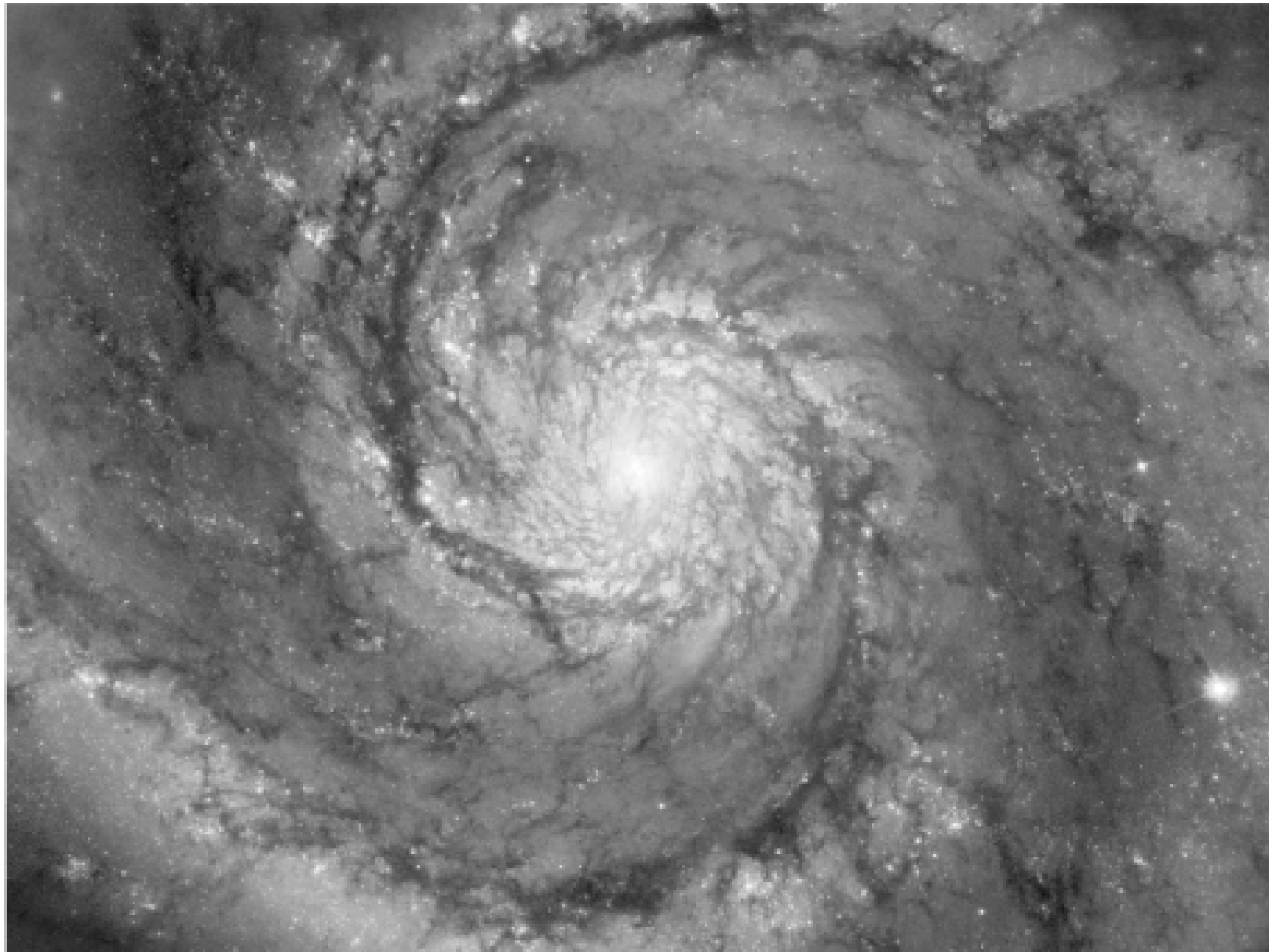

ASTRONOMY 101

INTRODUCTION TO ASTRONOMY



WINTER 2010
PART 1: LABS 1-7

Credits:

Cover image of M51 from NASA's Hubble Heritage Project - **Labs:** Gravity: Oliver Fraser, Julianne Dalcanton - Atoms: Apocryphal, Julianne Dalcanton - Thermal Radiation: Julianne Dalcanton - Atoms & Light: Apocryphal, Julianne Dalcanton - Spectral Classification of Stars: Stacey Palen, Richard Plotkin, Julianne Dalcanton - Colors: Julianne Dalcanton - Color-Magnitude Diagrams: Marcel Agueros, Nate McCrady, Ana Larson, Julianne Dalcanton - Measuring Distance: Todd Grinsteiner, Julianne Dalcanton - Galaxy Classification: Andrew West, Julianne Dalcanton - Dark Matter: Greg Stinson, Julianne Dalcanton - Hubble Law: Luis Mendoza, Toby Smith, Ana Larson, Julianne Dalcanton

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Introduction to Gravity

Gravity is one of the most important forces in astronomy. Unlike the “strong” and the “weak” forces, it can act over the very long distances that are characteristic of Space¹.

For this course, you will need to learn a few simple facts about gravity and how it works.

1. Gravity is *always* “attractive”, meaning it can only pull objects towards each other.
2. The gravitational force between two objects depends on only two things:
 - How massive the two objects are
 - How far apart the two objects are
3. The gravitational force attracting two objects together **increases** if the mass of either object increases.
4. The gravitational force attracting two objects together **increases** if the objects are closer together.
5. The formula describing the strength of the gravitational force between two objects with masses M_1 and M_2 , separated by a distance D is

$$F_{\text{Gravity}} = G \frac{M_1 M_2}{D^2}$$

G is a constant which describes how strong the force of gravity is. It is known as “Newton’s Constant” and has a value of $G = 6.67 \times 10^{-11} \text{meters}^3 / (\text{kilogram} \times \text{seconds}^2)$.

6. The separation D between two objects is defined as the separation between their centers, not their edges. For example, if you calculate the gravitational force between two adjacent soccer balls that were touching each other, the separation would be about 22 cm, rather than zero.
7. The equation describing the force of gravity shows that
 - The force **increases linearly** with the *mass* of either object (i.e. if you double the mass of one object, the force between the objects doubles as well)
 - The force **decreases as the square** of the *separation* (i.e. if you double the separation between the objects, the force decreases by a factor of 4 ($= 2^2$)).

¹The electromagnetic force can also act over long distances. However, since the universe is electrically neutral (i.e. there is no positively charged galaxy attracting some other negatively charged galaxy), electrical forces play a role only on very small scales.