BLOSSOMS Teacher's Guide for Dark Matter Module

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Overview

The Dark Matter module has the goal of introducing the students to galaxies as large collections of gravitationally bound stars. We explore the amount of matter needed for the star to remain bound and then bring in the idea of Dark Matter, a new kind of matter that does not interact with light.

Galaxies

The module starts with s description of Fritz Zwicky's observation of the Coma cluster of galaxies and invites the students to look carefully at his telescope image of 1,000 galaxies. In a discussion question, the students learn to tell the difference between a galaxy and a star in an astronomical image. The, we examine a picture of the Andromeda galaxy, the closest to Earth and begin to wonder what holds it together.

Gravitation

Galaxies are held together by the gravitational force between the stars and two demonstrations establish a relationship between the velocity of a star in a galaxy, how much mass lies inside the star's orbit and the distance of the star's orbit from the center of the galaxy. Here, Vera Rubin's measurement of the rotation velocities in of stars in Andromeda.

Dark Matter

Vera Rubin's measurements allowed her to make an estimate of the mass inside the Andromeda galaxy and, when we compare this mass with the mass you would expect base don our Sun, it appears that there is five time as much mass in Andromeda than could be accounted for by the starts in Andromeda. This extra mass was called dark matter because it was not associated with the emission of light the way mass is a star is.

Dark Matter is something new

Dark matter is not any known particle and we conclude with a discussion of how dark matter can occasionally strike a nucleus, allowing the inference of the presence of dark matter. We conclude with a demonstration and discussion of cross section: how large an object appears to be.

Prerequisites

It is best if students have had some high school level mechanics, ideally Newton's laws, orbital motion and centripetal force. The teacher's module has a derivation of centripetal acceleration. The module should be mostly accessible to students with no physics background.

Duration

The video runs about 30 minutes. The questions and demos will give a total activity time

of about an hour if the materials are all at hand and the students work quickly. An hour an a half is a more comfortable amount of time.

Materials

There are several demonstrations that can be carried out using string, ten or so balls a few inches in diameter, a stopwatch or clock with a sweep second hand and some tape. The demonstrations are best done outside, but can also be carried out in a gymnasium or other large room. If the materials or space are not available, there are videos of the demonstrations in the module and these may be used.