

Angular momentum

Phys H308, Haverford College

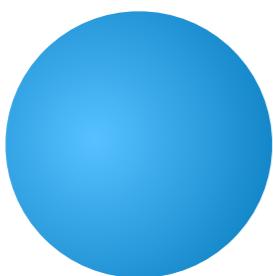
Ted Brzinski, Sept. 9 2022

Recall: linear momentum

- Momentum: $\vec{p} = m \dot{\vec{x}}$
- Momentum is a conserved quantity:

To change the momentum of a system, an external force must be applied: $\vec{F} = \frac{d}{dt} \vec{p}$

Without external forcing, momentum is constant.

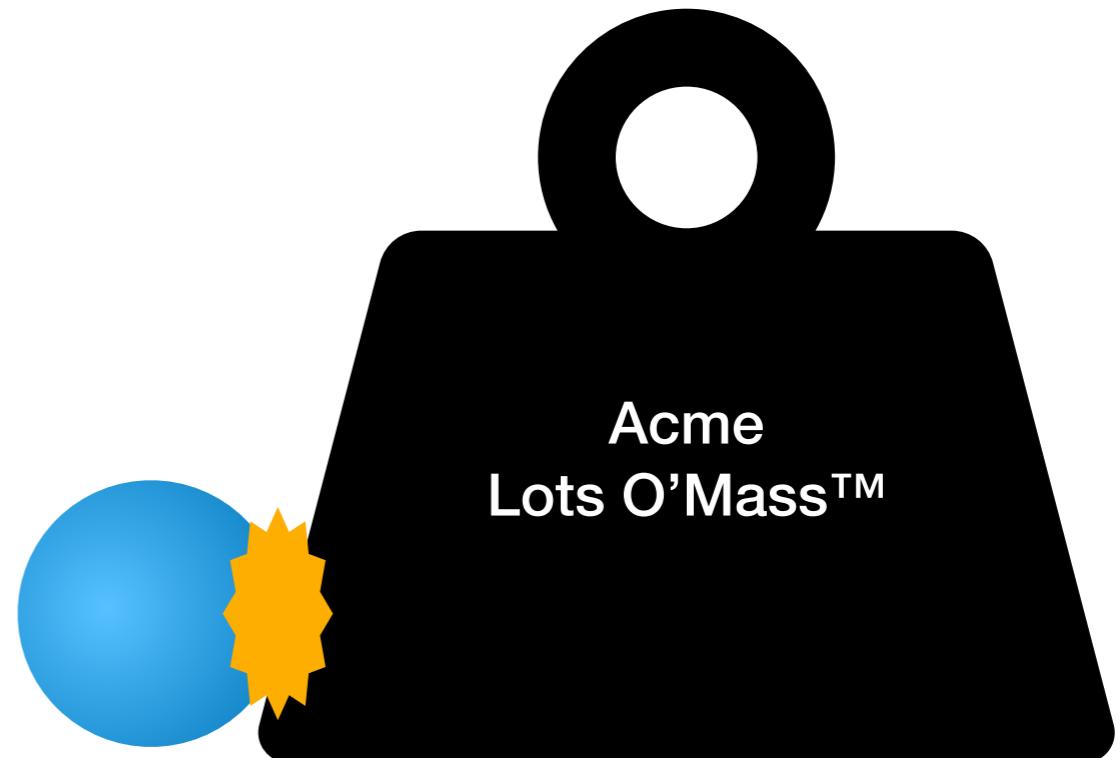


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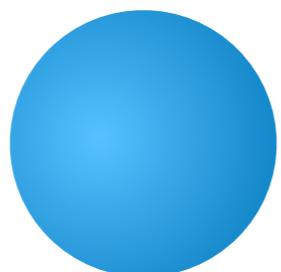


