MS-ESS1-2 Earth's Place in the Universe

Students who demonstrate understanding can:

MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).] [*Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena.

Disciplinary Core Ideas

ESS1.A: The Universe and Its Stars

- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.

ESS1.B: Earth and the Solar System

- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.

Crosscutting Concepts

Systems and System Models

- Models can be used to represent systems and their interactions.

- -

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

Observable features of the student performance by the end of the course:			
1	Components of the model		
	a	To make sense of a given phenomenon, students develop a model in which they identify the relevant components of the system, including:	
		i.	Gravity.
		ii.	The solar system as a collection of bodies, including the sun, planets, moons, and asteroids.
		iii.	The Milky Way galaxy as a collection of stars (e.g., the sun) and their associated systems of objects.
		iv.	Other galaxies in the universe
	b	Students indicate the relative spatial scales of solar systems and galaxies in the model.	
2	Relationships		
	a	Students describe* the relationships and interactions between components of the solar and galaxy systems, including:	
		i.	Gravity as an attractive force between solar system and galaxy objects that:
			1. Increases with the mass of the interacting objects increases.
			2. Decreases as the distances between objects increases.
		ii.	The orbital motion of objects in our solar system (e.g., moons orbit around planets, all objects within the solar system orbit the sun).
		iii.	The orbital motion, in the form of a disk, of vast numbers of stars around the center of the Milky Way.
		iv.	That our solar system is one of many systems orbiting the center of the larger system of the Milky Way galaxy.

		v. The Milky Way is one of many galaxy systems in the universe.
3	Connections	
	a	Students use the model to describe* that gravity is a predominantly inward-pulling force that can keep smaller/less massive objects in orbit around larger/more massive objects.
	b	Students use the model to describe* that gravity causes a pattern of smaller/less massive objects orbiting around larger/more massive objects at all system scales in the universe, including that:
		i. Gravitational forces from planets cause smaller objects (e.g., moons) to orbit around planets.
		ii. The gravitational force of the sun causes the planets and other bodies to orbit around it, holding the solar system together.
		iii. The gravitational forces from the center of the Milky Way cause stars and stellar systems to orbit around the center of the galaxy.
		iv. The hierarchy pattern of orbiting systems in the solar system was established early in its history as the disk of dust and gas was driven by gravitational forces to form moon-planet and planet-sun orbiting systems.
	c	Students use the model to describe* that objects too far away from the sun do not orbit it because the sun's gravitational force on those objects is too weak to pull them into orbit.
	d	Students use the model to describe* what a given phenomenon might look like without gravity (e.g., smaller planets would move in straight paths through space, rather than orbiting a more massive body).