.54×10^{95} kg/m ³



