

## 16.1: Introduction

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*Most galaxies exhibit rising rotational velocities at the largest measured velocity; only for the very largest galaxies are the rotation curves flat. Thus the smallest SC's (i.e. lowest luminosity) exhibit the same lack of Keplerian velocity decrease at large  $R$  as do the high-luminosity spirals. The form for the rotation curves implies that the mass is not centrally condensed, but that significant mass is located at large  $R$ . The integral mass is increasing at least as fast as  $R$ . The mass is not converging to a limiting mass at the edge of the optical image. The conclusion is inescapable that nonluminous matter exists beyond the optical galaxy. ~Vera Rubin*

The physical objects that we encounter in the world consist of collections of atoms that are bound together to form systems of particles. When forces are applied, the shape of the body may be stretched or compressed like a spring, or sheared like jello. In some systems the constituent particles are very loosely bound to each other as in fluids and gasses, and the distances between the constituent particles will vary. We shall begin by restricting ourselves to an ideal category of objects, rigid bodies, which do not stretch, compress, or shear.

A body is called a rigid body if the distance between any two points in the body does not change in time. Rigid bodies, unlike point masses, can have forces applied at different points in the body. Let's start by considering the simplest example of rigid body motion, rotation about a fixed axis.

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