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EVOLUTIONARY SEQUENCES FOR RED GIANT STARS

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ABSTRACT

A set of 46 evolutionary sequences has been computed for stars ascending the red giant branch for the first time. These red giant sequences, extending from the subgiant branch to the onset of helium burning within the core, cover the following ranges in the helium abundance Y, the heavy-element abundance Z, and the mass M: $0.10 \leq Y \leq 0.40$, $0.00001 \leq Z \leq 0.04$, and $0.70 \leq M \leq 2.20\ M_{\odot}$. Combinations of these values appropriate to galactic and globular clusters have been emphasized. The effects of varying the rate of neutrino emission from zero to twice the normally adopted value have also been investigated. Except for one sequence, helium ignition occurred under degenerate conditions. Extensive tabulations of the numerical results are provided, and from these data the systematic dependences of red giant properties on composition and mass can be determined. For $(M, Y, Z) = (0.80, 0.30, 0.001)$, the core mass M_c at the flash and its derivatives are given by $M_c = 0.474\ M_{\odot}$, $\partial M_c/\partial Y = -0.24$, $\partial M_c/\partial \log Z = -0.007$, and $\partial M_c/\partial M = -0.038$. These derivatives depend significantly on the composition and mass. When neutrino emission is neglected, M_c decreases by $0.03\ M_{\odot}$. The enhanced rates of neutrino emission due to neutral current interactions increase M_c by about $0.007\ M_{\odot}$. The temperature inversion produced by the neutrino cooling of the core leads to a noncentral flash in almost all of the sequences. The flash site shifts outward in mass with decreases in Y or M or increases in the rate of neutrino emission. For many of the sequences a temporary period of decreasing surface luminosity occurs during the early part of the red giant phase. This luminosity drop is more prominent at low values of Y and large values of Z. The morphology of the red giant tracks in the H-R diagram is discussed.

Subject headings: stars: evolution — stars: interiors — stars: late-type

I. INTRODUCTION

The pioneering investigations of Sandage and Schwarzschild (1952) and Hoyle and Schwarzschild (1955) first elucidated the overall characteristics of the red giant evolution of low-mass stars. During the ascent of the red giant branch such stars possess a hydrogen-burning shell that gradually advances outward in mass, leading to the formation of a degenerate helium core. The ignition of helium within the core then terminates this red giant phase.

This basic description has been supported by numerous later investigations (Schwarzschild and Selberg 1962; Iben 1968*a*; Demarque and Mengel 1973; Chiosi 1977), although many quantitative refinements have been made. Eggleton (1968) studied the evolution of the helium core by using an approximate representation of the hydrogen-shell region and was able to determine the dependence of some red giant properties on composition. The sensitivity of red giant models to various assumptions concerning the input physics has been evaluated by Demarque and Mengel (1971). The most comprehensive study published so far with up-to-date physics has been that of Rood (1972), who constructed six evolutionary sequences for parameters appropriate mainly to globular-cluster stars.

Some reasons for making stellar-evolution calculations of the red giant phase include the following.

1. The morphology of red giant tracks is important for interpreting the H-R diagrams of both galactic and globular clusters. For example, the location and slope of the giant branch are known to depend on the heavy-element abundance (Sandage and Wallerstein 1960; Hartwick 1968). Although the effective temperature of the giant branch is not well determined theoretically due to uncertainties in the convection theory, differential effects should nevertheless be reliable at least in a qualitative sense. Data on the luminosities at the tip of the giant branch are essential for estimating the amount of mass loss (Fusi-Pecci and Renzini 1975, 1976).

2. The core mass M_c, defined as the amount of mass interior to the center of the hydrogen-burning shell at the time of the helium-core flash, is a crucial parameter in models for horizontal-branch stars

(Faulkner 1966; Iben and Rood 1970). The value of M_c strongly affects the horizontal-branch luminosities, effective temperatures, and lifetimes (Sweigart and Gross 1976). The dependence of M_c on the red giant helium abundance is needed in determining the helium abundance of blue horizontal-branch stars according to the method of Gross (1972, 1973) (cf. Rood 1973 and Danford 1976). Red giant sequences are necessary in order to determine M_c and its dependence on composition, mass, and the assumed rate of neutrino emission.

3. Detailed stellar models near the end of the red giant phase can serve as the starting point for subsequent studies of the helium-core flash. One topic of current interest is whether mixing between the surface and the deeper interior occurs in some stars following the flash (Thomas 1967; Paczyński and Tremaine 1977). The abundance peculiarities observed in the CH and CN stars suggest that such mixing does occur at some point during the red giant phase (Bell and Dickens 1974; Bond 1974; Bessell and Norris 1976; Dickens and Bell 1976; Scalo 1976; McClure and Norris 1977).

4. Theoretical luminosity functions can be obtained from red giant sequences and compared with the observed number distributions of stars along the giant branch in various clusters (Tinsley and Gunn 1976). One specific problem is to understand the origin of gaps in this distribution (Sandage, Katem, and Kristian 1968; Bahcall and Yahil 1972; Lee 1977*a*, *b*). The rate of evolution along the giant branch must be known in order to calibrate the relationship between the helium abundance and the ratio of horizontal branch to red giant branch lifetimes (Iben 1968*b*; Iben and Rood 1969; Iben *et al.* 1969; Demarque, Sweigart, and Gross 1972).

The red giant sequences currently available are not sufficient to provide all of the above information, since the full range in composition and mass has not yet been explored and since the earlier calculations did not always include such important physical effects as relativistic degeneracy and intermediate screening in the helium reactions. Furthermore, comparisons among the results of previous investigations are hindered by differences in the input physics and numerical techniques. This paper attempts to overcome some of these limitations by presenting an extensive grid of red giant sequences computed in a self-consistent manner. The main difference between the present calculations and those of Rood (1972) is in the treatment of intermediate screening (Tarbell and Rood 1975, 1976).

In total, 46 stars have been evolved from the subgiant branch to the onset of helium burning. Except for one case, helium burning began under degenerate conditions. If evolved further, these stars would therefore undergo a helium-core flash. The starting models for these calculations were taken from the earlier computations of Mengel *et al.* (1978) for evolutionary sequences extending from the main sequence to the subgiant branch. Red giant sequences for values of the helium abundance Y, the heavy-element abundance Z, and the total mass M spanning the intervals

$$0.10 \leq Y \leq 0.40\,, \quad 0.00001 \leq Z \leq 0.04\,,$$

$$0.70 \leq M \leq 2.20\, M_\odot\,, \qquad (1)$$

have been constructed. Here the value of Y refers to the zero-age main-sequence (ZAMS) phase and thus does not include the slight helium enrichment of the envelope that occurs along the subgiant branch. The more plausible combinations of these parameter values have been emphasized in selecting the specific cases to study. For example, most of the sequences are for $Y = 0.20$ and 0.30, while the larger values of M are associated primarily with the larger values of Z. These results should be applicable to both galactic and globular clusters.

The remainder of this paper will concentrate on the first three items mentioned above. Luminosity functions derived from the present sequences will be considered separately by Sweigart (1978*a*). After a review of the input physics and numerical techniques (§ II), data on each of the red giant sequences are tabulated in § III. A discussion of these results is deferred to § IV. Finally, § V briefly summarizes the principal points.

II. COMPUTATIONAL PROCEDURE

a) *Relativistic Equation of State*

The present computations were carried out with the stellar-evolution program developed by Sweigart (1972, 1973) from the Princeton program (Schwarzschild and Härm 1965) and described by Sweigart and Gross (1974). This program has been modified to include three additional physical effects, namely, relativistic degeneracy in the equation of state, intermediate and strong screening in the helium-burning reactions, and the approach to equilibrium of the ON cycle. In other respects the program is unaltered. More specifically, the radiative and conductive opacities have been obtained from Cox and Stewart (1970*a*, *b*) and Hubbard and Lampe (1969), respectively, except at $Z = 0.00001$, where the radiative opacities of Cox and Tabor (1976) have been used.

A new numerical treatment for the equation of state, based on nonlinear interpolation in tabulated data for the density and thermodynamic quantities, has been developed for fully ionized material. This equation of state is applicable over the entire range between the ideal-gas and the completely degenerate limits. Relativistic effects have been taken into account for all degrees of electron degeneracy. A complete description of this equation of state will be provided by Sweigart (1978*b*).

b) *Screening Factors for the Helium Reactions*

Under the physical conditions prevailing at the onset of the helium-core flash, intermediate screening significantly enhances the rate of the helium-burning reactions. A treatment of screening is therefore essential if accurate values for M_c are to be determined (Tarbell and Rood 1975). The screening factor f and the screening function $H_{12}(0)$ are related by

$$f = \exp\,[H_{12}(0)] \tag{2}$$

(Salpeter 1954). From a statistical-mechanical analysis of the effects of plasma screening, Graboske *et al.* (1973) have derived the general expression

$$H_{12}(0) = k_b \eta_b \zeta_b \Lambda_0{}^b\,, \tag{3}$$

valid in the weak, intermediate, and strong regimes. Definitions of the various factors in equation (3) for each regime can be found in Graboske *et al.* (1973). In evaluating η_b the electron degeneracy factor θ_e has been set equal to 0, a necessary assumption at the present time, at least in the intermediate and strong regimes (DeWitt, Graboske, and Cooper 1973). For weak and intermediate screening it is convenient to write equation (3) in the form

$$H_{12}(0) = k_b \psi_b \zeta_b \Phi_0{}^b\,, \tag{4}$$

where

$$\psi_b = \eta_b \left(\frac{1}{\mu_I}\right)^{b/2} \tag{5}$$

and

$$\Phi_0 = 1.88 \times 10^8 \left(\frac{\rho}{T^3}\right)^{1/2}, \tag{6}$$

since the composition dependence of $H_{12}(0)$ then enters only through the factor ψ_b. Here μ_I is the mean molecular weight per ion. For a plasma consisting only of helium, carbon, and oxygen, ψ_b can be represented with an accuracy of roughly 1% by

$$\log \psi_b = X_{\rm C}(-0.125 X_{\rm CO} + 0.364) + X_{\rm O}(-0.194 X_{\rm CO} + 0.495) \tag{7}$$

in the weak regime and by

$$\log \psi_b = 0.142 X_{\rm C} + 0.180 X_{\rm O} - 0.042 \tag{8}$$

in the intermediate regime. The quantities $X_{\rm C}$ and $X_{\rm O}$ denote the abundances by mass of carbon and oxygen, respectively, while $X_{\rm CO} = X_{\rm C} + X_{\rm O}$. For strong screening a composition of pure helium has been assumed in evaluating $H_{12}(0)$.

The final recipe for screening in the present calculations is as follows. For $\log \Phi_0 \leq -0.55$ weak or intermediate screening is used, whichever is smaller. For $\log \Phi_0 \geq -0.30$ strong screening is used. Over the interval $-0.55 < \log \Phi_0 < -0.30$ a transition from intermediate to strong screening is made in a way that preserves the continuity of f and its first derivatives.

The unscreened rates of the triple-α and ^{12}C$(\alpha, \gamma)^{16}$O reactions were obtained from Fowler, Caughlan, and Zimmerman (1975) and (1967), respectively. The reduced α-particle width $\theta_\alpha{}^2$ for the ^{12}C$(\alpha, \gamma)^{16}$O reaction was assigned a value of 0.085. The uncertainty in the proper value of $\theta_\alpha{}^2$ has no effect on the present calculations, since the helium burning occurs almost entirely through the triple-α reaction. The ^{14}N$(\alpha, \gamma)^{18}$F reaction was omitted, as is justified by the results of Parker (1968) and Couch *et al.* (1972). Except for three sequences, neutrino emission was included according to the prescription of Beaudet, Petrosian, and Salpeter (1967).

c) ON *Approach to Equilibrium*

The approach of ^{14}N, ^{16}O, and ^{17}O to their equilibrium abundances was followed in the manner outlined by Clayton (1968). Lifetimes for the ^{14}N$(p, \gamma)^{15}$O and ^{16}O$(p, \gamma)^{17}$F reactions were determined from Fowler, Caughlan, and Zimmerman (1967), as was the lifetime for the ^{17}O$(p, \alpha)^{14}$N reaction at $\log T > 7.5$. The ^{17}O lifetime at lower temperatures as well as the branching ratio γ was interpolated from the tabulated data of Caughlan and Fowler (1962). Although the approach to equilibrium of the ON cycle can significantly affect the main-sequence evolution (Simoda and Iben 1970), it is less important in red giant models, since the ^{14}N, ^{16}O, and ^{17}O abundances are normally close to equilibrium throughout the hydrogen-burning shell, especially for the lower values of Z. However, significant departures from ON equilibrium can exist in the outer part of the hydrogen-burning shell in the higher Z models. In contrast, the CN cycle was always assumed to be in equilibrium, and consequently the present calculations cannot determine the changes in the ^{12}C/^{13}C ratio due to the deep penetration of the convective envelope during the subgiant-branch phase. The weak screening approximation was adopted for these hydrogen-burning reactions.

d) *Numerical Considerations*

Computational efficiency dictates that the hydrogen-burning shell be shifted outward by some means in addition to the normal nuclear burning. Otherwise the number of red giant models becomes prohibitively large. In the present sequences the hydrogen-burning shell was shifted according to the method of Härm and Schwarzschild (1966), with the maximum amount of shifting per model limited to 0.00075 $M_\odot$. This method has the advantage of combining the shifting with a means for readjusting the composition profile of the shell. Shifting was not permitted prior to the advance of the hydrogen-burning shell through the hydrogen discontinuity left behind by the convective envelope, nor was it permitted after the helium burning exceeded 10 $L_\odot$. Furthermore, the limit on the maximum shifting was gradually reduced well before the onset of the helium-core flash. Since there were a number of additional constraints on the time steps, the average amount of shifting per model was substantially less than 0.00075 $M_\odot$, especially toward the end of the sequences.