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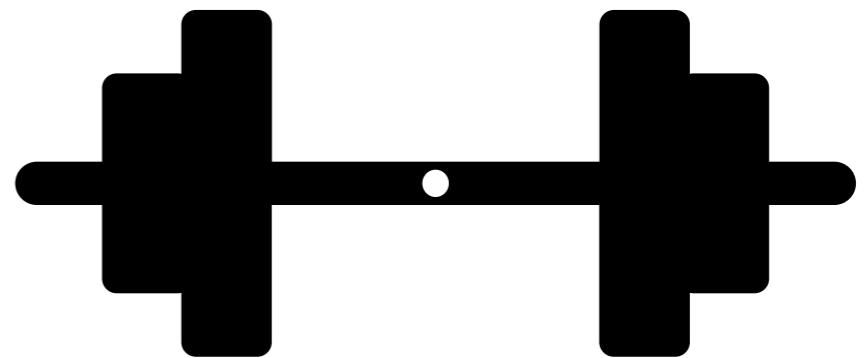
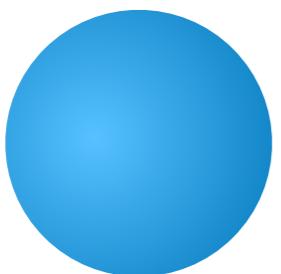
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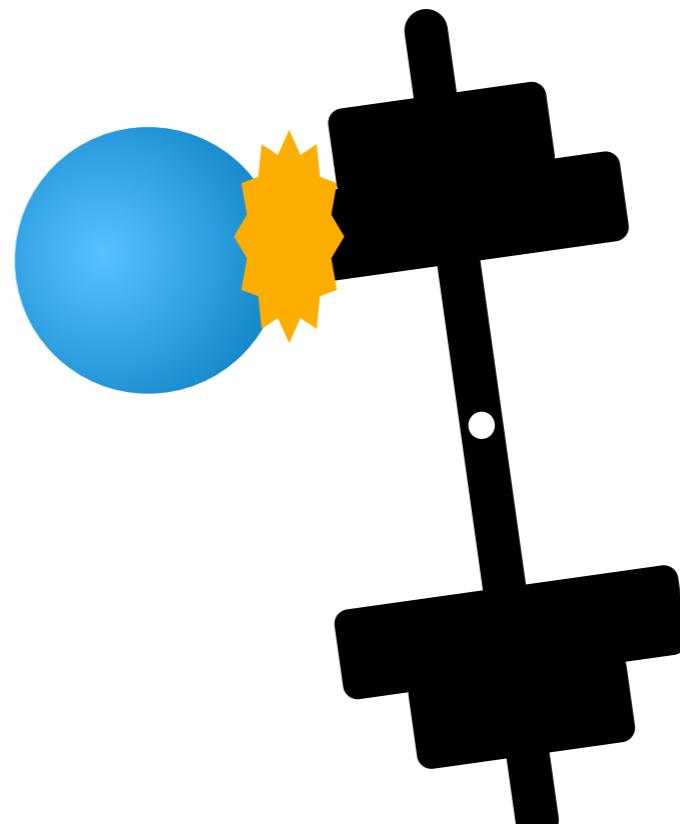
Angular momentum

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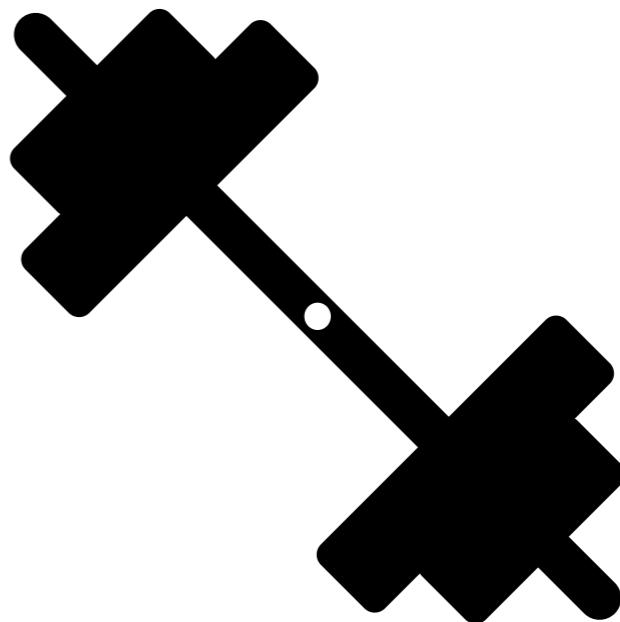
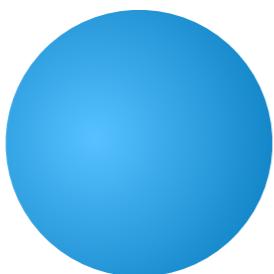
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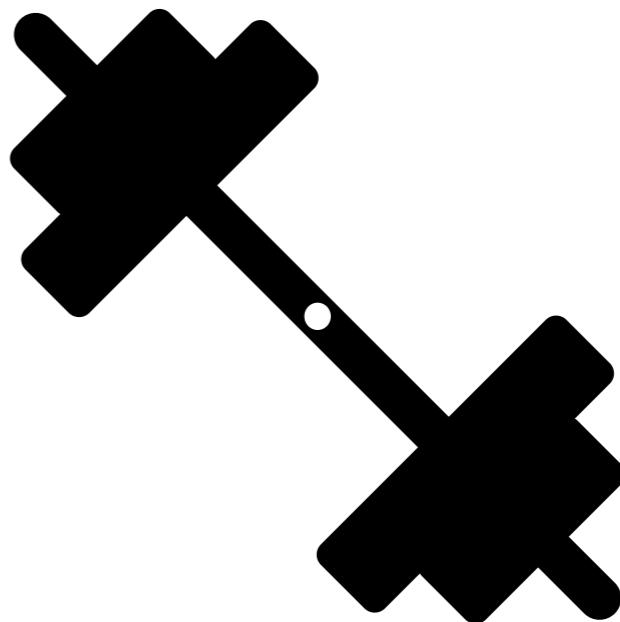
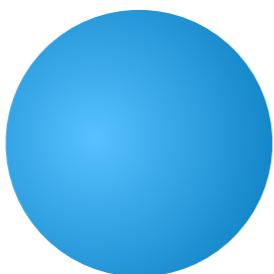
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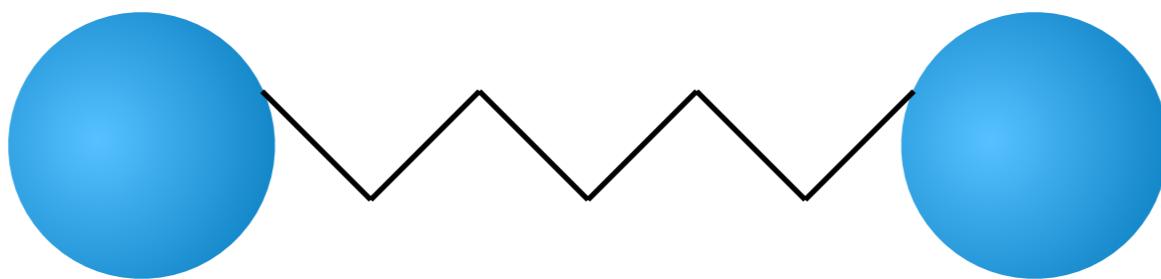
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- Angular momentum:
 $\vec{\ell} = \vec{r} \times \vec{p}$ or $\vec{L} = I\vec{\omega}$
- An external torque is required to change the angular momentum:
 $\vec{\tau} = \dot{\vec{L}}$



Angular momentum

Rotation is weird!

- Consider a pair of balls connected by a spring, and floating in empty space.



