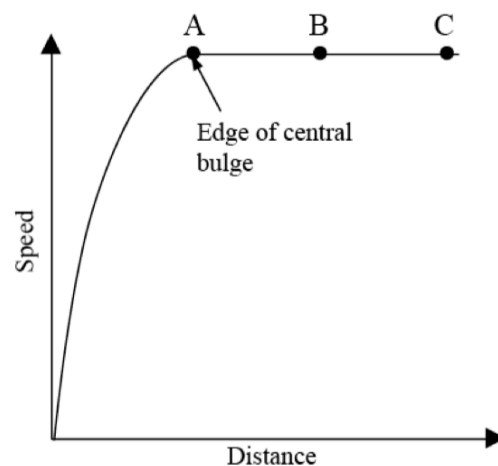


Answer key to the LT activity: Dark Matter

1. [The Sun.]
2. [Student 2 is correct] The planets only add a very tiny amount of mass to the total amount of mass in the Solar System. The Sun is where almost all of the solar system's mass is located.
3. [Planets farther from the Sun orbit the Sun slower than planets closer to the Sun.]
4. [A planet close to the Sun experiences a larger gravitational force between itself and the Sun than a planet farther from the Sun experiences.] This is because the gravitational force gets stronger as the distance between objects gets smaller, and because the mass inside planets' orbits are all about the same, since most of the solar system's mass is in the Sun.
5. [There are seven planets inside Neptune's orbit and zero planets inside Mercury's orbit. However, the interior mass for Neptune is approximately the same as the interior mass of Mercury. Neptune is much farther from the Sun than Mercury. Therefore the gravitational force exerted on Neptune is weaker than the force exerted on Mercury. As a result, Neptune has an orbital speed that is much slower than the orbital speed of Mercury.]
6. [Saturn, Uranus, and Neptune] The extra mass is interior to these planets' orbits, so only these planets will experience an increase in their orbital speeds and in the gravitational forces they feel.
7. [Most of the mass is in the center of the galaxy.]
8. [Star A would orbit the fastest, followed by the Sun, and then Star B.] Most of the galaxy's mass appears to be inside Star A's orbit, since that's where the galaxy's light is concentrated. That means Star A should experience the strongest gravitational force, followed by the Sun, and then Star B.
9. [Rotation Curve 1] Rotation Curve 1 shows that stars close to the center of the galaxy should orbit faster than stars farther from the center of the galaxy.
- 10.



11. [The real rotation curve shows that the orbital speeds are all the same past a certain distance from the galaxy's

center, while the rotation curve in Question 9 shows the orbital speeds getting smaller with increasing distance.
]

12. [The real rotation curve shows that the three stars all orbit the galaxy at approximately the same speed, even though in Question 8 we predicted that Star A would orbit at the fastest speed, followed by the Sun, and then Star B.]
13. [No] If most of the mass were located at the center, then we would expect to see a rotation curve like Rotation Curve 1 in Question 9, which looks completely different from the real rotation curve.
14. [The gravitational forces felt by the Milky Way Galaxy's stars must be greater than we expected since the stars are orbiting faster than we expected.]
15. [Student 1 is correct] If the galaxy's mass were concentrated at its center, then stars farther from the center should orbit slower. Since stars farther from the center are orbiting at the same speed, there must be more mass throughout the galaxy than we can see, and stars must feel greater gravitational forces than we originally expected.
16. [If the galaxy had more mass at its center than anywhere else, then we would expect to see stars orbiting at slower and slower speeds farther from the center, just like planets farther from the Sun orbit the Sun slower than planets closer to the Sun. Since we observe stars far from the center all orbiting at the same speed, the galaxy's mass cannot be concentrated at its center.]
17. [Yes] In order for stars far from the center of the galaxy to all orbit at the same speed, there must be more mass throughout the entire galaxy, including the disk and halo, than we originally expected.