In order to represent accurately the run of physical variables, the changes between Henyey mesh points were limited to 0.05 in $\log P$, $\log r$, and $\log M_r$, and 0.01 in the hydrogen abundance X. Energy generation between points was not allowed to contribute more than 2% of the total helium burning as soon as the

TABLE 1

PROPERTIES OF RED-GIANT SEQUENCES

M	Y	Z	F_ν	t_f^*	$\log T_{eff}^*$	$\log L^*$	M_c^*	ΔY_s	$\log L_d$	$\Delta\log L_d$
0.90	0.10	0.00001	1.0	22521.69	3.6121	3.1994	0.5491	0.0082	2.327	0.0021
0.70	0.20	0.00001	1.0	32052.62	3.6152	3.1628	0.5270	0.0025	-	-
0.90	0.20	0.00001	1.0	12831.84	3.6174	3.1385	0.5210	0.0083	2.490	0.0023
0.70	0.30	0.00001	1.0	17270.51	3.6207	3.0983	0.4989	0.0025	-	-
0.90	0.30	0.00001	1.0	7022.35	3.6261	3.0229	0.4849	0.0081	2.649	0.0012
0.70	0.40	0.00001	1.0	8848.66	3.6300	2.9816	0.4636	0.0024	-	-
0.90	0.10	0.0001	1.0	22510.75	3.5972	3.2766	0.5334	0.0132	2.126	0.0191
0.70	0.20	0.0001	1.0	32075.17	3.6002	3.2463	0.5136	0.0051	-	-
0.90	0.20	0.0001	1.0	12781.49	3.6031	3.2251	0.5078	0.0129	2.294	0.0173
1.40	0.20	0.0001	1.0	2801.94	3.6201	3.0804	0.4797	0.0277	2.542	0.0998
0.70	0.30	0.0001	1.0	17222.82	3.6061	3.1942	0.4886	0.0051	-	-
0.90	0.30	0.0001	1.0	6964.97	3.6118	3.1404	0.4778	0.0116	2.485	0.0120
1.40	0.30	0.0001	1.0	1559.12	3.6436	2.7206	0.4160	0.0217	2.742	0.0710
0.70	0.40	0.0001	1.0	8786.92	3.6149	3.1126	0.4597	0.0045	-	-
0.90	0.20	0.0004	1.0	12986.40	3.5828	3.2672	0.4993	0.0158	2.153	0.0288
0.70	0.30	0.0004	1.0	17499.07	3.5852	3.2408	0.4814	0.0070	-	-
0.90	0.10	0.001	1.0	24012.02	3.5562	3.3402	0.5176	0.0191	1.827	0.0455
0.70	0.20	0.001	1.0	34113.51	3.5580	3.3152	0.4999	0.0091	1.863	0.0004
0.90	0.20	0.001	1.0	13445.56	3.5619	3.2984	0.4948	0.0180	2.014	0.0398
0.70	0.30	0.001	0.0	18120.38	3.5714	3.1131	0.4473	0.0086	-	-
0.70	0.30	0.001	0.5	18120.69	3.5662	3.2107	0.4654	0.0087	-	-
0.70	0.30	0.001	1.0	18120.72	3.5629	3.2736	0.4777	0.0087	2.062	0.0005
0.70	0.30	0.001	2.0	18120.20	3.5597	3.3490	0.4908	0.0087	-	-
0.90	0.30	0.001	1.0	7216.04	3.5698	3.2383	0.4700	0.0153	2.218	0.0270
0.70	0.40	0.001	1.0	9100.56	3.5715	3.2151	0.4536	0.0074	-	-
0.90	0.20	0.004	1.0	15621.94	3.5199	3.3486	0.4896	0.0210	1.731	0.0495
0.70	0.30	0.004	1.0	20938.31	3.5207	3.3282	0.4739	0.0113	1.781	0.0017
0.90	0.10	0.01	1.0	35949.96	3.4808	3.3993	0.5046	0.0239	1.337	0.0698
1.10	0.10	0.01	1.0	16979.93	3.4888	3.3956	0.5022	0.0318	1.457	0.1249
0.90	0.20	0.01	1.0	19320.50	3.4868	3.3765	0.4861	0.0221	1.527	0.0566
1.10	0.20	0.01	1.0	9038.24	3.4954	3.3688	0.4836	0.0270	1.655	0.0889
1.40	0.20	0.01	1.0	3773.75	3.5066	3.3608	0.4819	0.0254	1.826	0.0906
1.75	0.20	0.01	1.0	1775.16	3.5178	3.3537	0.4812	0.0187	1.996	0.0659
2.20	0.20	0.01	1.0	838.34	3.5395	3.2215	0.4581	0.0120	2.184	0.0822
0.70	0.30	0.01	1.0	25536.80	3.4868	3.3592	0.4712	0.0128	1.567	0.0037
0.90	0.30	0.01	1.0	9812.07	3.4944	3.3462	0.4674	0.0186	1.737	0.0344
1.10	0.30	0.01	1.0	4682.00	3.5033	3.3361	0.4652	0.0194	1.870	0.0461
1.40	0.30	0.01	1.0	2039.82	3.5157	3.3238	0.4632	0.0153	2.045	0.0387
1.75	0.30	0.01	1.0	989.67	3.5305	3.2782	0.4555	0.0102	2.246	0.0247
2.20	0.30	0.01	1.0	475.08	3.6045	2.4537	0.3435	0.0067	2.389	0.0027
0.70	0.40	0.01	1.0	12262.13	3.4942	3.3262	0.4527	0.0105	-	-
1.10	0.40	0.01	1.0	2374.91	3.5145	3.2931	0.4459	0.0112	2.109	0.0106
0.90	0.20	0.04	1.0	31750.20	3.4306	3.3990	0.4784	0.0234	1.207	0.0705
1.75	0.20	0.04	1.0	2600.80	3.4674	3.3878	0.4758	0.0173	1.681	0.0657
0.70	0.30	0.04	1.0	39988.78	3.4309	3.3857	0.4648	0.0143	1.264	0.0084
1.75	0.30	0.04	1.0	1372.40	3.4778	3.3541	0.4578	0.0090	1.916	0.0230

* Values refer to the onset of the helium-core flash when $L_{He} = 100\ L_\odot$.

helium burning became greater than 1 $L_\odot$. During much of the evolution neutrino emission generally causes a temperature inversion in the inner part of the core. The density of points in the neighborhood of the resulting temperature maximum was increased by a factor of 5 over the normal spacing. Throughout the temperature inversion the maximum change in $\log T$ between points was set at 0.005. These criteria yielded models containing roughly 500 points.

The present evolution program has been highly automated so that only a single computer run was needed to construct each of the red giant sequences. Typically a sequence consisted of about 1000 models and required about 1 hour on the IBM 360/91 computer.

III. RESULTS FOR RED GIANT SEQUENCES

Table 1 provides a complete listing of all 46 red giant sequences and summarizes some of their basic properties. The quantity F_ν denotes the factor by which the neutrino emission rates of Beaudet, Petrosian, and Salpeter (1967) have been multiplied in constructing each sequence. Usually $F_\nu = 1$ except for three sequences with $(M, Y, Z) = (0.70, 0.30, 0.001)$, where values of 0, 0.5, and 2 have been studied in order to determine the dependence of the core mass M_c on the rate of neutrino emission. All sequences were terminated as soon as the helium burning $L_{\rm He}$ exceeded 100 $L_\odot$, a point which coincided approximately with the appearance of flash convection. For each integral value of $\log Z$, sequences have been obtained with $M = 0.90\, M_\odot$ for $0.10 \leq Y \leq 0.30$ and with $M = 0.70\, M_\odot$ for $0.20 \leq Y \leq 0.40$, except for the omission of the case $(M, Y, Z) = (0.70, 0.20, 0.01)$. A range of mass values has been studied at $Z = 0.01$, and these results should serve as a guide for interpolating between the high- and low-mass sequences at $Z = 0.04$. Two sequences with $M = 1.4\, M_\odot$ have been computed for $Z = 0.0001$ because of their possible relevance to the anomalous Cepheids in the dwarf spheroidal galaxies (Zinn and Searle 1976; Renzini, Mengel, and Sweigart 1977). All of the present sequences assume a mixing length equal to 1 pressure-scale height. How red giant properties depend on the mixing length will be discussed by Sweigart (1978*a*).

The quantities marked with asterisks in columns (5) to (8) of Table 1 refer to the onset of the helium-core flash, defined here as the time when the helium burning $L_{\rm He}$ equals 100 $L_\odot$. The quantity t_f is the time elapsed since the ZAMS phase in units of 10^6 yrs. The data in these columns do not change significantly until after the flash peak, as has been shown by continuing one of these sequences through the flash (Mengel and Sweigart 1978*a*).

During the subgiant-branch phase, the convective envelope penetrates inward into the region that was partially depleted of hydrogen during the preceding evolution. Later, as the hydrogen-burning shell approaches, the convective envelope retreats outward, leaving behind a discontinuity in the hydrogen abundance. This behavior has two consequences. First, there is an enrichment in the surface helium abundance by the amount ΔY_s given in column (9) of Table 1. Second, there is a brief hesitation in the rate of evolution up the giant branch when the hydrogen-burning shell reaches the hydrogen discontinuity. In many cases this hesitation is accompanied by an actual drop in the surface luminosity (Thomas 1967; Iben 1968*a*; Demarque and Heasley 1971). Refsdal and Weigert (1970) have explained this drop by considering the way in which a shell source readjusts to a change in the composition. The average value of $\log L$ during the luminosity drop is denoted by $\log L_d$ in Table 1, while the size of the drop is represented by $\Delta \log L_d$.

All masses and luminosities in Table 1, as well as in all subsequent tables, are in solar units.

The variations in a number of model characteristics along each red giant sequence are presented in Table 2 at increments of 0.1 in $\log L$. Near the end of each sequence, data are also tabulated for $\log L_{\rm He} = -1$, 0, 1, and 2. The asterisks indicate the models at the beginning and end of the luminosity drop, if one occurred. For sequences overlapping two pages, the sequence parameters (M, Y, Z, F_ν) have been repeated at the top of the second page. Table 2 is organized overall in order of increasing Z. For fixed Z the order is first in terms of increasing Y, then increasing M, and finally increasing F_ν.

The first column of Table 2 gives $t - t_f$, the time before the onset of the helium-core flash in units of 10^6 yr. The total rates at which energy is lost by neutrino emission and released by the hydrogen-burning reactions are denoted by L_ν and $L_{\rm H}$, respectively, while g and R stand for the surface gravity and radius in cgs units. The central density and temperature are designated by ρ_c and T_c. The maximum temperature within the core and its location in mass are represented by $\log T_{\rm max}$ and $M_r(T_{\rm max})$, respectively. The quantity $M_{\rm SH}$ gives the amount of mass interior to the center of the hydrogen-burning shell, defined as the point where the hydrogen abundance is one-half of its envelope value, while $M_{\rm CE}$ gives the amount of mass interior to the edge of the convective envelope. The core mass M_c is then simply the value of $M_{\rm SH}$ at $\log L_{\rm He} = 2$.

Further data on the interior structure of selected red giant models at various points along the giant branch are furnished in Tables 3–7 for five sequences chosen to span a wide range in the basic parameters. No entries are given at the location of the temperature maximum when this point coincided with the center. Here η represents an approximate value for the degeneracy parameter. All of the remaining quantities either have their standard meanings or have already been defined.

In the following section the data in Tables 1–7 will be more closely examined in order to study the systematic behavior of the red giant sequences.

IV. DISCUSSION OF RED GIANT CHARACTERISTICS

a) Track Morphology in the H-R Diagram

All of the red giant sequences with $F_\nu = 1$ are plotted in Figures 1*a*–1*c*. The section of each track

