Chapter 24. Stellar Remnants

Note. In this section we describe the remains of different types stars.

Note. A white dwarf may have a very strong magnetic field. A photon under the influence of a gravitational field can be *gravitationally redshifted.* After several billion years, a white dwarf will cool off becoming a *black dwarf.* If a white dwarf is in a binary system, it can pull matter off of its larger companion and build up matter in an *accretion disk.* This matter can ignite producing a*nova* This process can repeat. If the flare-ups are relatively minor and frequent, it is called a *cataclysmic variable.*

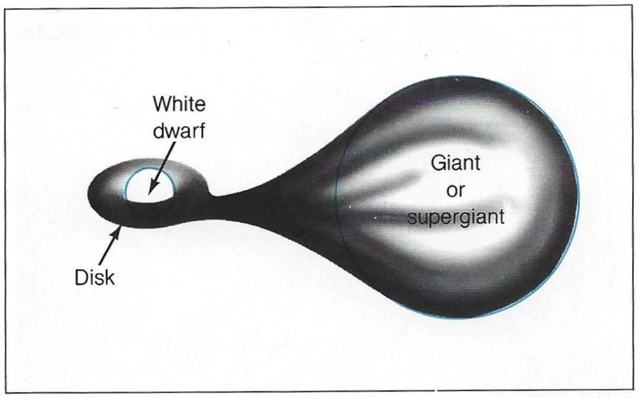

Figure 24.4. Mass transfer to a white dwarf.

Note. A supernova explosion is followed by a *supernova remnant* and possibly a *neutron star.* A neutron star can have mass up to between 2 and 3 solar masses. The radius is around 10 km.

