Question 1:

a)

PA Paul Allen
19 Dec 2024, 11:20

The black eye glaxy

The Black Eye Galaxy, also called the Evil Eye Galaxy, is a beautiful spiral galaxy with a distinctive black band of carbon particles surrounding its bright inner zone. This unique feature led William Herschel to describe it as resembling a "black eye" on a galaxy.

The galaxy is approximately 17 million light-years away and can be observed in the constellation of Coma Berenices. However, this distance is under debate. Despite having Cepheid variable stars that could help determine its precise distance, estimates range from 14 million light-years (R. Tully) to 44 million light-years (E. Holmberg). These varying distances have led to disagreements over the dimensions of the galaxy's different regions. Using Hubble's estimate of 17 million light-years, we can approximate its diameter to be about 16 kiloparsecs, which is roughly two-thirds the size of the Milky Way.

Another remarkable characteristic of the Black Eye Galaxy, aside from the dark cloud that gives it its name, is its intense starburst activity. This region of rapid star formation was triggered by the collision and merger of a smaller galaxy with the Black Eye Galaxy about a billion years ago. The same collision is likely responsible for the gas in its outer regions rotating in the opposite direction to the stars within.

References

1. Astronomy Picture of the Day. https://apod.nasa.gov, accessed 19/12/2024.
2. Astronomy Magazine. https://www.astronomy.com, accessed 19/12/2024.

Reply Permalink ★ Star post ↑ Parent

b)

Galaxy	Classification
1	Sa
2	E1
3	E4
4	E6
5	SBb

Question 2:

a)

Orientation	size (*arcsec*)	error (*arcsec*)
vertical	494.22	± 5
horizontal	482.48	± 5
$45 deg$	450.54	± 5
$135 deg$	498.34	± 5

b)

This gives us an average diameter of

$$\frac{494.22 + 482.48 + 450.54 + 498.34}{4} = 481.395$$

The average diameter of the SNR is $481.395''$
Converting this to radians, and then to parsecs

$$481.395'' \times \frac{\pi}{3600\ arcsec\ deg^{-1} \times 180\ deg\ rad^{-1}} = 0.0023 \ldots rad$$

and as it is 4.8kpc away and using the small angle approximation

$$D = \theta d = 0.0023 rad \times 4800\text{pc} = 11.2\,\text{pc}$$

to 3 s.f

c)
Hence the speed of the SNR is

The size of the SNR in km is

$$11.2\,\mathrm{pc} \times 3.09 \times 10^{13}\,\mathrm{km\,pc^{-1}} = 3.46 \times 10^{14}\,\mathrm{km}$$

assuming that the speed has bee consistent since its conception

$$\begin{aligned} speed &= \frac{distance}{time} \\ &= \frac{3.46 \times 10^{14}}{5.048 \times 10^{10}} \\ &= 6860\,\mathrm{km\,s^{-1}} \end{aligned}$$

to 3 s.f

While the Tycho SNR likely expanded faster in its initial stages due to being younger (600 years), the older SNR analysed here (1600 years) continues to expand at a significant velocity. of $6860\,\mathrm{km\,s^{-1}}$.

Looking at the measurements of the SNR it does not appear to be expanding evenly in all directions. The measurement taken across the SNR at an angle of $45 deg$ is significantly less than the other three measurements, implying the SNR has an asymmetry in its expansion. This could indicate either non-uniform energy distribution or potentially to external factors like interactions with surrounding material.

The measurements used here are only approximations due to the resolution of the x-ray observation, and the asymmetry of the expansion and the limited measurements taken to approximate the diameter.

d)

Using

$$\frac{r_1}{r_2} = \left(\frac{t_1}{t_2}\right)^{0.4}$$

$$r_1 = r_2 \left(\frac{t_1}{t_2}\right)^{0.4}$$

Substituting in our values

$$= \frac{11.2\ldots}{2} \left(\frac{1952 - 406}{1600}\right)^{0.4}$$

$$= 5.6\ldots \left(\frac{1546}{1600}\right)^{0.4}$$

$$= 5.52\,\mathrm{pc}$$

Converting this into *arcsec*

$$5.52\ldots\,\mathrm{pc} \div 4800\,\mathrm{pc} = 1.15 \times 10^{-3}\,\mathit{rad}$$

$$\frac{1.15 \times 10^{-3}}{\frac{\pi}{3600 \times 180}} = 237.36''$$

giving an angular size in 1952 of

$$D = 237.36\ldots \times 2$$

$$= 475'' \qquad \textit{to 3 s.f}$$

This result for the angular size of the SNR for 1952 corresponds to the larger radius measured in 2006. This size discrepancy is in alignment with the power law relationship $r \propto t^{0.4}$.

The instrument used in 1952 had a spatial resolution of $2' = 120''$ and therfore would be well within the capabilities of this instrument to resolve the SNRs angular diameter of $475''$, assuming that it was sufficiently bright.