TABLE 2

CHARACTERISTICS OF RED-GIANT EVOLUTION

$t - t_f$	log T_{eff}	log L	log L_ν	log L_{He}	log L_H	log g	log R	log ρ_c	log T_c	log T_{max}	$M_r(T_{max})$	M_{SH}	M_{CE}
				$M = 0.90$	$Y = 0.10$		$Z = 0.00001$		$F_\nu = 1.0$				
−200.8956	3.6829	1.3000	−2.466	–	1.2981	2.770	11.653	5.3020	7.6410	7.6410	0.000	0.2689	0.459
−164.9416	3.6799	1.4000	−2.327	–	1.3983	2.658	11.709	5.3647	7.6466	7.6466	0.000	0.2811	0.436
−134.8831	3.6765	1.5000	−2.183	–	1.4981	2.544	11.766	5.4205	7.6556	7.6557	0.022	0.2933	0.421
−110.1817	3.6731	1.6000	−2.039	–	1.5981	2.431	11.823	5.4715	7.6673	7.6680	0.053	0.3057	0.411
−90.0819	3.6698	1.7000	−1.897	–	1.6979	2.318	11.880	5.5195	7.6796	7.6811	0.076	0.3179	0.407
−73.8279	3.6662	1.8000	−1.764	–	1.7979	2.203	11.937	5.5658	7.6915	7.6935	0.089	0.3300	0.404
−60.6064	3.6625	1.9000	−1.634	−9.761	1.8979	2.088	11.994	5.6107	7.7030	7.7056	0.102	0.3422	0.407
−49.8562	3.6588	2.0000	−1.509	−9.371	1.9978	1.974	12.051	5.6547	7.7140	7.7174	0.114	0.3546	0.409
−41.0269	3.6551	2.1000	−1.386	−8.995	2.0976	1.859	12.109	5.6980	7.7247	7.7292	0.133	0.3670	0.414
−33.6116	3.6512	2.2000	−1.261	−8.608	2.1976	1.743	12.167	5.7410	7.7356	7.7421	0.161	0.3800	0.420
−27.0822	3.6471	2.3000	−1.124	−8.175	2.2974	1.627	12.225	5.7862	7.7478	7.7576	0.196	0.3943	0.428
−24.1709*	3.6462	2.3281	−1.054	−7.946	2.3253	1.595	12.241	5.8093	7.7542	7.7659	0.210	0.4017	0.435
−23.2327*	3.6463	2.3260	−1.030	−7.870	2.3231	1.598	12.239	5.8171	7.7563	7.7685	0.212	0.4041	0.438
−19.8337	3.6433	2.4000	−0.953	−7.623	2.3975	1.512	12.283	5.8451	7.7631	7.7765	0.221	0.4131	0.443
−15.6869	3.6393	2.5000	−0.838	−7.223	2.4974	1.396	12.340	5.8849	7.7727	7.7903	0.253	0.4265	0.453
−12.1940	3.6351	2.6000	−0.716	−6.674	2.5973	1.279	12.399	5.9253	7.7832	7.8066	0.281	0.4407	0.464
−9.2599	3.6311	2.7000	−0.587	−5.871	2.6971	1.163	12.457	5.9665	7.7946	7.8247	0.304	0.4557	0.476
−6.7853	3.6272	2.8000	−0.454	−4.837	2.7969	1.047	12.515	6.0090	7.8067	7.8445	0.327	0.4716	0.490
−4.6952	3.6231	2.9000	−0.315	−3.694	2.8967	0.931	12.573	6.0530	7.8191	7.8657	0.349	0.4886	0.505
−2.9247	3.6192	3.0000	−0.171	−2.503	2.9966	0.815	12.631	6.0989	7.8316	7.8883	0.370	0.5066	0.521
−1.4111	3.6154	3.1000	−0.021	−1.261	3.0964	0.700	12.688	6.1473	7.8440	7.9128	0.391	0.5261	0.538
−1.1348	3.6149	3.1200	0.009	−1.000	3.1163	0.678	12.699	6.1573	7.8464	7.9180	0.394	0.5301	0.542
−0.3055	3.6125	3.1828	0.114	0.000	3.1789	0.606	12.736	6.1890	7.8537	7.9382	0.394	0.5436	0.554
−0.0211	3.6120	3.1995	0.162	1.000	3.1954	0.587	12.745	6.1971	7.8543	7.9619	0.354	0.5487	0.559
0.0000	3.6121	3.1994	0.171	2.000	3.1948	0.587	12.745	6.1957	7.8530	7.9985	0.341	0.5491	0.560
				$M = 0.70$	$Y = 0.20$		$Z = 0.00001$		$F_\nu = 1.0$				
−178.8212	3.6841	1.3000	−2.493	–	1.2981	2.666	11.651	5.3123	7.6307	7.6307	0.000	0.2688	0.421
−145.8100	3.6811	1.4000	−2.358	–	1.3982	2.554	11.707	5.3660	7.6387	7.6387	0.000	0.2800	0.409
−118.3231	3.6773	1.5000	−2.216	–	1.4982	2.439	11.765	5.4147	7.6502	7.6506	0.034	0.2915	0.402
−95.9806	3.6739	1.6000	−2.074	–	1.5981	2.325	11.821	5.4600	7.6634	7.6644	0.065	0.3029	0.398
−77.9406	3.6706	1.7000	−1.936	–	1.6980	2.212	11.878	5.5036	7.6769	7.6783	0.076	0.3143	0.397
−63.3697	3.6666	1.8000	−1.804	–	1.7979	2.096	11.936	5.5459	7.6896	7.6917	0.089	0.3256	0.397
−51.5423	3.6629	1.9000	−1.674	–	1.8978	1.981	11.993	5.5874	7.7023	7.7049	0.099	0.3371	0.399
−41.9944	3.6592	2.0000	−1.550	−9.421	1.9976	1.866	12.051	5.6284	7.7144	7.7175	0.107	0.3486	0.404
−34.1869	3.6554	2.1000	−1.426	−9.030	2.0976	1.751	12.108	5.6687	7.7261	7.7301	0.122	0.3603	0.408
−27.7022	3.6514	2.2000	−1.301	−8.631	2.1975	1.635	12.166	5.7090	7.7379	7.7435	0.144	0.3725	0.414
−22.1819	3.6474	2.3000	−1.171	−8.205	2.2974	1.519	12.224	5.7497	7.7502	7.7587	0.175	0.3854	0.423
−17.1859	3.6435	2.4000	−1.025	−7.712	2.3973	1.404	12.282	5.7943	7.7643	7.7765	0.202	0.4000	0.434
−13.5145	3.6395	2.5000	−0.897	−7.231	2.4972	1.288	12.340	5.8334	7.7767	7.7927	0.226	0.4133	0.443
−10.4143	3.6354	2.6000	−0.764	−6.563	2.5971	1.171	12.398	5.8733	7.7896	7.8106	0.250	0.4274	0.453
−7.8078	3.6315	2.7000	−0.627	−5.610	2.6969	1.056	12.456	5.9143	7.8029	7.8300	0.273	0.4423	0.465
−5.6177	3.6278	2.8000	−0.485	−4.476	2.7967	0.940	12.514	5.9565	7.8165	7.8508	0.294	0.4580	0.478
−3.7717	3.6240	2.9000	−0.339	−3.278	2.8965	0.825	12.571	6.0002	7.8303	7.8727	0.315	0.4748	0.493
−2.2020	3.6202	3.0000	−0.189	−2.047	2.9963	0.710	12.629	6.0459	7.8440	7.8963	0.336	0.4927	0.508
−1.0880	3.6178	3.0821	−0.061	−1.000	3.0782	0.619	12.675	6.0849	7.8551	7.9171	0.352	0.5083	0.522
−0.8627	3.6173	3.1000	−0.031	−0.754	3.0961	0.598	12.685	6.0936	7.8575	7.9221	0.355	0.5119	0.525
−0.3043	3.6154	3.1454	0.049	0.000	3.1414	0.546	12.711	6.1158	7.8634	7.9372	0.351	0.5214	0.534
−0.0213	3.6152	3.1636	0.101	1.000	3.1593	0.527	12.721	6.1236	7.8641	7.9611	0.305	0.5266	0.539
0.0000	3.6152	3.1628	0.111	2.000	3.1579	0.528	12.720	6.1219	7.8627	7.9981	0.292	0.5270	0.540
				$M = 0.90$	$Y = 0.20$		$Z = 0.00001$		$F_\nu = 1.0$				
−111.0247	3.6825	1.5000	−2.196	–	1.4977	2.569	11.754	5.2950	7.7067	7.7067	0.000	0.2806	0.477
−91.4155	3.6791	1.6000	−2.056	–	1.5978	2.455	11.811	5.3603	7.7101	7.7101	0.000	0.2923	0.450
−75.2423	3.6751	1.7000	−1.923	–	1.6976	2.339	11.869	5.4188	7.7156	7.7156	0.000	0.3042	0.430
−61.9631	3.6713	1.8000	−1.793	−9.669	1.7976	2.224	11.926	5.4730	7.7226	7.7226	0.000	0.3161	0.420
−50.9862	3.6680	1.9000	−1.663	−9.323	1.8974	2.110	11.983	5.5236	7.7310	7.7312	0.016	0.3280	0.415
−41.7990	3.6637	2.0000	−1.530	−8.942	1.9975	1.993	12.042	5.5718	7.7409	7.7420	0.050	0.3403	0.413
−34.2686	3.6594	2.1000	−1.399	−8.566	2.0973	1.876	12.100	5.6184	7.7515	7.7534	0.064	0.3527	0.416
−27.9751	3.6557	2.2000	−1.270	−8.188	2.1972	1.761	12.158	5.6641	7.7620	7.7650	0.083	0.3656	0.419
−22.7068	3.6519	2.3000	−1.141	−7.793	2.2973	1.646	12.215	5.7094	7.7725	7.7772	0.109	0.3789	0.424
−18.2256	3.6473	2.4000	−1.007	−7.319	2.3971	1.528	12.274	5.7548	7.7835	7.7913	0.148	0.3929	0.432
−13.8302*	3.6436	2.4907	−0.843	−6.532	2.4875	1.422	12.327	5.8084	7.7976	7.8104	0.186	0.4102	0.444
−13.1965*	3.6438	2.4884	−0.818	−6.384	2.4851	1.425	12.326	5.8168	7.7998	7.8134	0.189	0.4129	0.448
−12.8344	3.6436	2.5000	−0.804	−6.304	2.4971	1.413	12.332	5.8215	7.8009	7.8149	0.192	0.4143	0.449
−9.9197	3.6395	2.6000	−0.689	−5.590	2.5970	1.297	12.390	5.8621	7.8103	7.8275	0.211	0.4277	0.457
−7.3917	3.6354	2.7000	−0.567	−4.739	2.6969	1.180	12.448	5.9042	7.8201	7.8428	0.241	0.4423	0.468
−5.2531	3.6311	2.8000	−0.437	−3.780	2.7967	1.063	12.507	5.9475	7.8306	7.8606	0.270	0.4577	0.481
−3.4458	3.6268	2.9000	−0.301	−2.743	2.8965	0.946	12.566	5.9918	7.8417	7.8805	0.297	0.4742	0.494
−1.9032	3.6228	3.0000	−0.159	−1.634	2.9964	0.830	12.623	6.0381	7.8534	7.9026	0.322	0.4920	0.509
−1.1739	3.6204	3.0534	−0.078	−1.000	3.0495	0.767	12.655	6.0635	7.8598	7.9154	0.334	0.5019	0.518
−0.5786	3.6188	3.1000	−0.003	−0.371	3.0961	0.714	12.681	6.0860	7.8654	7.9282	0.339	0.5111	0.526
−0.3173	3.6177	3.1209	0.034	0.000	3.1169	0.689	12.694	6.0960	7.8678	7.9357	0.333	0.5155	0.530
−0.0213	3.6173	3.1395	0.088	1.000	3.1353	0.668	12.704	6.1036	7.8682	7.9595	0.283	0.5206	0.535
0.0000	3.6174	3.1385	0.100	2.000	3.1331	0.670	12.704	6.1017	7.8667	7.9968	0.270	0.5210	0.536

TABLE 2—*Continued*

$t - t_f$	log T_{eff}	log L	log L_ν	log L_{He}	log L_H	log g	log R	log ρ_c	log T_c	log T_{max}	$M_r(T_{max})$	M_{SH}	M_{CE}
				M = 0.70 Y = 0.30 Z = 0.00001 F_ν = 1.0									
−98.4370	3.6848	1.5000	−2.241	–	1.4977	2.469	11.750	5.2964	7.6944	7.6944	0.000	0.2786	0.443
−80.2529	3.6806	1.6000	−2.102	–	1.5977	2.352	11.808	5.3535	7.7015	7.7015	0.000	0.2898	0.426
−65.4222	3.6768	1.7000	−1.969	–	1.6977	2.237	11.865	5.4057	7.7098	7.7098	0.000	0.3009	0.416
−53.3417	3.6728	1.8000	−1.839	−9.793	1.7976	2.121	11.924	5.4549	7.7190	7.7190	0.000	0.3122	0.410
−43.4371	3.6691	1.9000	−1.708	−9.410	1.8975	2.006	11.981	5.5014	7.7293	7.7296	0.016	0.3235	0.407
−35.2815	3.6647	2.0000	−1.576	−9.012	1.9974	1.888	12.040	5.5460	7.7405	7.7415	0.044	0.3350	0.407
−28.5682	3.6603	2.1000	−1.444	−8.608	2.0972	1.771	12.099	5.5892	7.7523	7.7542	0.063	0.3468	0.411
−23.0423	3.6567	2.2000	−1.314	−8.206	2.1971	1.656	12.156	5.6319	7.7644	7.7671	0.076	0.3589	0.414
−18.4312	3.6526	2.3000	−1.184	−7.783	2.2971	1.540	12.214	5.6745	7.7763	7.7801	0.091	0.3714	0.420
−14.5548	3.6481	2.4000	−1.051	−7.280	2.3969	1.422	12.273	5.7168	7.7882	7.7945	0.123	0.3846	0.428
−11.2269	3.6442	2.5000	−0.910	−6.556	2.4968	1.306	12.331	5.7603	7.8011	7.8112	0.157	0.3988	0.436
−8.2985	3.6403	2.6000	−0.762	−5.559	2.5967	1.191	12.389	5.8059	7.8148	7.8296	0.183	0.4140	0.447
−6.0764	3.6361	2.7000	−0.626	−4.548	2.6965	1.074	12.447	5.8475	7.8274	7.8473	0.210	0.4286	0.458
−4.2013	3.6320	2.8000	−0.486	−3.471	2.7964	0.957	12.505	5.8901	7.8404	7.8669	0.238	0.4440	0.469
−2.6133	3.6281	2.9000	−0.339	−2.341	2.8962	0.842	12.563	5.9342	7.8537	7.8883	0.262	0.4604	0.483
−1.2634	3.6242	3.0000	−0.187	−1.164	2.9959	0.726	12.621	5.9800	7.8674	7.9116	0.285	0.4780	0.498
−1.1021	3.6237	3.0131	−0.166	−1.000	3.0090	0.711	12.628	5.9861	7.8692	7.9149	0.288	0.4804	0.500
−0.3101	3.6212	3.0801	−0.049	0.000	3.0759	0.634	12.667	6.0172	7.8787	7.9349	0.284	0.4933	0.511
−0.0208	3.6206	3.0998	0.011	1.000	3.0952	0.612	12.678	6.0240	7.8796	7.9588	0.228	0.4985	0.516
0.0000	3.6207	3.0983	0.025	2.000	3.0921	0.614	12.677	6.0217	7.8779	7.9970	0.216	0.4989	0.516
				M = 0.90 Y = 0.30 Z = 0.00001 F_ν = 1.0									
−59.4885	3.6822	1.7000	−1.992	−9.147	1.6968	2.367	11.855	5.2779	7.7691	7.7691	0.000	0.2921	0.495
−49.4761	3.6777	1.8000	−1.840	−8.882	1.7970	2.249	11.914	5.3492	7.7728	7.7728	0.000	0.3030	0.463
−40.9719	3.6739	1.9000	−1.705	−8.640	1.8969	2.134	11.971	5.4115	7.7756	7.7756	0.000	0.3144	0.443
−33.7658	3.6701	2.0000	−1.572	−8.359	1.9970	2.019	12.029	5.4688	7.7803	7.7803	0.000	0.3262	0.431
−27.6474	3.6660	2.1000	−1.439	−8.030	2.0969	1.902	12.087	5.5225	7.7866	7.7866	0.000	0.3384	0.425
−22.3972	3.6618	2.2000	−1.303	−7.621	2.1968	1.786	12.146	5.5738	7.7943	7.7944	0.008	0.3512	0.424
−17.8438	3.6573	2.3000	−1.159	−7.019	2.2968	1.668	12.205	5.6225	7.8044	7.8064	0.051	0.3649	0.429
−14.0599	3.6529	2.4000	−1.016	−6.233	2.3967	1.550	12.263	5.6704	7.8162	7.8200	0.077	0.3789	0.432
−10.9176	3.6489	2.5000	−0.874	−5.333	2.4966	1.434	12.321	5.7177	7.8281	7.8343	0.102	0.3933	0.439
−8.2114	3.6441	2.6000	−0.727	−4.349	2.5964	1.315	12.381	5.7660	7.8402	7.8503	0.134	0.4087	0.447
−6.3896*	3.6424	2.6501	−0.611	−3.563	2.6462	1.258	12.409	5.8039	7.8497	7.8638	0.159	0.4210	0.457
−6.0970*	3.6425	2.6489	−0.591	−3.430	2.6449	1.260	12.409	5.8104	7.8513	7.8661	0.165	0.4231	0.460
−5.0763	3.6398	2.7000	−0.527	−3.020	2.6965	1.198	12.440	5.8326	7.8561	7.8733	0.175	0.4302	0.465
−3.2779	3.6358	2.8000	−0.401	−2.198	2.7963	1.082	12.498	5.8767	7.8657	7.8882	0.199	0.4451	0.475
−1.7393	3.6316	2.9000	−0.266	−1.294	2.8962	0.965	12.556	5.9219	7.8760	7.9056	0.228	0.4612	0.487
−1.3273	3.6302	2.9295	−0.224	−1.000	2.9256	0.930	12.574	5.9354	7.8793	7.9115	0.235	0.4661	0.491
−0.4027	3.6269	3.0000	−0.109	−0.115	2.9959	0.846	12.615	5.9675	7.8883	7.9288	0.233	0.4788	0.501
−0.3227	3.6268	3.0061	−0.096	0.000	3.0020	0.840	12.619	5.9700	7.8892	7.9310	0.229	0.4800	0.502
−0.0181	3.6260	3.0241	−0.029	1.000	3.0197	0.819	12.629	5.9750	7.8901	7.9557	0.161	0.4847	0.507
0.0000	3.6261	3.0229	−0.009	2.000	3.0169	0.820	12.628	5.9724	7.8883	7.9950	0.151	0.4849	0.507
				M = 0.70 Y = 0.40 Z = 0.00001 F_ν = 1.0									
−42.3438	3.6798	1.8000	−1.882	−8.957	1.7970	2.149	11.910	5.3296	7.7714	7.7714	0.000	0.2999	0.447
−34.7194	3.6761	1.9000	−1.749	−8.690	1.8970	2.034	11.967	5.3875	7.7761	7.7761	0.000	0.3105	0.434
−28.3021	3.6721	2.0000	−1.618	−8.388	1.9969	1.918	12.025	5.4410	7.7821	7.7821	0.000	0.3216	0.425
−22.8973	3.6676	2.1000	−1.487	−8.037	2.0968	1.800	12.084	5.4914	7.7897	7.7897	0.000	0.3331	0.422
−18.3522	3.6635	2.2000	−1.354	−7.609	2.1968	1.683	12.142	5.5393	7.7984	7.7984	0.000	0.3450	0.421
−14.3993	3.6592	2.3000	−1.214	−6.992	2.2966	1.566	12.201	5.5853	7.8083	7.8092	0.034	0.3579	0.425
−11.1002	3.6551	2.4000	−1.070	−6.131	2.3965	1.450	12.259	5.6299	7.8208	7.8239	0.063	0.3713	0.428
−8.3764	3.6503	2.5000	−0.927	−5.161	2.4964	1.331	12.319	5.6743	7.8341	7.8391	0.085	0.3850	0.435
−6.1068	3.6457	2.6000	−0.782	−4.147	2.5962	1.212	12.378	5.7189	7.8476	7.8554	0.107	0.3993	0.443
−4.0969	3.6414	2.7000	−0.627	−3.063	2.6960	1.095	12.436	5.7661	7.8617	7.8739	0.139	0.4151	0.453
−2.4191	3.6375	2.8000	−0.474	−2.001	2.7960	0.980	12.494	5.8130	7.8755	7.8933	0.167	0.4312	0.464
−1.1377	3.6333	2.8954	−0.331	−1.000	2.8911	0.867	12.550	5.8555	7.8886	7.9124	0.188	0.4466	0.476
−1.0801	3.6329	2.9000	−0.324	−0.947	2.8958	0.861	12.553	5.8575	7.8893	7.9135	0.188	0.4474	0.477
−0.2830	3.6306	2.9666	−0.205	0.000	2.9622	0.785	12.591	5.8863	7.9013	7.9313	0.174	0.4591	0.486
−0.0151	3.6298	2.9836	−0.133	1.000	2.9790	0.765	12.601	5.8896	7.9043	7.9567	0.102	0.4634	0.490
0.0000	3.6300	2.9816	−0.111	2.000	2.9748	0.768	12.600	5.8861	7.9022	7.9972	0.093	0.4636	0.490
				M = 0.90 Y = 0.10 Z = 0.0001 F_ν = 1.0									
−277.3711	3.6837	1.1000	−3.231	–	1.0982	2.974	11.552	5.1265	7.5461	7.5461	0.000	0.2272	0.438
−228.4020	3.6807	1.2000	−3.068	–	1.1982	2.861	11.608	5.1942	7.5551	7.5551	0.000	0.2384	0.407
−188.4760	3.6779	1.3000	−2.906	–	1.2982	2.750	11.663	5.2537	7.5673	7.5673	0.000	0.2497	0.382
−155.7325	3.6745	1.4000	−2.747	–	1.3984	2.636	11.720	5.3079	7.5809	7.5809	0.000	0.2609	0.366
−128.9394	3.6710	1.5000	−2.593	–	1.4980	2.523	11.777	5.3583	7.5951	7.5951	0.000	0.2720	0.361
−106.9888	3.6680	1.6000	−2.442	–	1.5981	2.411	11.833	5.4057	7.6097	7.6097	0.000	0.2833	0.356
−88.8693	3.6641	1.7000	−2.293	–	1.6982	2.295	11.891	5.4512	7.6246	7.6246	0.000	0.2945	0.355
−73.6099	3.6602	1.8000	−2.134	–	1.7980	2.179	11.949	5.4942	7.6411	7.6418	0.055	0.3062	0.360
−61.0039	3.6566	1.9000	−1.976	–	1.8980	2.065	12.006	5.5363	7.6589	7.6601	0.074	0.3181	0.364
−50.7529	3.6527	2.0000	−1.824	–	1.9980	1.949	12.064	5.5781	7.6762	7.6776	0.072	0.3301	0.369
−41.9255	3.6484	2.1000	−1.670	–	2.0978	1.832	12.122	5.6217	7.6932	7.6950	0.081	0.3428	0.374
−37.3763*	3.6471	2.1356	−1.580	−8.703	2.1332	1.792	12.143	5.6479	7.7029	7.7050	0.087	0.3505	0.381
−34.7740*	3.6482	2.1165	−1.529	−8.521	2.1139	1.815	12.131	5.6636	7.7084	7.7107	0.093	0.3549	0.388
−29.7768	3.6446	2.2000	−1.444	−8.253	2.1979	1.717	12.180	5.6924	7.7167	7.7189	0.087	0.3633	0.392
−24.2437	3.6404	2.3000	−1.334	−7.904	2.2978	1.600	12.238	5.7293	7.7267	7.7300	0.117	0.3746	0.400

