



Figure 12.8 Theoretical pre-main-sequence evolutionary tracks for stars of various masses. The mass of each model (in solar mass units) is indicated beside its evolutionary track. (Figure from Iben, *Ap. J.*, 141, 993, 1965.)

Mass (M_{\odot})	Age of Model at Points (in years)			
	1	2	3	4
15.0	6.740 (2)	3.766 (3)	9.350 (3)	2.203 (4)
9.0	1.443 (3)	1.473 (4)	3.645 (4)	6.987 (4)
5.0	2.936 (4)	1.069 (5)	2.001 (5)	2.860 (5)
3.0	3.420 (4)	2.078 (5)	7.633 (5)	1.135 (6)
2.25	7.862 (4)	5.940 (5)	1.883 (6)	2.505 (6)
1.5	2.347 (5)	2.363 (6)	5.801 (6)	7.584 (6)
1.25	4.508 (5)	3.957 (6)	8.800 (6)	1.155 (7)
1.0	1.189 (5)	1.058 (6)	8.910 (6)	1.821 (7)
0.5	3.195 (5)	1.786 (6)	8.711 (6)	3.092 (7)

Mass (M_{\odot})	Age of Model at Points (in years)			
	5	6	7	8
15.0	2.657 (4)	3.984 (4)	4.585 (7)	6.170 (8)
9.0	7.922 (4)	1.019 (5)	1.195 (5)	1.505 (5)
5.0	3.137 (4)	3.880 (5)	4.559 (5)	5.759 (5)
3.0	1.250 (6)	1.465 (6)	1.741 (6)	2.514 (6)
2.25	2.818 (6)	3.319 (6)	3.993 (6)	5.855 (6)
1.5	8.620 (6)	1.043 (7)	1.339 (7)	1.821 (7)
1.25	1.404 (7)	1.755 (7)	2.796 (7)	2.945 (7)
1.0	2.529 (7)	3.418 (7)	5.016 (7)	
0.5	1.550 (8)			

Table 12.1 Pre-Main-Sequence Evolutionary Times. The times represent the time that has elapsed (in years) since the initial model (powers of 10 are given in parentheses). The points correspond to the labels in Fig. 12.8. (Data from Iben, *Ap. J.*, 141, 993, 1965.)

As the central temperature continues to rise, increasing levels of ionization decrease the opacity in that region (see Fig. 9.10) and a radiative core develops, progressively encompassing more and more of the star's mass. By point 3, the radiative core allows energy to escape into the convective envelope more readily, causing the luminosity of the star to increase again. Also, as required by Eq. (3.17), the effective temperature continues to increase, since the star is still shrinking.

At about the time that the luminosity begins to increase again, the temperature near the center has become high enough for nuclear reactions to begin in earnest, although not yet at their equilibrium rates. Initially, the first two steps of the PP I chain [the conversion of ${}^1_1\text{H}$ to ${}^3_2\text{He}$; Eq. (10.46)] and the CNO