



# Dark Matter in Spiral Galaxies

## Mass from Motion

Classroom – After visiting the Observatory

### Overview

**Age Range:** 14-18

**Prep. Time:** 1 hour

**Lesson Time:** 2 hours

**Cost per activity:** printer costs

**Includes the use of:** ruler, paper, pen, calculator

### Outline

In this project you will gain insight into why astronomers think there are large amounts of dark matter in galaxies. Dark matter is material that is “dark” in the sense that it neither absorbs nor emits electromagnetic radiation (“light”). We can infer its presence through the gravitational effect it has on the matter we can see (stars and gas).

### Pupils will learn:

- Circular motion
- Gravitation
- Doppler-shifts of spectral lines
- How we know that there is dark matter in spiral galaxies

### Lesson Plan:

Overview of the time required to complete lesson.

Description	Time	Notes
Introduction to the subject	15 min	
Activity 1: Measurements	30 min	Measure the inclination angle of the galaxy

The online observatory collaboration consists of the following partners:

Baldone Observatory, Brorfelde Observatory, Cardiff University, Harestua Solar Observatory, Helsinki Observatory



		Determine the velocities of the gas in the galaxy.
Assessment	15 min	
Break	15 min	
Activity 2: Calculations	30 min	Calculate the velocities of gas in circular motion around the centre of a galaxy and from there the total mass of the galaxy.
Activity 3: Interpretation	15 min	Compare the mass of galaxy with the mass of stars and gas and conclude if there is evidence for dark matter.

### Introduction to the subject:

The main point is to make it clear to the students that astronomers can infer the presence of matter from the gravitational effect it has on material that can be observed with light. Other than that, the exercise is given in the student handout and is self-explanatory.

### Background Material/Knowledge:

The project is self-contained.