13.7: Rigidity Modulus (Shear Modulus)

When we are discussing the bulk modulus of a material we are usually thinking in terms of applying pressure and noting the compression, so the adiabatic bulk modulus is usually greater than the isothermal bulk modulus. We could in principle also imagine a situation in which we are moving a material into a vacuum, thus decreasing the external pressure, and then measuring the resulting expansion. In that case we would find that the adiabatic bulk modulus is less than the isothermal bulk modulus – but that is a rather artificial situation. In Section 13.5 we derived (see equation 13.5.14) the usual relation for compression:

$$\frac{1}{B_{\text{iso}}}-\frac{1}{B_{\text{ad}}}=\frac{\beta^2 T}{\rho C_P}, \tag{13.7.1}$$

in which β is the volume coefficient of expansion, and C_P is the specific heat capacity at constant pressure. (Compare this with equations 13.6.12 and 13.6.20.)

We now must ask ourselves what is the difference between the adiabatic and isothermal rigidity moduli (also known as shear modulus). If you are unfamiliar with the rigidity modulus, see my Classical Mechanics notes, Chapter 20, Section 20.3.

The rigidity modulus involves no change in volume or length, and hence *there is no difference between the adiabatic and isothermal rigidity moduli*.