

Book I

The Direct Problem – given the orbit, what is the force?

Lemma 10-11: Parabolic approximation - deviation  $\propto t^2$

Prop 1.2-4: Inscribed polygon approximation - deviation  $\propto f$

Prop 6.1:  $f \propto \text{deviation}/t^2 \propto 1/(\text{SP}^2 \times \text{QT}^2/\text{QR})$

Kepler II  $\Leftrightarrow$  Centripetal Force

Prop 1: 'if' - polygon approximation

Prop 2-3: 'only if' - inscribed polygon approximation

Kepler III  $\Leftrightarrow 1/r^2$

Prop 15:  $f \propto 1/r^2 \Rightarrow T \propto r^{3/2}$

Prop 4.6:  $T \propto r^{3/2} \Rightarrow f \propto 1/r^2$  for uniform circular motion

Wren's Problem: Kepler I  $\Leftrightarrow 1/r^2$

Prop 11-14:  $f \propto 1/r^2 \Leftrightarrow$  conic orbit with force center at focus

Book III

Force Law: Applying Kepler II & III

(also Prop I.45.1 on stationary apsides)

Prop 1: Jupiter and Saturn -  $f \propto 1/r^2$  for moons

Prop 2: Sun -  $f \propto 1/r^2$  for the planets

Prop 3: Earth -  $f \propto 1/r^2$  for the moon

Universal Gravity

Prop 4: moon gravitates to the Earth

Prop 5 and Cors: all the planets/sun/moons gravitate to each other as  $f \propto 1/r^2$

Prop 6: All bodies gravitate to the planets/sun/moons and  $f \propto$  quantity of matter

Prop 7: All bodies gravitate to each other according to  $f \propto \text{matter}/r^2$

One important point to remark is that, surprisingly (since Wren's problem was the motivation for *De Motu* and hence the *Principia*), Props 11-14 are not used in the derivation of the gravity law; this can be clearly seen by following the arrows from Book I to Book III.