TABLE 2—*Continued*

$t - t_f$	$\log T_{eff}$	$\log L$	$\log L_\nu$	$\log L_{He}$	$\log L_H$	$\log g$	$\log R$	$\log \rho_c$	$\log T_c$	$\log T_{max}$	$M_r(T_{max})$	M_{SH}	M_{CE}
$M = 0.90$ $Y = 0.10$ $Z = 0.0001$ $F_\nu = 1.0$													
−19.5820	3.6360	2.4000	−1.213	−7.511	2.3977	1.482	12.297	5.7666	7.7379	7.7437	0.153	0.3866	0.409
−15.6786	3.6315	2.5000	−1.086	−7.082	2.4976	1.365	12.356	5.8043	7.7505	7.7596	0.185	0.3992	0.419
−12.3859	3.6271	2.6000	−0.950	−6.620	2.5975	1.247	12.415	5.8430	7.7643	7.7774	0.215	0.4127	0.430
−9.6288	3.6225	2.7000	−0.809	−6.129	2.6974	1.128	12.474	5.8826	7.7789	7.7966	0.240	0.4269	0.442
−7.2922	3.6181	2.8000	−0.664	−5.563	2.7972	1.011	12.533	5.9235	7.7939	7.8174	0.264	0.4420	0.455
−5.3107	3.6135	2.9000	−0.513	−4.771	2.8971	0.892	12.592	5.9659	7.8093	7.8395	0.286	0.4582	0.470
−3.6272	3.6090	3.0000	−0.358	−3.644	2.9969	0.775	12.651	6.0102	7.8248	7.8630	0.309	0.4754	0.486
−2.1901	3.6046	3.1000	−0.197	−2.346	3.0967	0.657	12.710	6.0568	7.8403	7.8881	0.331	0.4940	0.503
−0.9702	3.6005	3.1984	−0.032	−1.000	3.1949	0.542	12.767	6.1055	7.8553	7.9145	0.351	0.5139	0.522
−0.9520	3.6005	3.2000	−0.030	−0.978	3.1964	0.540	12.768	6.1063	7.8555	7.9150	0.351	0.5142	0.522
−0.2924	3.5979	3.2585	0.079	0.000	3.2549	0.472	12.803	6.1364	7.8641	7.9345	0.351	0.5271	0.534
−0.0234	3.5971	3.2776	0.138	1.000	3.2737	0.450	12.814	6.1456	7.8655	7.9575	0.302	0.5329	0.540
0.0000	3.5972	3.2766	0.152	2.000	3.2724	0.451	12.813	6.1438	7.8640	7.9939	0.286	0.5334	0.540
$M = 0.70$ $Y = 0.20$ $Z = 0.0001$ $F_\nu = 1.0$													
−458.4260	3.6948	0.8000	−3.762	–	0.7986	3.208	11.380	4.9390	7.5026	7.5026	0.000	0.1983	0.474
−375.6068	3.6914	0.9000	−3.565	–	0.8984	3.095	11.436	5.0267	7.5115	7.5115	0.000	0.2086	0.438
−306.1471	3.6885	1.0000	−3.387	–	0.9984	2.983	11.492	5.0992	7.5222	7.5222	0.000	0.2194	0.407
−249.4586	3.6852	1.1000	−3.220	–	1.0984	2.870	11.549	5.1613	7.5344	7.5344	0.000	0.2301	0.388
−203.6139	3.6819	1.2000	−3.060	–	1.1984	2.757	11.605	5.2166	7.5480	7.5480	0.000	0.2406	0.371
−166.6159	3.6789	1.3000	−2.907	–	1.2984	2.645	11.661	5.2670	7.5620	7.5620	0.000	0.2510	0.360
−136.6020	3.6753	1.4000	−2.757	–	1.3983	2.531	11.719	5.3139	7.5764	7.5764	0.000	0.2613	0.354
−112.1264	3.6717	1.5000	−2.610	–	1.4983	2.416	11.776	5.3583	7.5911	7.5911	0.000	0.2716	0.351
−92.2108	3.6685	1.6000	−2.466	–	1.5983	2.303	11.832	5.4006	7.6060	7.6060	0.000	0.2819	0.349
−75.6258	3.6644	1.7000	−2.317	–	1.6981	2.187	11.890	5.4414	7.6216	7.6219	0.037	0.2924	0.352
−61.9889	3.6605	1.8000	−2.165	–	1.7981	2.071	11.948	5.4808	7.6392	7.6398	0.047	0.3032	0.355
−50.7532	3.6568	1.9000	−2.014	–	1.8980	1.956	12.006	5.5193	7.6564	7.6577	0.070	0.3143	0.359
−41.6301	3.6527	2.0000	−1.869	–	1.9978	1.840	12.064	5.5579	7.6735	7.6750	0.072	0.3254	0.365
−33.9837	3.6484	2.1000	−1.722	–	2.0977	1.723	12.122	5.5973	7.6905	7.6922	0.076	0.3371	0.371
−26.1660	3.6444	2.2000	−1.544	−8.499	2.1978	1.607	12.180	5.6464	7.7104	7.7131	0.095	0.3517	0.383
−21.2650	3.6401	2.3000	−1.417	−8.063	2.2976	1.490	12.239	5.6821	7.7241	7.7276	0.113	0.3630	0.390
−17.1112	3.6357	2.4000	−1.285	−7.604	2.3976	1.372	12.298	5.7188	7.7383	7.7439	0.139	0.3749	0.399
−13.6285	3.6312	2.5000	−1.146	−7.122	2.4974	1.254	12.357	5.7562	7.7533	7.7618	0.167	0.3875	0.409
−10.7208	3.6267	2.6000	−1.004	−6.621	2.5973	1.136	12.416	5.7943	7.7689	7.7809	0.191	0.4007	0.420
−8.2673	3.6222	2.7000	−0.856	−6.087	2.6971	1.018	12.475	5.8336	7.7851	7.8014	0.215	0.4148	0.432
−6.1941	3.6180	2.8000	−0.703	−5.451	2.7970	0.902	12.533	5.8741	7.8016	7.8230	0.235	0.4298	0.445
−4.4399	3.6135	2.9000	−0.548	−4.522	2.8968	0.784	12.592	5.9161	7.8182	7.8460	0.258	0.4457	0.459
−2.9462	3.6094	3.0000	−0.387	−3.284	2.9966	0.667	12.650	5.9600	7.8349	7.8702	0.278	0.4628	0.475
−1.6698	3.6054	3.1000	−0.221	−1.938	3.0964	0.551	12.708	6.0062	7.8517	7.8961	0.300	0.4812	0.491
−0.9149	3.6031	3.1670	−0.105	−1.000	3.1633	0.475	12.746	6.0388	7.8629	7.9145	0.312	0.4944	0.504
−0.5674	3.6020	3.2000	−0.045	−0.500	3.1962	0.437	12.765	6.0551	7.8684	7.9244	0.316	0.5013	0.510
−0.2847	3.6008	3.2273	0.008	0.000	3.2234	0.405	12.781	6.0686	7.8728	7.9343	0.311	0.5071	0.516
−0.0231	3.6001	3.2470	0.073	1.000	3.2429	0.383	12.792	6.0774	7.8746	7.9574	0.258	0.5130	0.522
0.0000	3.6002	3.2463	0.089	2.000	3.2419	0.384	12.792	6.0753	7.8730	7.9946	0.243	0.5136	0.522
$M = 0.90$ $Y = 0.20$ $Z = 0.0001$ $F_\nu = 1.0$													
−156.1135	3.6844	1.3000	−2.997	–	1.2977	2.776	11.650	5.1367	7.5944	7.5944	0.000	0.2366	0.446
−129.5962	3.6812	1.4000	−2.836	–	1.3981	2.663	11.707	5.2027	7.6029	7.6029	0.000	0.2475	0.410
−107.5340	3.6774	1.5000	−2.676	–	1.4978	2.548	11.764	5.2615	7.6141	7.6141	0.000	0.2586	0.387
−89.2793	3.6738	1.6000	−2.519	–	1.5980	2.434	11.822	5.3154	7.6270	7.6270	0.000	0.2698	0.373
−74.1479	3.6703	1.7000	−2.363	–	1.6978	2.320	11.879	5.3658	7.6411	7.6411	0.000	0.2811	0.368
−61.5886	3.6663	1.8000	−2.210	–	1.7979	2.204	11.937	5.4136	7.6558	7.6558	0.000	0.2926	0.363
−51.2075	3.6623	1.9000	−2.057	–	1.8977	2.088	11.995	5.4594	7.6711	7.6711	0.000	0.3041	0.363
−42.4409	3.6582	2.0000	−1.900	–	1.9976	1.972	12.053	5.5037	7.6868	7.6872	0.031	0.3161	0.367
−35.0409	3.6541	2.1000	−1.737	−8.900	2.0976	1.855	12.111	5.5467	7.7047	7.7062	0.064	0.3286	0.372
−28.9536	3.6497	2.2000	−1.578	−8.321	2.1975	1.737	12.170	5.5897	7.7230	7.7250	0.072	0.3412	0.378
−23.0170	3.6451	2.3000	−1.392	−7.683	2.2973	1.619	12.229	5.6412	7.7440	7.7468	0.079	0.3567	0.387
−22.4308*	3.6450	2.3027	−1.373	−7.615	2.2999	1.616	12.231	5.6468	7.7462	7.7490	0.083	0.3584	0.389
−20.8102*	3.6462	2.2854	−1.318	−7.432	2.2824	1.638	12.219	5.6628	7.7521	7.7553	0.089	0.3630	0.397
−20.3141	3.6454	2.3000	−1.303	−7.387	2.2975	1.620	12.228	5.6673	7.7537	7.7569	0.087	0.3642	0.397
−16.4821	3.6408	2.4000	−1.189	−7.027	2.3975	1.502	12.288	5.7048	7.7653	7.7687	0.089	0.3753	0.403
−13.1353	3.6364	2.5000	−1.067	−6.643	2.4973	1.384	12.346	5.7434	7.7766	7.7817	0.116	0.3876	0.412
−10.3035	3.6319	2.6000	−0.938	−6.214	2.5973	1.266	12.405	5.7826	7.7887	7.7968	0.149	0.4006	0.423
−7.9102	3.6271	2.7000	−0.803	−5.706	2.6971	1.147	12.465	5.8227	7.8017	7.8141	0.181	0.4145	0.433
−5.8824	3.6225	2.8000	−0.660	−5.006	2.7970	1.029	12.524	5.8639	7.8157	7.8334	0.210	0.4293	0.446
−4.1656	3.6178	2.9000	−0.512	−4.017	2.8968	0.910	12.583	5.9064	7.8302	7.8544	0.238	0.4450	0.460
−2.6972	3.6133	3.0000	−0.357	−2.830	2.9966	0.792	12.643	5.9509	7.8452	7.8772	0.263	0.4620	0.475
−1.4443	3.6087	3.1000	−0.197	−1.566	3.0964	0.673	12.702	5.9975	7.8605	7.9019	0.287	0.4802	0.491
−0.9637	3.6067	3.1426	−0.125	−1.000	3.1389	0.623	12.727	6.0181	7.8671	7.9132	0.296	0.4885	0.499
−0.3535	3.6040	3.2000	−0.020	−0.116	3.1961	0.554	12.761	6.0461	7.8761	7.9307	0.297	0.5003	0.510
−0.2925	3.6036	3.2058	−0.008	0.000	3.2020	0.547	12.765	6.0489	7.8770	7.9331	0.294	0.5015	0.511
−0.0228	3.6031	3.2257	0.058	1.000	3.2216	0.525	12.776	6.0573	7.8787	7.9562	0.236	0.5073	0.517
0.0000	3.6031	3.2251	0.075	2.000	3.2207	0.526	12.775	6.0551	7.8770	7.9937	0.221	0.5078	0.517

