Hypothetical Super-massive Black Hole Candidate Claims Rubrics

Astronomer's Rubric

Clues / Observations	No Way	Maybe – needs more observing time	Very likely
Motion of luminous matter (stars, gas, dust in IR)	Slow moving. Little organization of orbits.	Organized, but slow moving.	Calculated central mass from the motion of stars, gas, and dust does not fit a model of a dense star system.
Distribution of luminous matter	Sparse	Spherical bulge. Large bulge. Lots of gas and dust.	Concentrated around a center. Disc or spherical distribution.
Accretion disc	No disc.	Possible disc hidden from view.	Well organized disc.
Jets	None	Wispy high velocity strands near the core.	Distinct structure.
Visible light	Star or star system like luminosity.	Distinct bulge structure visible.	Extremely luminous core and/or bulge.
X-ray emission	None	Some	Strong emission from jets.
Infrared emission	Weak	Some	Strong in a small region.
Radio emission	Some or none	Some	Strong emission from jets.

Dr. Starr Brite

Using the Harlan J. Smith telescope at McDonald Observatory, we observed the bulge of a spiral galaxy, NGC 314159. Although the galaxy's bulge was not very bright, we measured a high velocity for stars of about 350 kilometers per second inside the bulge. Perhaps thick masses of dust are blocking the visible light from reaching the telescope. The bulge appears extremely compact and organized. We would like to do follow up observations, which may support our hypothesis that a 10^4 to 10^5 solar-mass black hole lies in the bulge of this galaxy.

Clues / Observations	No Way	Maybe – needs more observing time	Very likely
Motion of luminous matter (stars, gas, dust in IR)			Fast moving material in the bulge at about 350 km/s.
Distribution of luminous matter			Well developed bulge in galaxy's center. Spherical distribution.
Accretion disc	Can't see a disc. BH candidate inside the bulge of a spiral galaxy.		
Jets	Unobserved		
Visible light		Low brightness bulge. Could be obscured by dust.	
X-ray emission	Unobserved		
Infrared emission	Unobserved		
Radio emission	Unobserved		

Black Hole Database panel decision: REJECTED

Recommendation from Black Hole Database panel:
Do follow up observations to find more data that helps resolve the validity of your claim. The motion of the material and structure of the bulge strongly support your hypothesis, but the bulge does not appear luminous enough. Hopefully, your follow up observations will unravel that mystery. When you submit your new data and conclusions, we will reconsider adding this galaxy to our database.

Follow up observations:
Chandra X-Ray Observatory, Spitzer Space Telescope, and VLA to resolve possible X-ray, infrared, and radio emission from this galaxy.

Dr. Ima Stronomer

We have detected a black hole with a mass of 10^9 solar-masses. The bulge of its host galaxy is extremely bright, which could only come from a compact and powerful source like a black hole. Although the velocity of luminous material is low (50 km/s), we think that the black hole is so large that our instrument can not record the innermost and fastest moving matter. The matter that our instrument can record is located far away from the black hole, so is moving more slowly than other claims reported in the Black Hole Database. We are considering follow up observations that may further support our claim.

Clues / Observations	No Way	Maybe – needs more observing time	Very likely
Motion of luminous matter (stars, gas, dust in IR)	Slow radial velocity of 50 km/s		
Distribution of luminous matter			
Accretion disc	Can't see a disc. BH candidate inside the bulge of a spiral galaxy.		
Jets	Unobserved		
Visible light			Very bright bulge
X-ray emission	Unobserved		
Infrared emission	Unobserved		
Radio emission	Unobserved		

Black Hole Database panel decision: REJECTED

Recommendation from Black Hole Database panel:
Your observations of a very bright bulge look promising, but there is not enough information to support your claim.
Do follow-up observations to resolve:

1. Shape of the bulge and/or core.
2. Luminosity of the bulge. You will have to calculate the distance to the galaxy.
3. Name of your galaxy so that other astronomers can verify your observations.
4. The kind of galaxy: spiral, elliptical, irregular?

We also suggest that you consider the possibility of a bright foreground object that happens appear at the center of your target galaxy.

Follow up observations: Radio, IR, X-ray. Check to make sure no foreground objects are causing the extremely bright bulge.