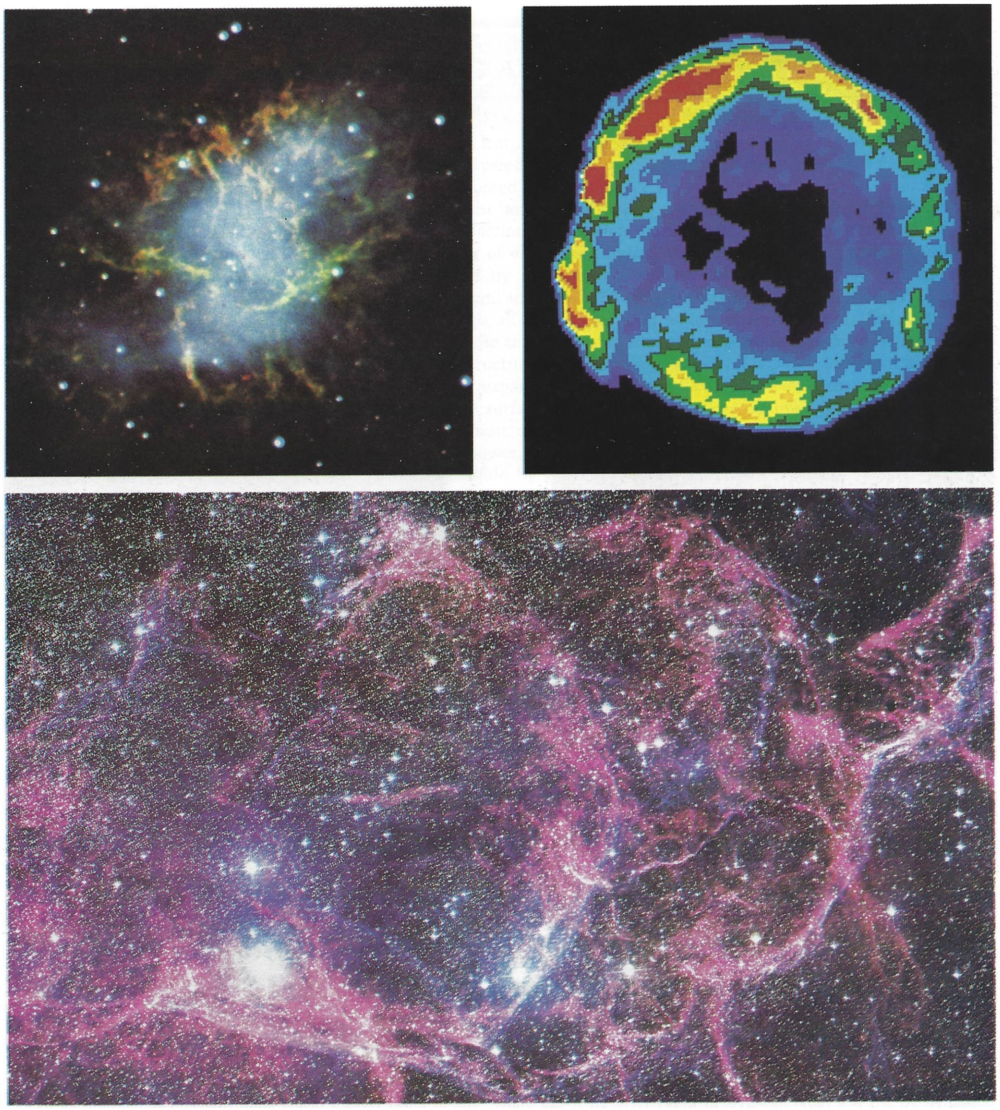

Figure 24.6. Supernova remnants. The Crab nebula (upper left), remnant of Tycho's supernova (upper right), and the Vela supernova remnant.

Note. A *pulsar* is a radio source that flashes on and off very regularly several times per second. The pulsating is due to *synchronized radiation* of electrons falling into the magnetic poles of a rotating neutron star. The magnetic axis and rotational neutron star. The magnetic axis and rotational axis must be at an angle.

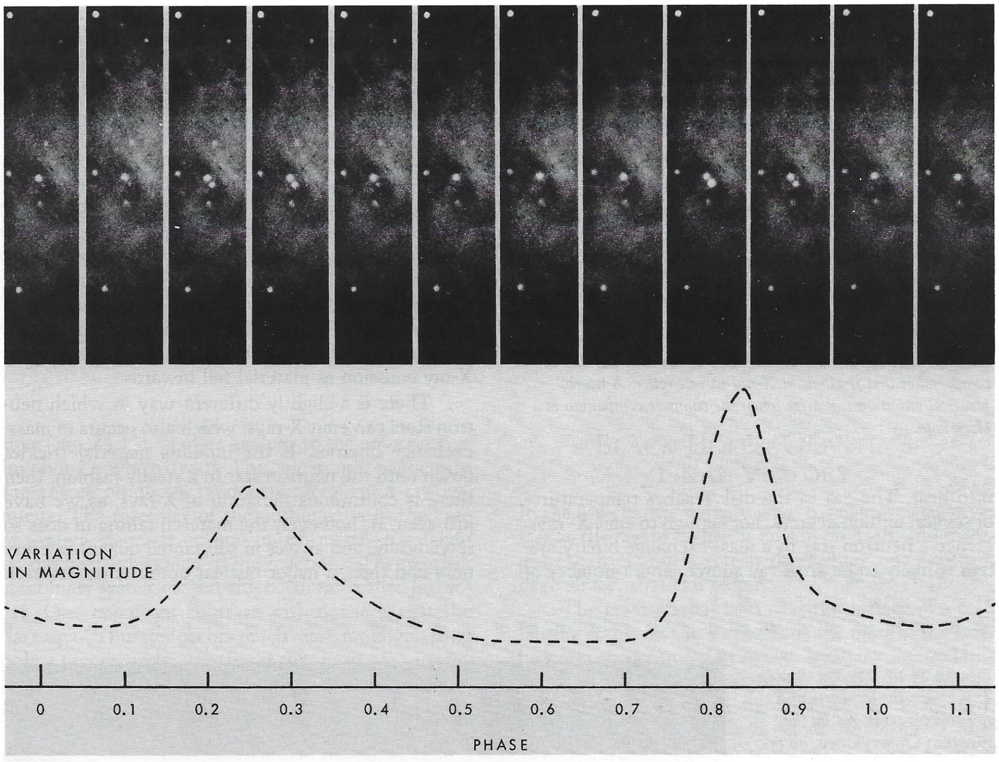

Figure 24.12. Images of the Crab Pulsar and the light curve.

Note. If a neutron star occurs in a binary system, X-ray radiation may be emitted as matter is accelerated in the gravitational field of the neutron star (a *binary* X-*ray source*). The material may fall sporadically producing an X-*ray burster* (the maximum lasts a few seconds).