TABLE 2—*Continued*

$t - t_f$	log T_{eff}	log L	log L_ν	log L_{He}	log L_H	log g	log R	log ρ_c	log T_c	log T_{max}	$M_r(T_{max})$	M_{SH}	M_{CE}
M = 1.40 Y = 0.20 Z = 0.0001 F_ν = 1.0													
−43.2439	3.6741	1.9000	−2.049	−8.487	1.8971	2.327	11.971	5.2833	7.7572	7.7572	0.000	0.2886	0.455
−36.5007	3.6702	2.0000	−1.887	−8.114	1.9967	2.211	12.029	5.3467	7.7650	7.7650	0.000	0.3005	0.418
−30.6991	3.6660	2.1000	−1.726	−7.706	2.0970	2.094	12.087	5.4061	7.7750	7.7750	0.000	0.3130	0.401
−25.7751	3.6616	2.2000	−1.565	−7.272	2.1967	1.977	12.146	5.4621	7.7864	7.7864	0.000	0.3260	0.395
−21.5887	3.6572	2.3000	−1.405	−6.812	2.2967	1.859	12.205	5.5158	7.7988	7.7988	0.000	0.3394	0.394
−18.0214	3.6525	2.4000	−1.246	−6.304	2.3969	1.740	12.264	5.5680	7.8121	7.8121	0.000	0.3534	0.398
−14.8364	3.6482	2.5000	−1.074	−5.598	2.4968	1.623	12.323	5.6188	7.8263	7.8282	0.046	0.3688	0.404
−11.8037*	3.6437	2.5923	−0.881	−4.502	2.5887	1.513	12.378	5.6778	7.8451	7.8488	0.066	0.3866	0.413
−10.4845*	3.6490	2.4925	−0.794	−3.957	2.4884	1.634	12.317	5.7058	7.8530	7.8580	0.077	0.3943	0.432
−10.3900	3.6487	2.5000	−0.789	−3.933	2.4973	1.625	12.322	5.7075	7.8533	7.8584	0.077	0.3947	0.431
−8.1397	3.6435	2.6000	−0.692	−3.457	2.5970	1.504	12.382	5.7481	7.8595	7.8652	0.082	0.4053	0.435
−5.9873	3.6381	2.7000	−0.587	−2.963	2.6970	1.383	12.443	5.7918	7.8650	7.8725	0.100	0.4180	0.443
−4.1174	3.6335	2.8000	−0.474	−2.390	2.7968	1.264	12.502	5.8363	7.8711	7.8819	0.128	0.4319	0.453
−2.5028	3.6290	2.9000	−0.353	−1.702	2.8967	1.146	12.561	5.8816	7.8783	7.8943	0.164	0.4470	0.465
−1.3257	3.6247	2.9839	−0.240	−1.000	2.9805	1.045	12.612	5.9204	7.8861	7.9078	0.190	0.4606	0.476
−1.1153	3.6241	3.0000	−0.217	−0.845	2.9965	1.027	12.621	5.9278	7.8879	7.9109	0.193	0.4634	0.478
−0.2926	3.6206	3.0653	−0.105	0.000	3.0617	0.947	12.661	5.9574	7.8979	7.9265	0.181	0.4751	0.489
−0.0148	3.6201	3.0813	−0.028	1.000	3.0774	0.930	12.670	5.9617	7.9011	7.9512	0.101	0.4795	0.493
0.0000	3.6201	3.0804	−0.002	2.000	3.0758	0.931	12.669	5.9587	7.8993	7.9911	0.092	0.4797	0.493
M = 0.70 Y = 0.30 Z = 0.0001 F_ν = 1.0													
−249.3736	3.6985	1.0000	−3.559	–	0.9982	3.023	11.472	4.9284	7.5541	7.5541	0.000	0.2062	0.500
−206.2079	3.6940	1.1000	−3.358	–	1.0981	2.905	11.531	5.0182	7.5617	7.5617	0.000	0.2161	0.455
−169.6813	3.6900	1.2000	−3.181	–	1.1981	2.789	11.589	5.0921	7.5704	7.5704	0.000	0.2265	0.424
−139.5061	3.6864	1.3000	−3.017	–	1.2979	2.675	11.646	5.1552	7.5809	7.5809	0.000	0.2369	0.401
−114.6999	3.6827	1.4000	−2.858	–	1.3980	2.560	11.704	5.2114	7.5933	7.5933	0.000	0.2474	0.383
−94.3213	3.6787	1.5000	−2.702	–	1.4980	2.444	11.762	5.2628	7.6069	7.6069	0.000	0.2579	0.371
−77.6100	3.6750	1.6000	−2.550	–	1.5979	2.329	11.819	5.3107	7.6213	7.6213	0.000	0.2683	0.363
−63.8596	3.6713	1.7000	−2.400	–	1.6979	2.215	11.877	5.3561	7.6362	7.6362	0.000	0.2789	0.359
−52.4962	3.6670	1.8000	−2.250	–	1.7978	2.097	11.935	5.3998	7.6517	7.6517	0.000	0.2895	0.358
−43.1304	3.6630	1.9000	−2.100	–	1.8977	1.981	11.993	5.4420	7.6676	7.6676	0.000	0.3004	0.360
−35.2594	3.6590	2.0000	−1.945	–	1.9976	1.865	12.051	5.4828	7.6841	7.6847	0.036	0.3118	0.363
−28.7069	3.6548	2.1000	−1.788	−9.029	2.0975	1.749	12.110	5.5227	7.7023	7.7038	0.061	0.3234	0.368
−23.3233	3.6503	2.2000	−1.632	−8.430	2.1974	1.631	12.169	5.5627	7.7208	7.7230	0.069	0.3354	0.375
−18.7205	3.6458	2.3000	−1.473	−7.865	2.2973	1.513	12.228	5.6044	7.7395	7.7424	0.082	0.3481	0.383
−14.2228	3.6414	2.4000	−1.292	−7.239	2.3973	1.395	12.286	5.6536	7.7605	7.7641	0.089	0.3632	0.395
−11.2829	3.6368	2.5000	−1.156	−6.776	2.4972	1.276	12.346	5.6913	7.7754	7.7805	0.107	0.3754	0.403
−8.7903	3.6322	2.6000	−1.015	−6.280	2.5970	1.158	12.405	5.7301	7.7908	7.7982	0.131	0.3884	0.413
−6.6815	3.6274	2.7000	−0.868	−5.698	2.6968	1.039	12.464	5.7697	7.8064	7.8174	0.159	0.4022	0.424
−4.9042	3.6228	2.8000	−0.718	−4.882	2.7967	0.921	12.524	5.8103	7.8224	7.8383	0.185	0.4169	0.436
−3.3947	3.6184	2.9000	−0.561	−3.757	2.8965	0.803	12.582	5.8524	7.8390	7.8606	0.208	0.4326	0.449
−2.1102	3.6140	3.0000	−0.400	−2.491	2.9963	0.686	12.641	5.8964	7.8558	7.8845	0.233	0.4494	0.464
−1.0118	3.6098	3.1000	−0.231	−1.167	3.0961	0.569	12.699	5.9423	7.8729	7.9103	0.255	0.4675	0.480
−0.8894	3.6092	3.1121	−0.211	−1.000	3.1081	0.554	12.707	5.9480	7.8750	7.9136	0.255	0.4697	0.482
−0.2787	3.6066	3.1748	−0.091	0.000	3.1707	0.481	12.743	5.9775	7.8863	7.9332	0.252	0.4822	0.494
−0.0218	3.6060	3.1953	−0.019	1.000	3.1910	0.458	12.755	5.9852	7.8887	7.9565	0.190	0.4881	0.500
0.0000	3.6061	3.1942	0.000	2.000	3.1894	0.460	12.754	5.9825	7.8869	7.9951	0.177	0.4886	0.500
M = 0.90 Y = 0.30 Z = 0.0001 F_ν = 1.0													
−86.6076	3.6853	1.5000	−2.743	–	1.4973	2.580	11.749	5.1389	7.6538	7.6538	0.000	0.2477	0.456
−72.1549	3.6811	1.6000	−2.578	–	1.5977	2.463	11.807	5.2049	7.6627	7.6627	0.000	0.2585	0.421
−59.9842	3.6771	1.7000	−2.417	–	1.6976	2.347	11.865	5.2642	7.6732	7.6732	0.000	0.2696	0.400
−49.7908	3.6731	1.8000	−2.260	–	1.7974	2.231	11.923	5.3187	7.6852	7.6852	0.000	0.2808	0.386
−41.2550	3.6692	1.9000	−2.103	–	1.8974	2.115	11.981	5.3698	7.6986	7.6986	0.000	0.2922	0.379
−34.1198	3.6647	2.0000	−1.948	−9.132	1.9974	1.997	12.040	5.4185	7.7129	7.7129	0.000	0.3039	0.376
−28.1603	3.6600	2.1000	−1.793	−8.597	2.0973	1.879	12.099	5.4653	7.7279	7.7279	0.000	0.3158	0.376
−23.1717	3.6558	2.2000	−1.637	−8.083	2.1972	1.762	12.158	5.5110	7.7436	7.7436	0.000	0.3282	0.380
−18.8609	3.6515	2.3000	−1.473	−7.518	2.2971	1.645	12.216	5.5551	7.7601	7.7614	0.044	0.3413	0.385
−15.2433	3.6465	2.4000	−1.309	−6.951	2.3970	1.525	12.276	5.5995	7.7784	7.7809	0.067	0.3548	0.392
−11.6882*	3.6422	2.4906	−1.114	−6.267	2.4873	1.417	12.330	5.6533	7.8002	7.8041	0.079	0.3714	0.403
−10.8686*	3.6433	2.4786	−1.066	−6.087	2.4750	1.433	12.322	5.6668	7.8053	7.8098	0.085	0.3755	0.410
−10.3895	3.6423	2.5000	−1.041	−5.991	2.4969	1.408	12.335	5.6743	7.8080	7.8127	0.085	0.3777	0.410
−8.0690	3.6376	2.6000	−0.913	−5.438	2.5969	1.289	12.394	5.7138	7.8211	7.8267	0.093	0.3899	0.418
−6.0436	3.6327	2.7000	−0.780	−4.698	2.6968	1.170	12.454	5.7547	7.8341	7.8417	0.113	0.4033	0.428
−4.3190	3.6280	2.8000	−0.642	−3.785	2.7967	1.051	12.513	5.7966	7.8471	7.8584	0.143	0.4177	0.439
−2.8493	3.6230	2.9000	−0.497	−2.755	2.8964	0.930	12.573	5.8397	7.8606	7.8773	0.174	0.4331	0.452
−1.5921	3.6181	3.0000	−0.344	−1.645	2.9962	0.811	12.633	5.8846	7.8749	7.8985	0.203	0.4497	0.466
−0.9866	3.6158	3.0542	−0.256	−1.000	3.0503	0.748	12.665	5.9095	7.8832	7.9112	0.216	0.4593	0.475
−0.5101	3.6133	3.1000	−0.177	−0.385	3.0960	0.692	12.692	5.9306	7.8908	7.9232	0.218	0.4677	0.482
−0.2820	3.6124	3.1223	−0.131	0.000	3.1183	0.666	12.706	5.9405	7.8951	7.9305	0.208	0.4721	0.486
−0.0187	3.6117	3.1417	−0.055	1.000	3.1375	0.644	12.717	5.9466	7.8980	7.9543	0.137	0.4774	0.491
0.0000	3.6118	3.1404	−0.031	2.000	3.1356	0.645	12.716	5.9436	7.8961	7.9940	0.126	0.4778	0.492
M = 1.40 Y = 0.30 Z = 0.0001 F_ν = 1.0													
−29.3734	3.6810	1.9000	−2.067	−7.483	1.8968	2.354	11.957	5.1743	7.8136	7.8136	0.000	0.2865	0.604
−24.0755	3.6766	2.0000	−1.896	−7.178	1.9967	2.237	12.016	5.2477	7.8178	7.8178	0.000	0.2970	0.517
−19.4602	3.6724	2.1000	−1.732	−6.818	2.0967	2.120	12.074	5.3140	7.8241	7.8241	0.000	0.3084	0.458

