Chapter C14: Conservation of Angular Momentum

Physics I

College of the Atlantic

Chapter 13

Angular momentum definition for a particle relative to point X:

$$\vec{L} \equiv m(\vec{r} \times \vec{v}) = mr_{\perp}v = mrv_{\perp} \, . \tag{1}$$

where $\vec{v}$ is the object's velocity and $\vec{r}$ is a vector from point O to the object.

Angular momentum for particle moving in a circle:

$$\vec{L} = mr^2\vec{\omega} \tag{2}$$

Angular momentum of a rigid object:

$$\vec{L} = I\vec{\omega} \, . \tag{3}$$

C14.3 Conservation of Angular Momentum

Interactions transfer angular momentum. Thus, in the absence of external interactions (twirls), angular momentum is conserved.

C14.4 Some worked examples

For what we'll be doing in this class, we won't need to treat $\vec{L}$ or $\vec{\omega}$ fully as vectors. It will suffice to just use plus and minus signs to indicate the direction (clockwise or counter-clockwise) of rotation.

C14.5 Application: Neutron Stars

When stars collapse, they spin faster.

Examples:

1. A 100 solid sphere with radius 3 m is rolling due east at 20 m/s. The ball passes 100 meters to the north of you. What is the angular momentum of the ball about you?

2. A thin-armed person is sitting on a stool that can rotate. Her moment of inertia is 2.5 kgm^2. She holds a 5 kg weight in each hand. Her arms are 0.8 m long. When her arms are fully extended, someone pushes her so that she's rotating at 0.25 rev/s. She pulls her arms in so that the weights are now 0.4 meters from her axis of rotation. How fast is she spinning now?

3. A 30 kg child is running at 2 m/s and jumps on a merry-go-round as shown below. The merry-go-round has a radius of 1.5 m and a mass of 50 kg. How fast is the merry-go-round spinning after the child jumps on it?

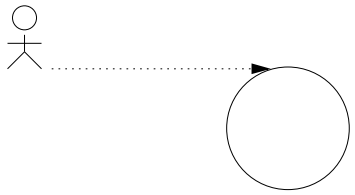

Figure 1: