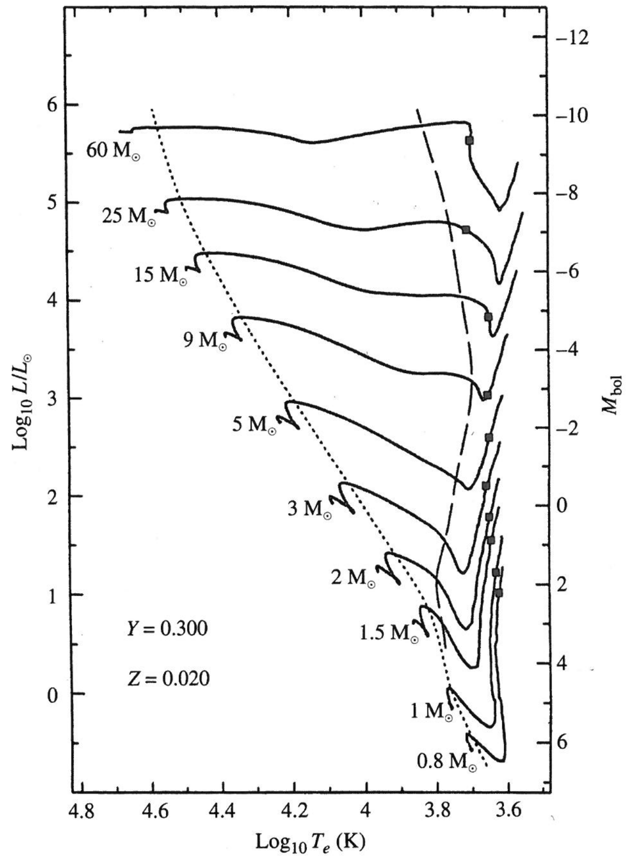

FIGURE 12.11 Classical pre-main-sequence evolutionary tracks computed for stars of various masses with the composition $X = 0.68$, $Y = 0.30$, and $Z = 0.02$. The direction of evolution on each track is generally from low effective temperature to high effective temperature (right to left). The mass of each model is indicated beside its evolutionary track. The square on each track indicates the onset of deuterium burning in these calculations. The long-dash line represents the point on each track where convection in the envelope stops and the envelope becomes purely radiative. The short-dash line marks the onset of convection in the core of the star. Contraction times for each track are given in Table 12.1. (Figure adapted from Bernasconi and Maeder, *Astron. Astrophys.*, *307*, 829, 1996.)

computed with state-of-the-art physics are shown in Fig. 12.11, and the total time for each evolutionary track is given in Table 12.1.

Consider the pre-main-sequence evolution of a 1 $M_\odot$ star, beginning on the Hayashi track. With the high H^- opacity near the surface, the star is completely convective during approximately the first one million years of the collapse. In these models, deuterium burning also occurs during this early period of collapse, beginning at the square indicated on the evolutionary tracks in Fig. 12.11.[12] However, since ${}^2_1H$ is not very abundant, the nuclear

[12]Note that since these calculations did not include the formation of the protostar from the direct collapse of the cloud as was done for the tracks in Fig. 12.9, there is a fundamental inconsistency between when deuterium burning occurs in the two sets of calculations.