TABLE 2—*Continued*

$t - t_f$	log T_{eff}	log L	log L_ν	log L_{He}	log L_H	log g	log R	log ρ_c	log T_c	log T_{max}	$M_r(T_{max})$	M_{SH}	M_{CE}
				M = 1.40	Y = 0.30	Z = 0.0001	F_ν = 1.0						
−15.4883	3.6684	2.2000	−1.571	−6.379	2.1965	2.004	12.132	5.3749	7.8322	7.8322	0.000	0.3204	0.435
−12.0608	3.6637	2.3000	−1.411	−5.814	2.2965	1.885	12.192	5.4325	7.8421	7.8421	0.000	0.3331	0.420
−9.1258	3.6589	2.4000	−1.252	−5.090	2.3963	1.766	12.251	5.4876	7.8531	7.8531	0.000	0.3464	0.414
−6.6143	3.6542	2.5000	−1.092	−4.232	2.4963	1.647	12.311	5.5408	7.8652	7.8652	0.000	0.3603	0.414
−4.4582	3.6495	2.6000	−0.931	−3.297	2.5963	1.528	12.370	5.5933	7.8781	7.8781	0.000	0.3749	0.420
−2.4977	3.6449	2.7000	−0.758	−2.221	2.6961	1.410	12.429	5.6448	7.8914	7.8938	0.043	0.3913	0.426
−0.9045*	3.6407	2.7771	−0.587	−1.109	2.7730	1.316	12.476	5.6961	7.9103	7.9128	0.042	0.4074	0.435
−0.7745	3.6408	2.7749	−0.572	−1.000	2.7707	1.319	12.475	5.7004	7.9125	7.9147	0.040	0.4088	0.437
−0.1991*	3.6447	2.7061	−0.499	−0.397	2.7015	1.403	12.433	5.7166	7.9278	7.9278	0.000	0.4145	0.451
−0.0437	3.6435	2.7211	−0.475	0.000	2.7173	1.383	12.443	5.7174	7.9544	7.9544	0.000	0.4157	0.450
−0.0062	3.6434	2.7230	−0.457	1.000	2.7186	1.381	12.444	5.7120	7.9859	7.9859	0.000	0.4160	0.451
0.0000	3.6436	2.7206	−0.430	2.000	2.7108	1.384	12.442	5.7040	8.0108	8.0108	0.000	0.4160	0.451
				M = 0.70	Y = 0.40	Z = 0.0001	F_ν = 1.0						
−133.9320	3.7020	1.2000	−3.370	–	1.1957	2.837	11.565	4.9004	7.6143	7.6143	0.000	0.2157	0.542
−111.5067	3.6962	1.3000	−3.146	–	1.2978	2.714	11.627	4.9949	7.6239	7.6239	0.000	0.2251	0.491
−92.3461	3.6918	1.4000	−2.958	–	1.3977	2.597	11.686	5.0727	7.6326	7.6326	0.000	0.2353	0.451
−76.2910	3.6873	1.5000	−2.788	–	1.4977	2.479	11.745	5.1389	7.6420	7.6420	0.000	0.2457	0.419
−62.9593	3.6833	1.6000	−2.627	–	1.5976	2.363	11.803	5.1975	7.6531	7.6531	0.000	0.2561	0.399
−51.8765	3.6793	1.7000	−2.470	–	1.6975	2.247	11.861	5.2509	7.6656	7.6656	0.000	0.2665	0.386
−42.6624	3.6752	1.8000	−2.314	–	1.7975	2.130	11.919	5.3008	7.6794	7.6794	0.000	0.2772	0.378
−34.9944	3.6708	1.9000	−2.160	–	1.8974	2.012	11.978	5.3480	7.6940	7.6940	0.000	0.2881	0.373
−28.6147	3.6661	2.0000	−2.005	−9.296	1.9973	1.894	12.037	5.3934	7.7096	7.7096	0.000	0.2993	0.371
−23.3224	3.6614	2.1000	−1.852	−8.716	2.0972	1.775	12.096	5.4373	7.7255	7.7255	0.000	0.3106	0.373
−18.9185	3.6573	2.2000	−1.698	−8.188	2.1970	1.658	12.155	5.4802	7.7420	7.7420	0.000	0.3223	0.376
−15.1427	3.6526	2.3000	−1.537	−7.620	2.2969	1.540	12.214	5.5218	7.7589	7.7600	0.039	0.3348	0.382
−12.0085	3.6478	2.4000	−1.375	−7.047	2.3967	1.421	12.274	5.5632	7.7776	7.7799	0.059	0.3476	0.389
−9.3251	3.6433	2.5000	−1.208	−6.450	2.4966	1.303	12.332	5.6066	7.7972	7.8007	0.072	0.3613	0.397
−6.7571	3.6388	2.6000	−1.024	−5.676	2.5966	1.185	12.392	5.6560	7.8186	7.8237	0.086	0.3772	0.410
−5.0038	3.6339	2.7000	−0.878	−4.829	2.6965	1.065	12.451	5.6960	7.8351	7.8421	0.102	0.3906	0.419
−3.5100	3.6292	2.8000	−0.726	−3.763	2.7963	0.946	12.511	5.7372	7.8514	7.8614	0.123	0.4050	0.430
−2.2361	3.6242	2.9000	−0.571	−2.598	2.8961	0.826	12.571	5.7798	7.8680	7.8823	0.149	0.4204	0.442
−1.1516	3.6191	3.0000	−0.408	−1.383	2.9959	0.706	12.631	5.8239	7.8852	7.9052	0.171	0.4370	0.456
−0.8561	3.6182	3.0301	−0.356	−1.000	3.0258	0.672	12.648	5.8374	7.8907	7.9126	0.178	0.4423	0.461
−0.2514	3.6153	3.0952	−0.232	0.000	3.0908	0.595	12.686	5.8660	7.9048	7.9316	0.167	0.4542	0.471
−0.2041	3.6151	3.1000	−0.220	0.111	3.0956	0.590	12.689	5.8678	7.9060	7.9336	0.160	0.4552	0.472
−0.0162	3.6148	3.1143	−0.153	1.000	3.1097	0.574	12.697	5.8704	7.9098	7.9558	0.093	0.4594	0.476
0.0000	3.6149	3.1126	−0.128	2.000	3.1074	0.576	12.696	5.8670	7.9079	7.9969	0.083	0.4597	0.477
				M = 0.90	Y = 0.20	Z = 0.0004	F_ν = 1.0						
−178.6826	3.6772	1.2000	−3.301	–	1.1989	2.847	11.615	5.0628	7.5571	7.5571	0.000	0.2210	0.410
−149.1974	3.6736	1.3000	−3.137	–	1.2980	2.733	11.672	5.1284	7.5675	7.5675	0.000	0.2309	0.372
−124.5148	3.6700	1.4000	−2.982	–	1.3978	2.618	11.729	5.1862	7.5780	7.5780	0.000	0.2409	0.355
−103.9530	3.6661	1.5000	−2.827	–	1.4981	2.503	11.787	5.2392	7.5907	7.5907	0.000	0.2511	0.342
−86.9445	3.6621	1.6000	−2.674	–	1.5981	2.387	11.845	5.2886	7.6047	7.6047	0.000	0.2615	0.336
−72.7794	3.6580	1.7000	−2.521	–	1.6980	2.271	11.903	5.3354	7.6195	7.6195	0.000	0.2720	0.334
−60.9986	3.6538	1.8000	−2.367	–	1.7980	2.154	11.962	5.3804	7.6352	7.6352	0.000	0.2827	0.336
−51.1798	3.6494	1.9000	−2.214	–	1.8978	2.036	12.020	5.4241	7.6514	7.6514	0.000	0.2937	0.338
−42.9835	3.6446	2.0000	−2.060	–	1.9978	1.917	12.080	5.4669	7.6681	7.6681	0.000	0.3049	0.343
−35.8362	3.6399	2.1000	−1.894	–	2.0977	1.798	12.139	5.5093	7.6856	7.6864	0.058	0.3170	0.349
−29.9422*	3.6372	2.1670	−1.728	−8.271	2.1644	1.720	12.178	5.5505	7.7052	7.7070	0.069	0.3291	0.357
−27.5356*	3.6390	2.1382	−1.658	−8.006	2.1354	1.756	12.160	5.5693	7.7140	7.7156	0.059	0.3342	0.365
−24.7007	3.6358	2.2000	−1.591	−7.777	2.1977	1.682	12.197	5.5895	7.7220	7.7232	0.047	0.3396	0.368
−20.1893	3.6312	2.3000	−1.473	−7.391	2.2977	1.563	12.257	5.6258	7.7348	7.7358	0.043	0.3501	0.375
−16.3330	3.6263	2.4000	−1.350	−6.988	2.3976	1.444	12.317	5.6627	7.7471	7.7488	0.066	0.3613	0.383
−13.0859	3.6214	2.5000	−1.220	−6.556	2.4975	1.324	12.376	5.6998	7.7602	7.7637	0.094	0.3732	0.393
−10.3527	3.6164	2.6000	−1.083	−6.096	2.5974	1.204	12.436	5.7378	7.7745	7.7802	0.122	0.3859	0.403
−8.0510	3.6114	2.7000	−0.942	−5.609	2.6973	1.084	12.496	5.7766	7.7895	7.7984	0.152	0.3992	0.414
−6.0957	3.6063	2.8000	−0.794	−5.076	2.7971	0.964	12.557	5.8166	7.8052	7.8184	0.181	0.4135	0.427
−4.4313	3.6014	2.9000	−0.640	−4.415	2.8969	0.844	12.616	5.8581	7.8215	7.8403	0.208	0.4289	0.441
−3.0110	3.5961	3.0000	−0.480	−3.451	2.9968	0.723	12.677	5.9014	7.8383	7.8637	0.233	0.4454	0.456
−1.7930	3.5912	3.1000	−0.313	−2.203	3.0966	0.603	12.737	5.9469	7.8554	7.8890	0.257	0.4632	0.472
−0.8645	3.5867	3.1875	−0.160	−1.000	3.1840	0.498	12.790	5.9889	7.8707	7.9130	0.276	0.4800	0.488
−0.7411	3.5860	3.2000	−0.137	−0.817	3.1964	0.483	12.797	5.9950	7.8729	7.9166	0.278	0.4825	0.491
−0.2758	3.5838	3.2482	−0.041	0.000	3.2444	0.426	12.826	6.0187	7.8816	7.9329	0.275	0.4928	0.500
−0.0232	3.5827	3.2685	0.029	1.000	3.2646	0.401	12.838	6.0274	7.8840	7.9559	0.216	0.4987	0.506
0.0000	3.5828	3.2672	0.048	2.000	3.2630	0.403	12.837	6.0248	7.8821	7.9936	0.201	0.4993	0.507
				M = 0.70	Y = 0.30	Z = 0.0004	F_ν = 1.0						
−236.7049	3.6868	1.0000	−3.663	–	0.9981	2.977	11.495	4.9471	7.5234	7:5234	0.000	0.2016	0.421
−195.0193	3.6828	1.1000	−3.490	–	1.0982	2.861	11.554	5.0198	7.5324	7.5324	0.000	0.2113	0.389
−160.6978	3.6787	1.2000	−3.326	–	1.1982	2.744	11.612	5.0820	7.5432	7.5432	0.000	0.2210	0.366
−132.5523	3.6749	1.3000	−3.167	–	1.2982	2.629	11.669	5.1375	7.5559	7.5559	0.000	0.2306	0.348
−109.4404	3.6711	1.4000	−3.013	–	1.3982	2.514	11.727	5.1884	7.5697	7.5697	0.000	0.2402	0.338
−90.4218	3.6667	1.5000	−2.860	–	1.4981	2.396	11.786	5.2359	7.5843	7.5843	0.000	0.2499	0.332
−74.7796	3.6625	1.6000	−2.709	–	1.5981	2.280	11.844	5.2809	7.5994	7.5994	0.000	0.2596	0.329
−61.8842	3.6584	1.7000	−2.559	–	1.6980	2.163	11.902	5.3238	7.6151	7.6151	0.000	0.2695	0.329

