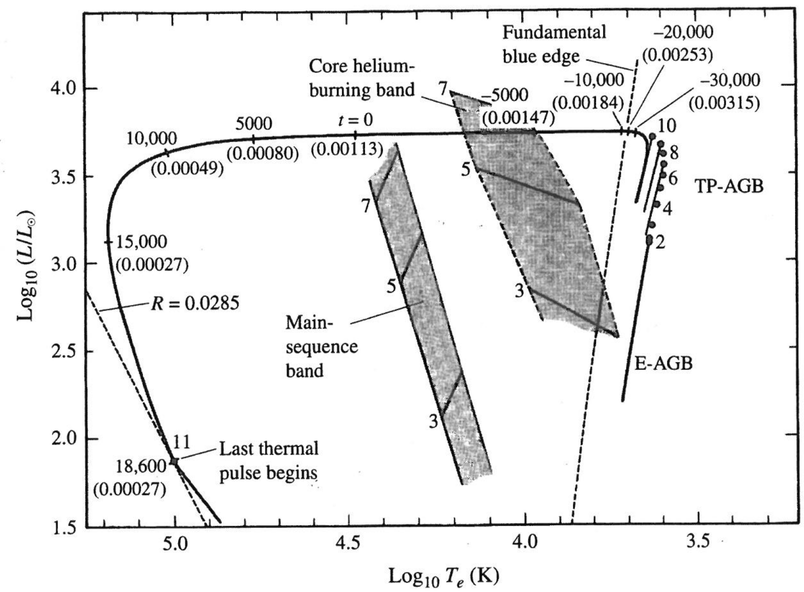

FIGURE 13.12 The AGB and post-AGB evolution of a 0.6 $M_\odot$ star undergoing mass loss. The initial composition of the model is $X = 0.749$, $Y = 0.25$, and $Z = 0.001$. The main-sequence and horizontal branches of 3, 5, and 7 $M_\odot$ stars are shown for reference. Details of the figure are discussed in the body of the text. (Figure adapted from Iben, *Ap. J.*, *260*, 821, 1982.)

across the H–R diagram. The amount of mass remaining in the hydrogen-rich envelope is indicated in parentheses along the evolutionary track (in $M_\odot$). Also indicated is the amount of time before (negative) or after (positive) the point when the star's effective temperature was 30,000 K (the time is measured in years). Following the eleventh helium shell flash, the star finally loses the last remnants of its envelope and becomes a white dwarf of radius 0.0285 $R_\odot$.[12]

Planetary Nebulae

The expanding shell of gas around a white dwarf progenitor is called a **planetary nebula**. Examples of planetary nebulae are shown in Figs. 13.13–13.15. These beautiful, glowing clouds of gas were given this name in the nineteenth century because, when viewed through a small telescope, they look somewhat like giant gaseous planets.

A planetary nebula owes its appearance to the ultraviolet light emitted by the hot, condensed central star. The ultraviolet photons are absorbed by the gas in the nebula, causing the atoms to become excited or ionized. When the electrons cascade back down to lower

[12]The line labeled "Fundamental blue edge" corresponds to the high-temperature limit for fundamental mode pulsations of a class of variable stars known as **RR Lyraes**. This important class of objects will be discussed extensively in Chapter 14.