Chapter 5. Gravity

- The *velocity* of an object describes both the speed and the direction of its motion. An object in a circular orbit may have a constant *speed*, but its *velocity* changes.
- Newton's laws of motion:
  (1) Law of inertia.
  (2) F = MA (F: force; M: mass; A: acceleration)
  (3) Law of action and reaction.
- Weight = Mg, where M is the mass and g is the acceleration of gravity. An object in different gravitational fields would have different weights, but its mass remains the same.
- Gravitational force $F = G \frac{M_1 M_2}{R^2}$.
- Gravitational field is not limited to the surface of the Earth. There is still gravity in space. Orbiting bodies are falling bodies.
- Newton used conic sections to describe orbits in a gravitational field. Possible orbits are circular, elliptical, parabolic, and hyperbolic. Circular and elliptical orbits indicate bound systems, and parabolic and hyperbolic orbits indicate unbound systems.
- Escape velocity V_{esc} is the minimum velocity an object needs to break free from a gravitational field and move to infinity (at infinity the velocity will be zero). $V_{esc}^2 = 2GM/R$.
- Kepler's equal-area law can be explained by the conservation of angular momentum.
- Newton's theory of gravity explains the motions of Saturn and the closer planets. Herschel accidentally found Uranus. The disagreement between the observed orbit of Uranus and the orbit predicted by Newton's theory of gravity led to the prediction and discovery of Neptune. Pluto was likewise discovered.
- The precession of Mercury's perihelion point cannot be explained by the Newtonian motion. Einstein's theory of relativity explains this precession nicely.