Dr Sol Faraway

In our survey of spiral galaxies, we observed a peculiar galaxy (NGC 141421) with an extremely bright bulge. Further spectroscopic observations showed that the bulge material is orbiting a central object at about 250 km/s. To rule out intervening foreground objects, like a nearby star, we checked the astronomical database *Set of Identifications, Measurements, and Bibliography for Astronomical Data* (SIMBAD) for other objects at the galaxy's coordinates. No other objects appear in the foreground. The bulge appears well organized. We think the central object is a black hole with a mass of 10^9 solar-masses.

Clues / Observations	No Way	Maybe – needs more observing time	Very likely
Motion of luminous matter (stars, gas, dust in IR)			250 km/s inside the bulge
Distribution of luminous matter			Well organized bulge No foreground objects
Accretion disc	Can't see a disc. BH candidate inside the bulge of a spiral galaxy.		
Jets	Unobserved		
Visible light			Extremely bright bulge
X-ray emission	Unobserved		
Infrared emission	Unobserved		
Radio emission	Unobserved		

Black Hole Database panel decision: APPROVED

Recommendations from the Black Hole Database panel:
Your data strongly support your claim of a black hole inside this galaxy. We will include it in our database. We also recommend follow up observations using the Chandra X-ray Observatory and Spitzer Space Telescope. This new data will hopefully support your black hole hypothesis.

Follow up observations:
Chandra X-ray Observatory, Spitzer Space Telescope, and VLA radio telescope.
Look for jets and IR excess in the bulge.

Teacher Note:
Set of Identifications, Measurements, and Bibliography for Astronomical Data (SIMBAD)
The SIMBAD astronomical database provides basic data, cross-identifications and bibliography for astronomical objects outside the solar system.
http://cdsweb.u-strasbg.fr/Simbad.html

Dr. Cal Q. Laater

Our observations suggest that a 3 x 10^6 solar-mass black hole is in the central core of the elliptical galaxy NGC 271828. We measure high velocities of gas and dust of 275 km/s. This elliptical galaxy shows no unusual brightness changes from end to end, most likely due to dust and gas scattering light from the core.

Clues / Observations	No Way	Maybe – needs more observing time	Very likely
Motion of luminous matter (stars, gas, dust in IR)			Fast moving material in the bulge at about 275 km/s.
Distribution of luminous matter		Normal core in galaxy's center. Spherical distribution.	
Accretion disc	Can't see a disc. BH candidate inside the core of an elliptical galaxy.		
Jets	Unobserved		
Visible light		Normal core for an elliptical galaxy	
X-ray emission	Unobserved		
Infrared emission	Unobserved		
Radio emission	Unobserved		

Black Hole Database panel decision: REJECTED

Recommendations from the Black Hole Database panel:
The high gas and dust velocity strongly supports your claim, but we are concerned about the visible light observations. A brighter core would be more supportive, however your calculated black hole mass is low compared to other super-massive black holes.

Follow up observations:
Infrared observations with the Spitzer Space Telescope may help you resolve the core of this elliptical galaxy. You may get a better idea of how luminous the core is compared to the rest of the galaxy. If the core appears extremely luminous, we would consider including your galaxy in our database.

Dr. Usee Themun

Recent observations with our new instrument on the McDonald Observatory 2.7-meter Harlan J. Smith telescope show strong support for a massive 5 x 10^5 solar-mass black hole in the bulge of NGC 20051205, a spiral galaxy. Our instrument could measure the velocity of bulge material orbiting at 100 km/s. We observed the galaxy along its spiral disc edge, so we could not see the bulge well. We strongly suspect that follow up infrared observations will show strong far infrared emission in the bulge. X-ray observations may show extremely energetic activity from the bulge.

Clues / Observations	No Way	Maybe – needs more observing time	Very likely
Motion of luminous matter (stars, gas, dust in IR)		Moving material in the bulge at about 100 km/s.	
Distribution of luminous matter		Bulge looks spherical, but obscured by the galaxy's disc of gas and dust.	
Accretion disc	Can't see a disc. BH candidate inside the bulge of a spiral galaxy.		
Jets	Unobserved		
Visible light		Low brightness bulge. Could be obscured by dust of the galaxy's disc.	
X-ray emission	Unobserved		
Infrared emission	Unobserved		
Radio emission	Unobserved		

Black Hole Database panel decision: REJECTED

Recommendations from the Black Hole Database panel:
Your data do not strongly enough support your claim for a super-massive black hole in NGC 20051205. We recommend several follow up observations with the Chandra X-ray Observatory, Spitzer Space Telescope, and Very Large Array (VLA) radio telescopes.

Follow up observations:
Chandra X-ray Observatory, Spitzer Space Telescope, and VLA radio telescope.