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TABLE 2—*Continued*

$t - t_f$	$\log T_{eff}$	$\log L$	$\log L_\nu$	$\log L_{He}$	$\log L_H$	$\log g$	$\log R$	$\log \rho_c$	$\log T_c$	$\log T_{max}$	$M_r(T_{max})$	M_{SH}	M_{CE}
				$M = 0.70$	$Y = 0.30$	$Z = 0.0004$	$F_\nu = 1.0$						
−51.2186	3.6539	1.8000	−2.409	–	1.7979	2.045	11.961	5.3654	7.6313	7.6313	0.000	0.2797	0.331
−42.3866	3.6494	1.9000	−2.259	–	1.8978	1.927	12.020	5.4059	7.6480	7.6480	0.000	0.2899	0.335
−35.0391	3.6446	2.0000	−2.107	–	1.9977	1.808	12.080	5.4458	7.6651	7.6651	0.000	0.3006	0.340
−28.6936	3.6398	2.1000	−1.945	–	2.0975	1.688	12.140	5.4850	7.6831	7.6840	0.052	0.3120	0.346
−21.4759	3.6354	2.2000	−1.715	−8.126	2.1972	1.571	12.198	5.5408	7.7112	7.7131	0.067	0.3285	0.359
−17.5223	3.6306	2.3000	−1.580	−7.638	2.2975	1.452	12.258	5.5761	7.7281	7.7298	0.056	0.3389	0.367
−14.1268	3.6257	2.4000	−1.443	−7.154	2.3974	1.332	12.318	5.6121	7.7441	7.7463	0.070	0.3501	0.375
−11.2676	3.6206	2.5000	−1.302	−6.658	2.4973	1.212	12.378	5.6489	7.7603	7.7638	0.089	0.3619	0.384
−8.8758	3.6156	2.6000	−1.156	−6.149	2.5972	1.092	12.438	5.6864	7.7770	7.7822	0.107	0.3744	0.394
−6.8572	3.6104	2.7000	−1.007	−5.619	2.6970	0.971	12.498	5.7248	7.7940	7.8020	0.134	0.3877	0.405
−5.1388	3.6056	2.8000	−0.852	−5.037	2.7968	0.852	12.558	5.7644	7.8115	7.8233	0.159	0.4019	0.417
−3.6846	3.6007	2.9000	−0.692	−4.286	2.8967	0.732	12.618	5.8053	7.8294	7.8461	0.182	0.4171	0.431
−2.4375	3.5959	3.0000	−0.527	−3.188	2.9965	0.613	12.677	5.8482	7.8477	7.8705	0.206	0.4334	0.446
−1.3712	3.5911	3.1000	−0.354	−1.859	3.0963	0.494	12.737	5.8932	7.8665	7.8966	0.228	0.4511	0.462
−0.7956	3.5884	3.1606	−0.244	−1.000	3.1568	0.422	12.773	5.9216	7.8781	7.9136	0.241	0.4626	0.473
−0.4452	3.5863	3.2000	−0.169	−0.390	3.1960	0.375	12.797	5.9404	7.8858	7.9257	0.242	0.4704	0.480
−0.2620	3.5854	3.2211	−0.125	0.000	3.2171	0.350	12.809	5.9502	7.8901	7.9334	0.237	0.4747	0.484
−0.0222	3.5850	3.2420	−0.049	1.000	3.2378	0.328	12.820	5.9582	7.8935	7.9564	0.174	0.4808	0.490
0.0000	3.5852	3.2408	−0.028	2.000	3.2364	0.329	12.819	5.9553	7.8915	7.9952	0.161	0.4814	0.491
				$M = 0.90$	$Y = 0.10$	$Z = 0.001$	$F_\nu = 1.0$						
−307.9827	3.6648	1.0000	−3.610	–	0.9982	2.998	11.540	5.0483	7.4969	7.4969	0.000	0.2091	0.334
−256.7485	3.6617	1.1000	−3.463	–	1.0986	2.886	11.596	5.1099	7.5053	7.5053	0.000	0.2187	0.318
−214.1745	3.6581	1.2000	−3.310	–	1.1982	2.771	11.653	5.1652	7.5170	7.5170	0.000	0.2284	0.309
−179.1527	3.6546	1.3000	−3.158	–	1.2982	2.657	11.710	5.2159	7.5305	7.5305	0.000	0.2382	0.305
−150.3381	3.6511	1.4000	−3.007	–	1.3984	2.543	11.767	5.2635	7.5449	7.5449	0.000	0.2480	0.304
−126.5234	3.6469	1.5000	−2.856	–	1.4983	2.426	11.825	5.3088	7.5599	7.5599	0.000	0.2579	0.306
−106.8460	3.6429	1.6000	−2.707	–	1.5984	2.310	11.883	5.3524	7.5755	7.5755	0.000	0.2679	0.309
−90.4828	3.6387	1.7000	−2.557	–	1.6983	2.193	11.942	5.3948	7.5915	7.5915	0.000	0.2782	0.313
−76.3133	3.6344	1.8000	−2.398	–	1.7981	2.076	12.000	5.4381	7.6088	7.6088	0.000	0.2892	0.318
−66.8139*	3.6322	1.8494	−2.276	–	1.8474	2.018	12.030	5.4716	7.6224	7.6224	0.000	0.2979	0.323
−60.4819*	3.6349	1.8039	−2.193	–	1.8016	2.074	12.001	5.4952	7.6318	7.6318	0.000	0.3036	0.334
−51.4046	3.6303	1.9000	−2.108	–	1.8983	1.960	12.058	5.5256	7.6403	7.6403	0.000	0.3112	0.337
−42.5230	3.6256	2.0000	−2.006	–	1.9982	1.841	12.118	5.5597	7.6492	7.6492	0.000	0.3203	0.343
−34.9979	3.6207	2.1000	−1.890	–	2.0982	1.722	12.178	5.5937	7.6603	7.6606	0.033	0.3301	0.350
−28.7082	3.6160	2.2000	−1.764	–	2.1980	1.603	12.237	5.6273	7.6737	7.6748	0.069	0.3404	0.358
−23.4484	3.6112	2.3000	−1.631	–	2.2980	1.483	12.297	5.6616	7.6885	7.6907	0.097	0.3513	0.367
−19.0707	3.6061	2.4000	−1.494	−7.533	2.3979	1.363	12.357	5.6963	7.7041	7.7079	0.125	0.3626	0.377
−15.4073	3.6010	2.5000	−1.352	−7.009	2.4978	1.243	12.417	5.7319	7.7206	7.7265	0.150	0.3746	0.388
−12.3221	3.5959	2.6000	−1.204	−6.474	2.5976	1.122	12.477	5.7684	7.7377	7.7464	0.177	0.3873	0.399
−9.7264	3.5904	2.7000	−1.051	−5.922	2.6976	1.000	12.538	5.8060	7.7555	7.7676	0.197	0.4007	0.411
−7.5287	3.5852	2.8000	−0.893	−5.354	2.7974	0.879	12.599	5.8451	7.7738	7.7902	0.220	0.4151	0.424
−5.6656	3.5798	2.9000	−0.730	−4.767	2.8973	0.758	12.660	5.8856	7.7923	7.8139	0.240	0.4305	0.438
−4.0699	3.5744	3.0000	−0.563	−4.127	2.9971	0.636	12.720	5.9281	7.8110	7.8391	0.262	0.4470	0.454
−2.7016	3.5689	3.1000	−0.390	−3.258	3.0969	0.514	12.781	5.9730	7.8300	7.8657	0.283	0.4648	0.471
−1.5213	3.5633	3.2000	−0.212	−1.984	3.1968	0.392	12.843	6.0208	7.8488	7.8939	0.304	0.4842	0.490
−0.8250	3.5600	3.2661	−0.088	−1.000	3.2627	0.312	12.882	6.0542	7.8613	7.9139	0.317	0.4981	0.503
−0.4895	3.5580	3.3000	−0.021	−0.443	3.2965	0.270	12.903	6.0718	7.8676	7.9251	0.321	0.5056	0.510
−0.2693	3.5570	3.3225	0.026	0.000	3.3190	0.244	12.916	6.0836	7.8716	7.9339	0.318	0.5108	0.516
−0.0243	3.5561	3.3425	0.093	1.000	3.3388	0.220	12.928	6.0932	7.8740	7.9568	0.266	0.5169	0.522
0.0000	3.5562	3.3402	0.109	2.000	3.3364	0.223	12.927	6.0910	7.8723	7.9936	0.250	0.5176	0.522
				$M = 0.70$	$Y = 0.20$	$Z = 0.001$	$F_\nu = 1.0$						
−506.7468	3.6756	0.7000	−4.123	–	0.6986	3.232	11.368	4.8776	7.4508	7.4508	0.000	0.1832	0.372
−414.2388	3.6725	0.8000	−3.942	–	0.7986	3.119	11.424	4.9567	7.4599	7.4599	0.000	0.1925	0.342
−338.7428	3.6690	0.9000	−3.778	–	0.8985	3.005	11.481	5.0217	7.4708	7.4708	0.000	0.2019	0.323
−277.7419	3.6658	1.0000	−3.618	–	0.9986	2.893	11.538	5.0789	7.4836	7.4836	0.000	0.2113	0.313
−228.1694	3.6624	1.1000	−3.463	–	1.0985	2.779	11.594	5.1307	7.4972	7.4972	0.000	0.2205	0.305
−187.9274	3.6585	1.2000	−3.313	–	1.1986	2.663	11.652	5.1786	7.5113	7.5113	0.000	0.2297	0.300
−155.2707	3.6547	1.3000	−3.167	–	1.2984	2.548	11.710	5.2234	7.5258	7.5258	0.000	0.2388	0.299
−128.6370	3.6509	1.4000	−3.021	–	1.3985	2.433	11.767	5.2659	7.5407	7.5407	0.000	0.2479	0.302
−106.7163	3.6466	1.5000	−2.877	–	1.4984	2.316	11.826	5.3068	7.5560	7.5560	0.000	0.2571	0.303
−88.7586	3.6423	1.6000	−2.733	–	1.5983	2.198	11.885	5.3463	7.5717	7.5717	0.000	0.2665	0.306
−73.9077	3.6379	1.7000	−2.588	–	1.6982	2.081	11.943	5.3850	7.5879	7.5879	0.000	0.2760	0.310
−61.2209	3.6332	1.8000	−2.436	–	1.7981	1.962	12.003	5.4245	7.6051	7.6051	0.000	0.2862	0.316
−50.0128*	3.6304	1.8636	−2.273	–	1.8614	1.888	12.040	5.4644	7.6232	7.6239	0.059	0.2971	0.326
−49.0061*	3.6305	1.8632	−2.256	–	1.8610	1.888	12.040	5.4683	7.6252	7.6259	0.055	0.2981	0.326
−45.2836	3.6290	1.9000	−2.201	–	1.8981	1.846	12.061	5.4819	7.6321	7.6329	0.046	0.3018	0.330
−37.4678	3.6241	2.0000	−2.079	–	1.9981	1.726	12.121	5.5145	7.6474	7.6476	0.020	0.3109	0.335
−30.8038	3.6191	2.1000	−1.952	–	2.0980	1.606	12.181	5.5479	7.6619	7.6622	0.030	0.3205	0.343
−25.2208	3.6143	2.2000	−1.820	–	2.1980	1.486	12.241	5.5816	7.6769	7.6778	0.053	0.3306	0.351
−20.5765	3.6093	2.3000	−1.682	–	2.2978	1.367	12.301	5.6155	7.6927	7.6947	0.081	0.3413	0.359
−16.7039	3.6043	2.4000	−1.541	−7.511	2.3978	1.246	12.361	5.6500	7.7094	7.7126	0.104	0.3525	0.369
−13.4556	3.5990	2.5000	−1.395	−6.972	2.4976	1.126	12.421	5.6855	7.7266	7.7317	0.128	0.3644	0.379
−10.7344	3.5938	2.6000	−1.245	−6.424	2.5975	1.004	12.482	5.7217	7.7444	7.7520	0.152	0.3768	0.390
−8.4310	3.5883	2.7000	−1.089	−5.857	2.6973	0.883	12.543	5.7592	7.7629	7.7737	0.174	0.3901	0.402
−6.4878	3.5832	2.8000	−0.929	−5.275	2.7972	0.762	12.603	5.7979	7.7818	7.7966	0.194	0.4042	0.415
−4.8317	3.5779	2.9000	−0.764	−4.671	2.8970	0.641	12.663	5.8381	7.8011	7.8207	0.216	0.4194	0.429

