Supermassive Black Hole in the Milky Way

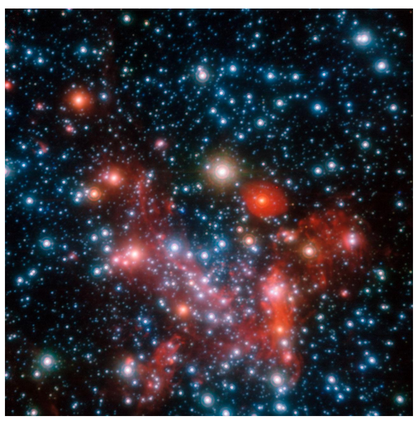
Nayda Guerrero P.
Departamento de Astronomía, Universidad de Concepción, Concepción, Chile

Abstract

A black hole is one of the most interesting objects in the galaxy. Several studies suggest the existence of a Super Massive Black Hole (SMBH) at the center of the galaxy due to the orbits of nearby stars, generated by its huge gravitational field. We can study the radiation emitted at different wavelengths and thus know what happens in the vicinity of the black hole, like, for example, the star forming activity close to it. It also important to know about new research about this SMBH, which delivers to us new knowledge about Sgr A*

Introduction

Sagittarius A* (Sgr A*) is a SMBH in the Milky Way. It is located in the center of the Galaxy, towards the Sagittarius constellation, at about 8.5 Kpc or 27000 lyr from the Sun. According to recent measurements, it has a mass of 4 x 10^6 $M_\odot$, concentrated in a 0.01pc region. It is a quiescent black hole without an accretion disk and a toroidal structure of gas and dust. However, is has a circumnuclear ring that could be the remnant of this kind of structure. Probably, the lack of dense gas close enough to it may be the cause of the faintness of Sgr A*.

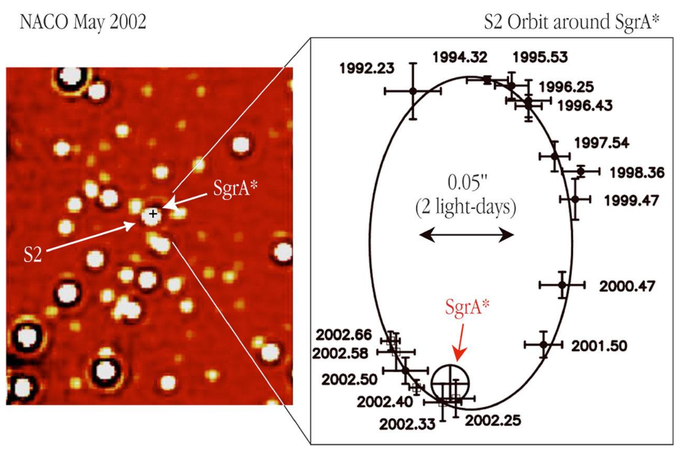


Credit: Gillessen et. al (2009)

The central part of our Galaxy, as observed in the NIR. The image was obtained in the K,H,I band with the NACO instrument on Very Large Telescope (VLT).

Detection

The confirmation of the presence of Sgr A* (Gillessen et. al 2009) is due to a 16 years-long investigation, during which high-velocity stars were detected on small orbits around the SMBH. In 2002 it was observed that the orbit of star S2 forms a really-pronounced ellipse around Sgr A*, reaching a velocity of ~ 5000 km/s. At the minimum distance, the star S2 is at about 3 times the Sun-Pluto distance. During the observations, S2 completed a revolution around Sgr A*, giving information on the Galactic Center, since it permitted to determine the mass and high density of Sgr A*.

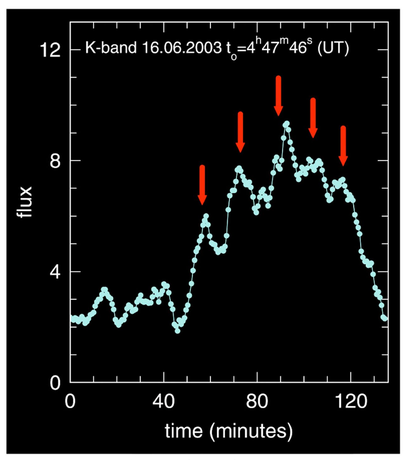


Credit: Shödel et. al (2002)

The motion of S2 around the SMBH in the Milky Way. The image was obtained in the K-band at wavelenght 2.2 µm with the NACO instrument on VLT and the angular resolution is about 0.060 arcsec.

Emission

Sgr A* flare emission has been simultaneously observed at sub-mm, NIR and X-ray wavelength. It happens when the gaseous matter plunges towards the SMBH, heading up and emitting copious electromagnetic radiation. The emission we detect from Sgr A* changes in brightness. NIR flares occurring several times per day, have a periodicity of ~ 17 minutes. Sgr A* is subject almost daily to several bursts and occasionally to enormous explosions. They are generated in the proximity of the event horizon and the cause is undetermined, but the emitted X-ray are quite weak.