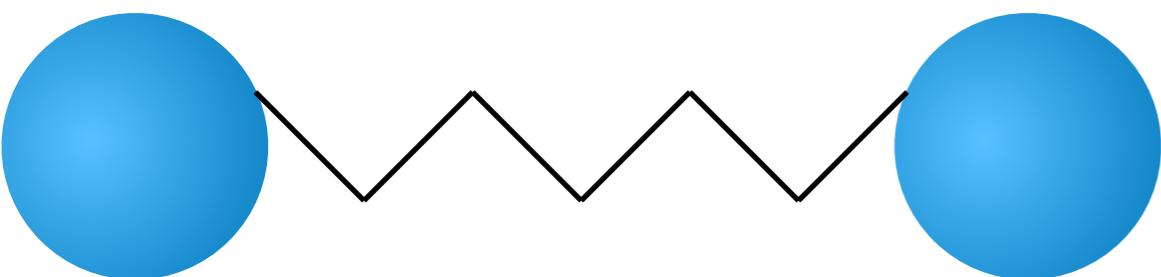
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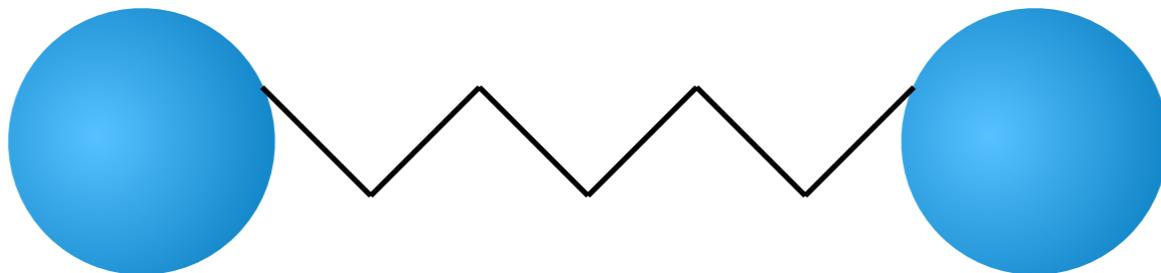
- Depending on my choice of reference frame, the springy barbell can have any linear momentum!



