Angular Momentum

Torque is the rotational counterpart to force. That is, when a net force is applied to an object, the object accelerates. Likewise, when a net torque is applied to an object the object *angularly* accelerates.

Momentum is related to a body's *mass* and *velocity*. It is also a number that gives you a relative feel for how large a force you might have to apply to get the object to stop.

Similarly, *angular momentum* is related to a mass-related term called the *moment of inertia*, and the body's *angular velocity*. It is also a number that gives you a relative feel for how large a torque you might have to apply to get the object to stop.

Just as momentum is defined as "mv," angular momentum is defined as "Iw," where the "I" term is that mass related quantity and "w" represents the angular velocity of the body (the "w" is supposed to represent the Greek letter omega).

That is:

$$p = mv \qquad \text{and} \qquad L = Iw$$

In a given direction, if all of the forces acting on any of the particles in a system of particles are *internal* to the system (i.e., if they are all action-reaction, N.T.L. type force couples), then the sum of all of the momenta in a particular direction is conserved (doesn't change in time) no matter how the individual particles interact.

$$\sum p_{1,x} + \sum F_{external} \triangle t = \sum p_{2,x}$$

In a given "direction," if all of the torques acting on any of the particles in a system of particles are *internal* to the system (i.e., if they are all due to the interaction of the pieces of the system), then the sum of all of the angular momenta is conserved (doesn't change in time) no matter how the individual particles interact.

In that case:

$$\sum L_1 + \sum \Gamma_{external} \Delta t = \sum L_2$$

The simplest example of this is an ice skater who pullers her arms in during a spin.

The most spectacular example of angular momentum being conserved in a big way in the universe is wrapped up in the idea of pulsars--really big stars that, when they supernova, have their outer shell blown outward and their inner shell blown inward with the inner section becoming a "neutron star."

Explanation: Stars rotate. They don't do it fast, but they do it. That means they have angular momentum (Iw). When moderately big stars blow, the implosion continues until the electrons in their atomic structure are forced into their respective nuclei whereupon they combine with the protons to make neutrons. Remnants that do this are called "neutron stars."

This makes for a very small (tens of kilometers across), very dense structure. With the moment of inertia "I" having diminished so spectacularly, the angular speed must increase proportionally. This leaves us with a celestial object that is, maybe fifteen kilometers across, that is spinning so fast it does, maybe 80 revolutions PER SECOND.

These creatures put out synchronous radiation, which is very directional, in the radio frequency range, so if the earth happens to be in the path of their radiation stream, we get very periodic, relatively high frequency (high in comparison to, say, your snapping your fingers) radio waves.

Because astronomers didn't originally know these EM waves were coming from neutron stars at the center of supernovas, they simply dubbed them "pulsars."