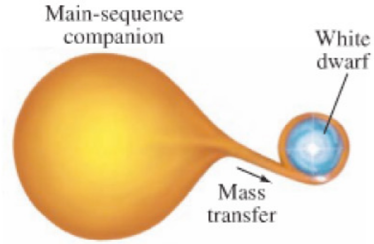

FIGURE 33–10 Hypothetical model for novae and type Ia supernovae, showing how a white dwarf could pull mass from its normal companion.

Novae and Supernovae

Novae (singular is *nova*, meaning "new" in Latin) are faint stars that have suddenly increased in brightness by as much as a factor of 10^4 and last for a month or two before fading. Novae are thought to be faint white dwarfs that have pulled mass from a nearby companion (they make up a *binary* system), as illustrated in Fig. 33–10. The captured mass of hydrogen fuses into helium at a high rate for a few weeks. Many novae (maybe all) are *recurrent*—they repeat their bright glow years later.

Supernovae are also brief explosive events, but release millions of times more energy than novae, up to 10^{10} times more luminous than our Sun. The peak of brightness may equal that of the entire galaxy in which they are located, but lasts only a few days. They remain bright but slowly fade over a few months. Many supernovae form by core collapse to a neutron star as described above.

Type Ia supernovae

Type Ia supernovae are different. They all seem to have very nearly the same luminosity. They are believed to be binary stars, one of which is a white dwarf that pulls mass from its companion, much like for a nova, Fig. 33–10. The mass is higher, and as mass is captured and the total mass reaches the Chandrasekhar limit of 1.4 solar masses, the star begins to collapse and then explodes as a supernova.

33–3 Distance Measurements

How astronomical distances are measured

We have talked about the vast distances of objects in the universe. But how do we measure these distances? One basic technique employs simple geometry to measure the **parallax** of a star. By parallax we mean the apparent motion of a star, against the background of more distant stars, due to the Earth's motion about the Sun. As shown in Fig. 33–11, the sighting angle of a star relative to the plane of Earth's orbit (angle θ) can be determined at different times of the year. Since we know the distance d from Earth to Sun, we can reconstruct the right triangles shown in Fig. 33–11 and can determine† the distance D to the star.

†This is essentially the way the heights of mountains are determined, by "triangulation." See Example 1–9.

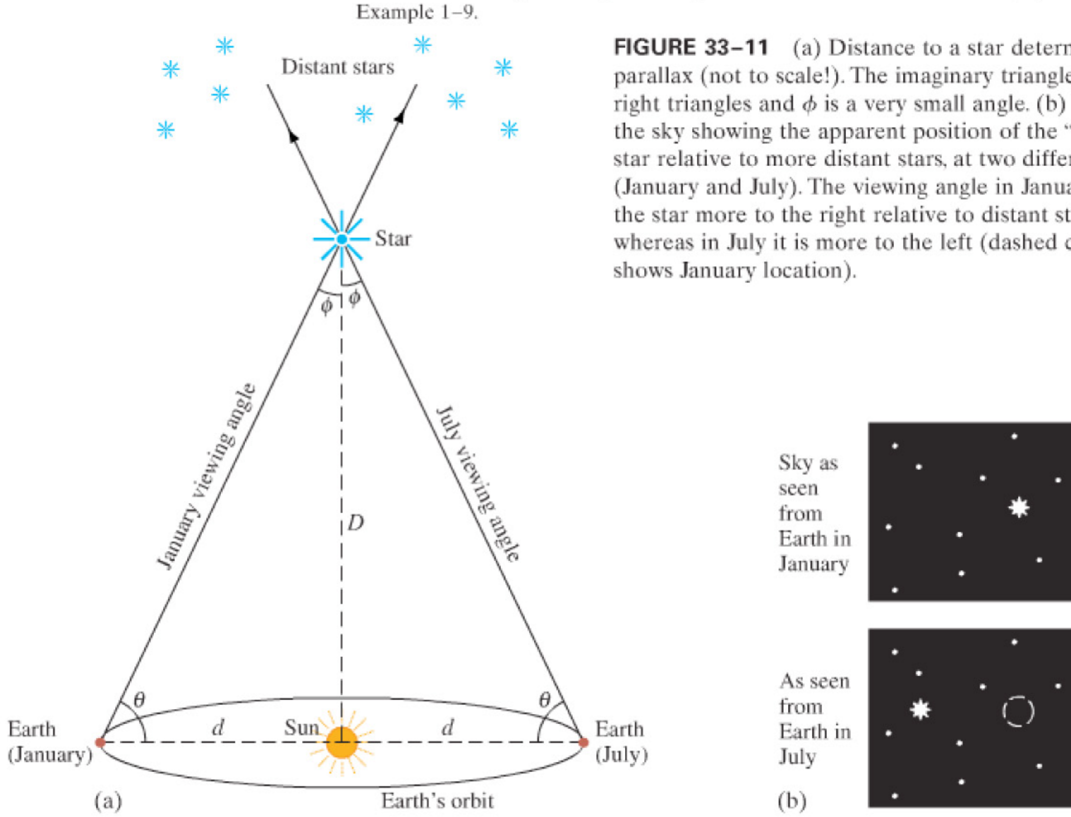

FIGURE 33–11 (a) Distance to a star determined by parallax (not to scale!). The imaginary triangles are right triangles and ϕ is a very small angle. (b) View of the sky showing the apparent position of the "nearby" star relative to more distant stars, at two different times (January and July). The viewing angle in January puts the star more to the right relative to distant stars, whereas in July it is more to the left (dashed circle shows January location).