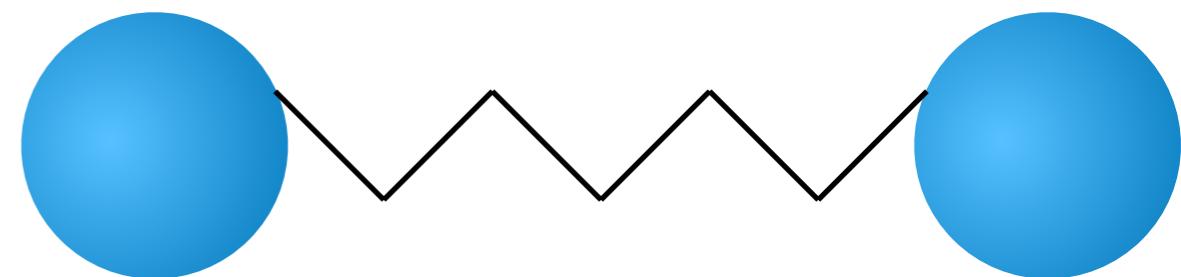
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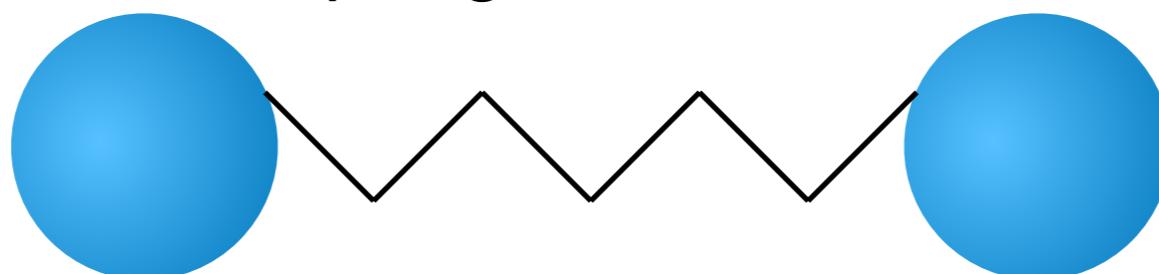
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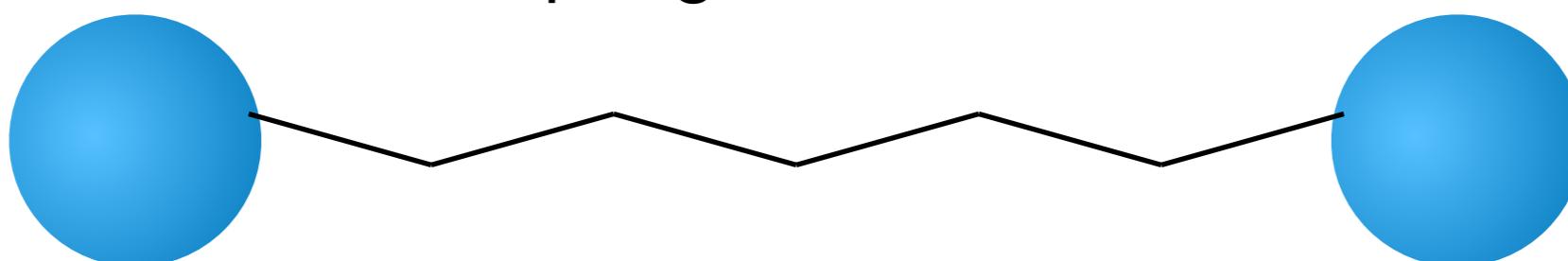
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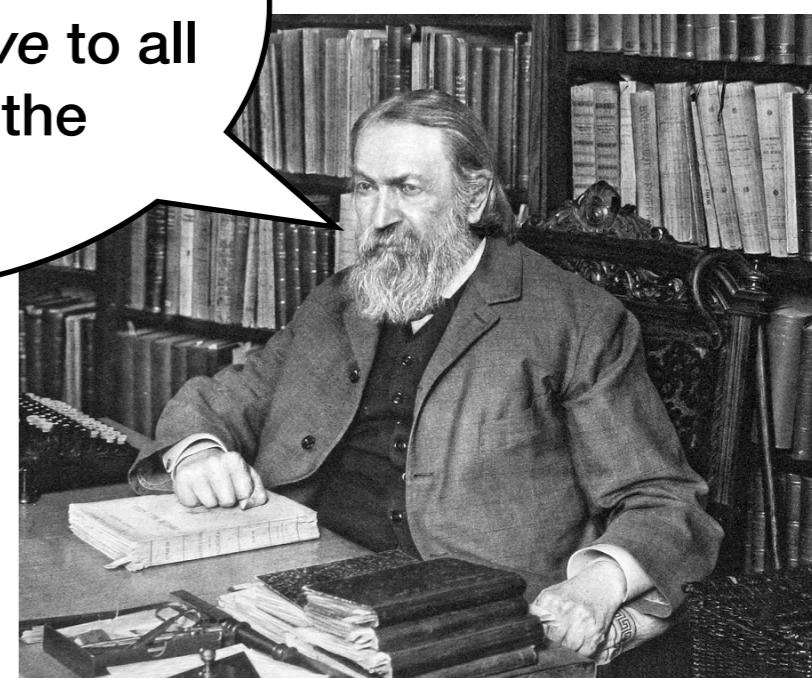
Why is rotation weird?

- Angular momentum, which can be read out of the extension of the spring, is measurable in any frame!



Mach, this tells us there is an *absolute* reference for all rotation - a fundamental property of the universe.

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Hmmm.
Relative, you say?