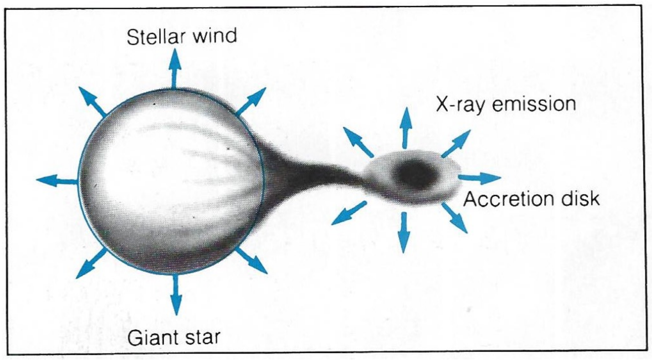

Figure 24.13. An accretion disk.

Note. A star of mass greater than 3 solar masses can end its "life" as a black hole. Spacetime is curved by gravitational forces. A photon of light may not follow what appears to be a "straight" line. If a star is massive enough and its radius is small enough, the escape velocity may be greater than that of light. If so, we have a *black hole.* For a given star, the radius it must have to be a black hole is the *Schwarzschild radius.* Think of a black hole as a region in space with this radius. The "surface" is called the *event horizon.* Once something goes past this point, it can never leave the black hole. In fact, once a star collapses past its event horizon, it will continue to collapse to a point, a *singularity.*

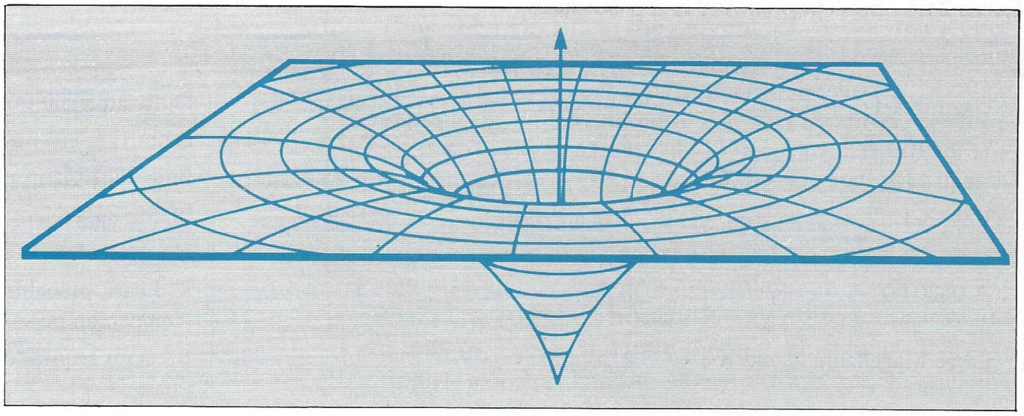

Figure 24.16. Geometry of space near a black hole.

Note. The best evidence for the existence of black holes is from binary systems. If a binary is expected with a massive unseen companion, then could be a black hole. Also, as above, this type of arrangement should produce X-rays. A lead candidate is Cygnus X-1.

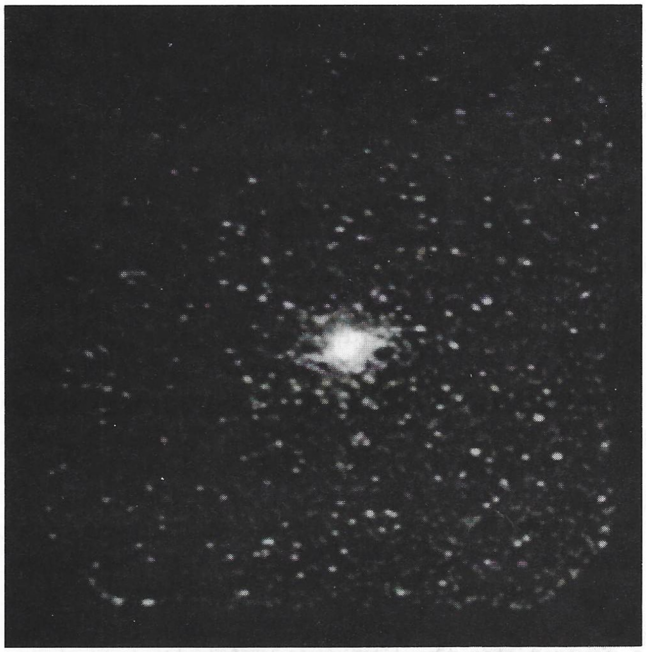

Figure 24.19. Cygnus X-1. A hot star thought to be orbited by a black hole.

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