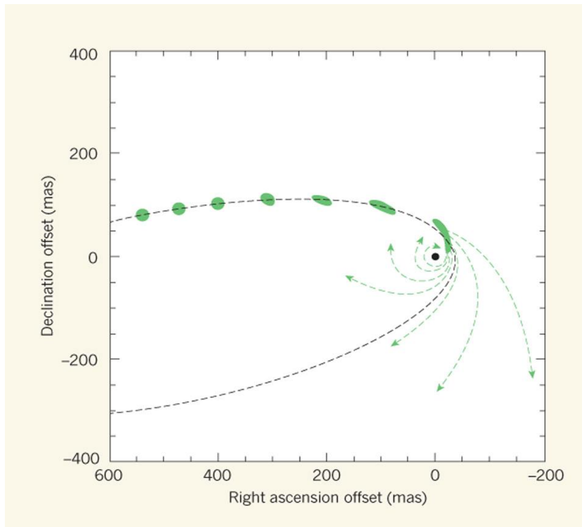


Credit: Genzel et. al (2003)

This image displays the "light curve" of a light flare from the galactic center, as observed in the K-band at a wavelength of 2.2 µm with NACO instrument on VLT. This shows variability on a time scale of a few minutes and appears to show larger variations (arrows) with a 17-minute periodicity (the rapid variability implies that the infrared emission comes from just outside the black hole).

Gas cloud around Sgr A*

A moving gas and dust cloud was detected approaching Sgr A*. The minimum distance is estimated to be reached in mid-2013. The cloud, located at a distance of Sgr A* about 260 times the mean Earth-Sun distance, have a mass 3 times that of Earth and about the size of the Solar System. It is believed that the SMBH's tidal force will break the cloud and generate a progressive elongation, dispersing the gas in several streams, so we will be able to see the radiation emitted during the in fall towards Sgr A*.

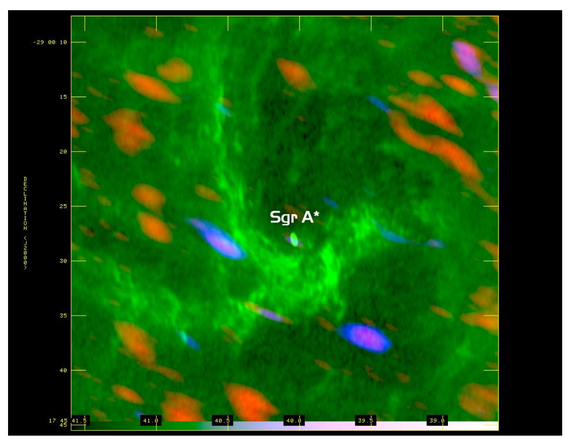


Credit: Gillessen et. al (2013)

"The sequence of green blobs represents the successive locations of the cloud of gas and dust. The black spot is the Milky Way's black hole. The dashed black line is a trajectory that a point mass would follow in the absence of tidal effects. The cloud becomes elongated because of the tidal force acting on it, especially as it nears the point of closest approach, where it is violently sheared and the trajectories of different parts of the cloud diverge (dashes green lines)." (Gillessen et. al 2013)

Star formation near Sgr A*

There are young and massive stars orbiting Sgr A*, however, it is not sure how they acquired their orbits. It was suggested the hypothesis that they could be formed in situ. Using the ALMA telescope, researches have found signs of star formation near the SMBH, which would be surprising because this area is affected by strong gravitational forces that stretch any molecular cloud, preventing star formation.



Credit: Yusef-Zadeh et. al (2013)

ALMA identified jets bursting out of what appears to be a dense cloud of gas and dust. The jets were detected by tracing the presence of SiO, excited during star formation, that emits at millimeter wavelengths.

Conclusion

Our supermassive black hole may provide clues on the formation of the Milky Way. Anyway, we have several items that have to be unveiled, i.e. whether the SMBH has an accretion disk, and what is the exact source of the emitted light.

There are several projects to analyze Sgr A*, included the Event Horizon Telescope (EHT), that will use the Very Long Baseline Interferometry (VLBI) to investigate the event horizon and probe the General Relativity.

Also, by studying Sgr A* it is possible to understand the SMBHs and their interaction with the host galaxy.

The study of Sgr A* has just started and we cannot know where it will lead us to.

References

Eckart, García-Marín, Vogel, 2012, J.Physics Conference Series 372, 012022
Gillessen, Genzel, Fritz, 2013, ApJ 763, 78
Gillessen, Eisenhauer, Trippe, 2009, ApJ 692, 1075-1109
Yusef-Zadeh, Royster, Wardle, 2013, ApJ 767, L32
Schödel, Ott, Genzel, 2002, Nature 419, 694-696
Genzel, Schödel, Ott, 2003, Nature 425, 934-937