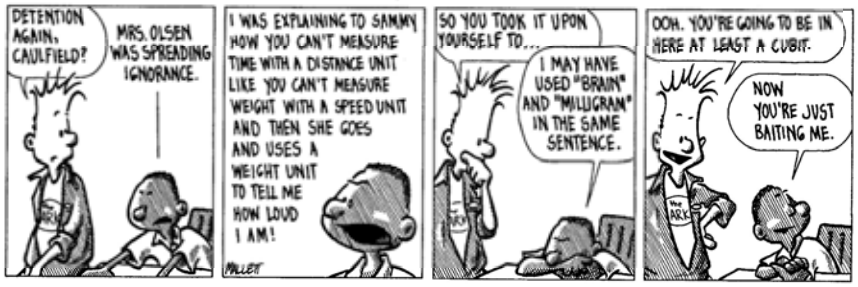
September 28, 2012 Physics 131 Prof. E. F. Redish

■ **Theme Music: Charlie Mingus**

Tensions

■ **Cartoon: Jef Mallet**

Frazz



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Tension: The Ideal (Hooke's Law) Spring

■ An ideal spring changes its length in response to pulls (or pushes) from opposite directions.

$$T = k\,\Delta l$$

Δl = change in length (stretch or squeeze)

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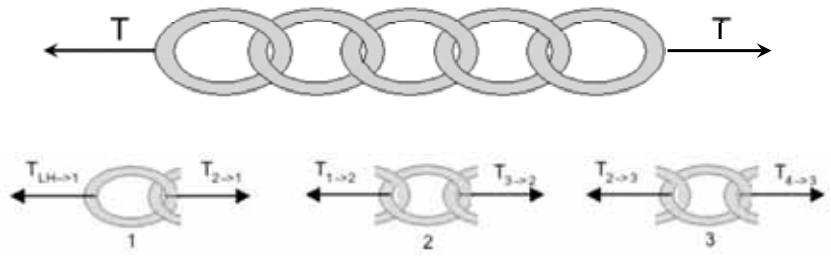
Scalar vs. Vector Tension: The Chain

- Consider a series of links of chain being pulled from opposite directions. What are the forces on each link?



Tension: Scalar vs. Vector

- Note we are using the word "tension" in two distinct ways!
- The "tension" in a spring, chain, or string has no direction (or rather, both directions at once). It is a tension scalar.
- When tension appears at the end of a spring, chain, or string, the choice of end gives us a direction and lets us create a tension force.

Foothold ideas: Resistive forces

- Resistive forces are contact forces acting between two touching surfaces that are parallel to the surface and tend to oppose the surfaces from sliding over each other.
- There are three types:
  - Friction (independent of velocity)
  - Viscosity (proportion to velocity)
  - Drag (proportional to the square of velocity)

Foothold Ideas: Friction

- Friction is our name for the interaction between two touching surfaces that is parallel to the surface.
- It acts to oppose the relative motion of the surfaces. That is, it acts as if the two surfaces stick together a bit.
- Normal forces adjust themselves in response to external forces. So does friction – up to a point.

Static *Sliding*

$$f_{A\to B} \le f_{A\to B}^{\max} = \mu_{AB}^{static} N_{A\to B} \qquad f_{A\to B} = \mu_{AB}^{kinetic} N_{A\to B} \qquad \mu_{AB}^{kinetic} \le \mu_{AB}^{static}$$

- Friction can oppose motion or cause it.