TABLE 2—*Continued*

$t - t_f$	log T_{eff}	log L	log L_ν	log L_{He}	log L_H	log g	log R	log ρ_c	log T_c	log T_{max}	$M_r(T_{max})$	M_{SH}	M_{CE}
				M = 0.70 Y = 0.20 Z = 0.001 F_ν = 1.0									
−3.4174	3.5725	3.0000	−0.594	−3.979	2.9969	0.519	12.724	5.8803	7.8206	7.8462	0.237	0.4357	0.444
−2.2026	3.5676	3.1000	−0.419	−2.979	3.0967	0.400	12.784	5.9247	7.8403	7.8733	0.257	0.4533	0.461
−1.1532	3.5626	3.2000	−0.236	−1.602	3.1965	0.280	12.844	5.9720	7.8602	7.9021	0.276	0.4725	0.479
−0.7761	3.5607	3.2395	−0.160	−1.000	3.2359	0.233	12.867	5.9915	7.8682	7.9142	0.285	0.4807	0.487
−0.2608	3.5585	3.2963	−0.043	0.000	3.2926	0.167	12.900	6.0201	7.8795	7.9342	0.282	0.4930	0.499
−0.2246	3.5583	3.3000	−0.035	0.084	3.2963	0.163	12.903	6.0215	7.8800	7.9359	0.280	0.4940	0.500
−0.0239	3.5579	3.3170	0.026	1.000	3.3131	0.144	12.912	6.0294	7.8825	7.9572	0.229	0.4992	0.505
0.0000	3.5580	3.3152	0.044	2.000	3.3112	0.146	12.911	6.0269	7.8806	7.9946	0.213	0.4999	0.505
				M = 0.90 Y = 0.20 Z = 0.001 F_ν = 1.0									
−174.7342	3.6664	1.2000	−3.370	–	1.1980	2.804	11.636	5.0709	7.5391	7.5391	0.000	0.2188	0.344
−146.5171	3.6624	1.3000	−3.220	–	1.2983	2.688	11.694	5.1287	7.5498	7.5498	0.000	0.2280	0.328
−122.8539	3.6585	1.4000	−3.071	–	1.3982	2.573	11.752	5.1814	7.5613	7.5613	0.000	0.2376	0.318
−103.1731	3.6544	1.5000	−2.920	–	1.4982	2.456	11.810	5.2304	7.5747	7.5747	0.000	0.2472	0.313
−86.8310	3.6499	1.6000	−2.770	–	1.5981	2.338	11.869	5.2768	7.5892	7.5892	0.000	0.2570	0.312
−73.2029	3.6452	1.7000	−2.617	–	1.6981	2.219	11.929	5.3214	7.6047	7.6047	0.000	0.2670	0.314
−61.8635	3.6404	1.8000	−2.466	–	1.7980	2.100	11.988	5.3643	7.6207	7.6207	0.000	0.2772	0.317
−52.3557	3.6358	1.9000	−2.311	–	1.8980	1.982	12.048	5.4063	7.6376	7.6376	0.000	0.2878	0.321
−43.9573	3.6312	2.0000	−2.147	–	1.9978	1.863	12.107	5.4503	7.6559	7.6559	0.000	0.2994	0.327
−39.5608*	3.6293	2.0340	−2.048	–	2.0317	1.822	12.128	5.4766	7.6672	7.6672	0.000	0.3064	0.333
−35.9995*	3.6320	1.9942	−1.963	–	1.9915	1.873	12.102	5.4978	7.6761	7.6765	0.035	0.3119	0.342
−35.6980	3.6318	2.0000	−1.957	–	1.9981	1.866	12.106	5.4994	7.6768	7.6772	0.033	0.3123	0.342
−29.8600	3.6266	2.1000	−1.847	–	2.0980	1.745	12.166	5.5318	7.6902	7.6903	0.012	0.3209	0.347
−24.5368	3.6215	2.2000	−1.730	−8.065	2.1979	1.625	12.226	5.5669	7.7027	7.7028	0.010	0.3307	0.353
−20.0272	3.6163	2.3000	−1.606	−7.538	2.2977	1.504	12.286	5.6023	7.7155	7.7160	0.032	0.3412	0.361
−16.2448	3.6111	2.4000	−1.475	−7.082	2.3977	1.383	12.347	5.6377	7.7293	7.7308	0.065	0.3523	0.370
−13.0533	3.6059	2.5000	−1.336	−6.599	2.4975	1.262	12.407	5.6739	7.7444	7.7476	0.092	0.3640	0.380
−10.3963	3.6006	2.6000	−1.196	−6.103	2.5975	1.141	12.468	5.7106	7.7603	7.7653	0.116	0.3763	0.391
−8.1465	3.5953	2.7000	−1.047	−5.582	2.6973	1.020	12.529	5.7486	7.7770	7.7849	0.142	0.3894	0.402
−6.2386	3.5897	2.8000	−0.894	−5.040	2.7972	0.897	12.590	5.7876	7.7942	7.8059	0.171	0.4035	0.415
−4.6111	3.5842	2.9000	−0.735	−4.455	2.8970	0.775	12.651	5.8283	7.8120	7.8287	0.195	0.4186	0.428
−3.2214	3.5783	3.0000	−0.570	−3.734	2.9969	0.652	12.712	5.8707	7.8302	7.8530	0.220	0.4347	0.444
−2.0282	3.5728	3.1000	−0.399	−2.670	3.0967	0.530	12.774	5.9154	7.8489	7.8791	0.243	0.4523	0.460
−0.9982	3.5673	3.2000	−0.220	−1.307	3.1965	0.408	12.834	5.9628	7.8678	7.9071	0.265	0.4713	0.478
−0.8009	3.5662	3.2208	−0.181	−1.000	3.2172	0.383	12.847	5.9729	7.8718	7.9133	0.269	0.4755	0.482
−0.2654	3.5628	3.2794	−0.062	0.000	3.2757	0.310	12.883	6.0020	7.8833	7.9332	0.265	0.4880	0.494
−0.0335	3.5617	3.3000	0.006	0.891	3.2962	0.285	12.896	6.0110	7.8864	7.9530	0.215	0.4939	0.500
−0.0235	3.5617	3.3001	0.010	1.000	3.2962	0.285	12.896	6.0109	7.8863	7.9562	0.209	0.4942	0.500
0.0000	3.5619	3.2984	0.030	2.000	3.2944	0.288	12.895	6.0083	7.8844	7.9940	0.194	0.4948	0.501
				M = 0.70 Y = 0.30 Z = 0.001 F_ν = 0.0									
−227.8327	3.6758	1.0000	–	–	0.9986	2.933	11.518	4.9620	7.5047	7.5047	0.000	0.2000	0.360
−187.8369	3.6719	1.1000	–	–	1.0984	2.817	11.575	5.0246	7.5152	7.5152	0.000	0.2091	0.338
−154.9443	3.6676	1.2000	–	–	1.1982	2.700	11.634	5.0802	7.5280	7.5280	0.000	0.2182	0.323
−127.9899	3.6635	1.3000	–	–	1.2982	2.583	11.692	5.1310	7.5419	7.5419	0.000	0.2273	0.316
−105.8354	3.6593	1.4000	–	–	1.3983	2.466	11.751	5.1781	7.5569	7.5569	0.000	0.2365	0.310
−87.5825	3.6549	1.5000	–	–	1.4982	2.349	11.809	5.2226	7.5727	7.5727	0.000	0.2457	0.309
−72.5471	3.6502	1.6000	–	–	1.5981	2.230	11.869	5.2651	7.5891	7.5891	0.000	0.2550	0.309
−60.1051	3.6452	1.7000	–	–	1.6981	2.110	11.929	5.3060	7.6062	7.6062	0.000	0.2645	0.312
−49.7687	3.6402	1.8000	–	–	1.7979	1.990	11.989	5.3459	7.6238	7.6238	0.000	0.2743	0.316
−41.1740	3.6354	1.9000	–	–	1.8978	1.871	12.048	5.3849	7.6422	7.6422	0.000	0.2844	0.320
−33.8114	3.6306	2.0000	–	–	1.9978	1.752	12.108	5.4245	7.6618	7.6618	0.000	0.2950	0.326
−24.8919	3.6258	2.1000	–	–	2.0978	1.633	12.167	5.4822	7.6916	7.6916	0.000	0.3109	0.339
−20.2377	3.6206	2.2000	–	−8.062	2.1977	1.512	12.228	5.5157	7.7087	7.7087	0.000	0.3206	0.346
−16.2528	3.6152	2.3000	–	−7.478	2.2976	1.390	12.289	5.5499	7.7263	7.7263	0.000	0.3311	0.354
−12.8921	3.6099	2.4000	–	−6.933	2.3975	1.269	12.349	5.5847	7.7451	7.7451	0.000	0.3422	0.363
−10.0787	3.6046	2.5000	–	−6.370	2.4974	1.148	12.410	5.6198	7.7647	7.7647	0.000	0.3540	0.373
−7.7091	3.5992	2.6000	–	−5.785	2.5972	1.026	12.471	5.6556	7.7855	7.7855	0.000	0.3664	0.383
−5.7018	3.5938	2.7000	–	−5.174	2.6971	0.905	12.532	5.6922	7.8077	7.8077	0.000	0.3796	0.394
−3.9996	3.5883	2.8000	–	−4.508	2.7969	0.783	12.593	5.7295	7.8309	7.8309	0.000	0.3938	0.407
−2.5377	3.5827	2.9000	–	−3.598	2.8968	0.660	12.654	5.7682	7.8554	7.8555	0.021	0.4091	0.421
−1.2722	3.5773	3.0000	–	−2.229	2.9966	0.539	12.715	5.8078	7.8816	7.8828	0.089	0.4257	0.436
−0.4468	3.5733	3.0749	–	−1.000	3.0713	0.448	12.760	5.8386	7.9051	7.9053	0.076	0.4391	0.449
−0.1858	3.5721	3.1000	–	−0.489	3.0963	0.418	12.775	5.8487	7.9179	7.9179	0.000	0.4437	0.453
−0.0420	3.5712	3.1140	–	0.000	3.1104	0.400	12.784	5.8524	7.9432	7.9432	0.000	0.4465	0.456
−0.0054	3.5711	3.1158	–	1.000	3.1121	0.398	12.785	5.8487	7.9770	7.9770	0.000	0.4472	0.457
0.0000	3.5714	3.1131	–	2.000	3.1084	0.402	12.783	5.8425	8.0016	8.0016	0.000	0.4473	0.457
				M = 0.70 Y = 0.30 Z = 0.001 F_ν = 0.5									
−228.2341	3.6758	1.0000	−4.028	–	0.9985	2.933	11.518	4.9621	7.5043	7.5043	0.000	0.2000	0.360
−188.3219	3.6719	1.1000	−3.867	–	1.0985	2.817	11.575	5.0248	7.5146	7.5146	0.000	0.2090	0.339
−155.4633	3.6676	1.2000	−3.709	–	1.1983	2.700	11.634	5.0805	7.5270	7.5270	0.000	0.2182	0.324
−128.5258	3.6635	1.3000	−3.555	–	1.2982	2.583	11.692	5.1313	7.5407	7.5407	0.000	0.2273	0.314
−106.4189	3.6593	1.4000	−3.402	–	1.3983	2.466	11.751	5.1784	7.5554	7.5554	0.000	0.2364	0.310
−88.1949	3.6549	1.5000	−3.250	–	1.4982	2.349	11.809	5.2232	7.5708	7.5708	0.000	0.2456	0.308
−73.1927	3.6501	1.6000	−3.100	–	1.5981	2.230	11.869	5.2657	7.5868	7.5868	0.000	0.2549	0.310
−60.7798	3.6452	1.7000	−2.950	–	1.6981	2.110	11.929	5.3068	7.6034	7.6034	0.000	0.2644	0.312

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TABLE 2—*Continued*

$t - t_f$	log T_{eff}	log L	log L_ν	log L_{He}	log L_H	log g	log R	log ρ_c	log T_c	log T_{max}	$M_r(T_{max})$	M_{SH}	M_{CE}
				$M = 0.70$ $Y = 0.30$ $Z = 0.001$ $F_\nu = 0.5$									
−50.4689	3.6402	1.8000	−2.798	–	1.7979	1.990	11.989	5.3467	7.6206	7.6206	0.000	0.2742	0.315
−41.8943	3.6354	1.9000	−2.645	–	1.8978	1.871	12.048	5.3859	7.6384	7.6384	0.000	0.2842	0.319
−34.5324	3.6306	2.0000	−2.486	–	1.9977	1.752	12.108	5.4259	7.6572	7.6572	0.000	0.2949	0.325
−25.6470	3.6258	2.1000	−2.255	–	2.0978	1.633	12.168	5.4837	7.6854	7.6854	0.000	0.3106	0.339
−21.0077	3.6206	2.2000	−2.124	−8.538	2.1977	1.512	12.228	5.5175	7.7014	7.7014	0.000	0.3203	0.346
−17.0434	3.6152	2.3000	−1.987	−7.638	2.2976	1.390	12.289	5.5521	7.7179	7.7179	0.000	0.3308	0.353
−13.7013	3.6099	2.4000	−1.843	−7.110	2.3975	1.269	12.349	5.5872	7.7352	7.7352	0.001	0.3418	0.363
−10.8777	3.6046	2.5000	−1.692	−6.548	2.4974	1.148	12.410	5.6223	7.7534	7.7541	0.048	0.3535	0.372
−8.5045	3.5992	2.6000	−1.536	−5.971	2.5972	1.026	12.471	5.6581	7.7730	7.7750	0.074	0.3660	0.383
−6.5066	3.5938	2.7000	−1.375	−5.381	2.6971	0.905	12.532	5.6951	7.7936	7.7968	0.091	0.3791	0.394
−4.8265	3.5883	2.8000	−1.212	−4.774	2.7969	0.783	12.593	5.7330	7.8148	7.8193	0.107	0.3931	0.407
−3.3853	3.5826	2.9000	−1.043	−4.062	2.8968	0.660	12.654	5.7725	7.8365	7.8432	0.131	0.4082	0.420
−2.1570	3.5772	3.0000	−0.867	−3.030	2.9966	0.538	12.715	5.8137	7.8589	7.8687	0.155	0.4244	0.435
−1.0980	3.5720	3.1000	−0.684	−1.656	3.0963	0.417	12.775	5.8570	7.8823	7.8960	0.178	0.4420	0.451
−0.6861	3.5699	3.1431	−0.601	−1.000	3.1394	0.366	12.801	5.8762	7.8933	7.9085	0.182	0.4500	0.459
−0.1942	3.5670	3.1972	−0.481	0.000	3.1934	0.300	12.834	5.8998	7.9122	7.9264	0.167	0.4608	0.469
−0.1675	3.5668	3.2000	−0.473	0.076	3.1961	0.296	12.836	5.9007	7.9139	7.9276	0.161	0.4615	0.470
−0.0119	3.5661	3.2118	−0.397	1.000	3.2078	0.282	12.843	5.9021	7.9348	7.9475	0.032	0.4652	0.473
0.0000	3.5661	3.2107	−0.363	2.000	3.2067	0.283	12.842	5.8981	7.9393	7.9896	0.020	0.4654	0.474
				$M = 0.70$ $Y = 0.30$ $Z = 0.001$ $F_\nu = 1.0$									
−228.3519	3.6758	1.0000	−3.729	–	0.9986	2.933	11.518	4.9622	7.5038	7.5038	0.000	0.1999	0.360
−188.4976	3.6719	1.1000	−3.568	–	1.0985	2.817	11.575	5.0250	7.5139	7.5139	0.000	0.2090	0.338
−155.6832	3.6676	1.2000	−3.411	–	1.1984	2.700	11.634	5.0808	7.5260	7.5260	0.000	0.2181	0.324
−128.7850	3.6635	1.3000	−3.257	–	1.2983	2.583	11.692	5.1316	7.5395	7.5395	0.000	0.2272	0.314
−106.7130	3.6593	1.4000	−3.105	–	1.3983	2.466	11.751	5.1789	7.5539	7.5539	0.000	0.2363	0.310
−88.5219	3.6549	1.5000	−2.955	–	1.4982	2.349	11.809	5.2236	7.5689	7.5689	0.000	0.2456	0.308
−73.5528	3.6501	1.6000	−2.806	–	1.5981	2.230	11.869	5.2663	7.5846	7.5846	0.000	0.2548	0.310
−61.1693	3.6452	1.7000	−2.657	–	1.6980	2.110	11.929	5.3075	7.6008	7.6008	0.000	0.2643	0.311
−50.8920	3.6402	1.8000	−2.507	–	1.7979	1.990	11.989	5.3475	7.6174	7.6174	0.000	0.2740	0.315
−42.3394	3.6354	1.9000	−2.356	–	1.8978	1.871	12.048	5.3869	7.6346	7.6346	0.000	0.2841	0.319
−35.0087	3.6306	2.0000	−2.199	–	1.9978	1.752	12.108	5.4270	7.6528	7.6528	0.000	0.2947	0.326
−28.5209*	3.6276	2.0620	−2.029	–	2.0595	1.678	12.145	5.4678	7.6719	7.6725	0.046	0.3061	0.335
−27.9427*	3.6277	2.0615	−2.013	–	2.0588	1.679	12.144	5.4714	7.6737	7.6745	0.055	0.3072	0.337
−25.9693	3.6258	2.1000	−1.962	–	2.0978	1.633	12.168	5.4843	7.6802	7.6812	0.044	0.3107	0.339
−21.3416	3.6206	2.2000	−1.830	–	2.1977	1.512	12.228	5.5181	7.6970	7.6976	0.031	0.3203	0.345
−17.3797	3.6152	2.3000	−1.693	−7.688	2.2976	1.390	12.289	5.5527	7.7131	7.7140	0.046	0.3308	0.353
−14.0398	3.6096	2.4000	−1.551	−7.169	2.3975	1.268	12.350	5.5879	7.7298	7.7317	0.061	0.3418	0.362
−11.2582	3.6044	2.5000	−1.407	−6.648	2.4974	1.147	12.410	5.6235	7.7468	7.7499	0.083	0.3534	0.372
−8.9307	3.5991	2.6000	−1.259	−6.116	2.5972	1.026	12.471	5.6601	7.7644	7.7691	0.101	0.3656	0.382
−6.9572	3.5936	2.7000	−1.106	−5.565	2.6971	0.904	12.532	5.6978	7.7826	7.7897	0.125	0.3786	0.393
−5.2926	3.5882	2.8000	−0.949	−4.996	2.7969	0.782	12.593	5.7364	7.8011	7.8115	0.148	0.3925	0.406
−3.8647	3.5825	2.9000	−0.785	−4.372	2.8968	0.659	12.654	5.7767	7.8202	7.8350	0.171	0.4073	0.419
−2.6487	3.5767	3.0000	−0.616	−3.555	2.9966	0.536	12.716	5.8187	7.8397	7.8600	0.193	0.4234	0.434
−1.6035	3.5718	3.1000	−0.441	−2.364	3.0964	0.417	12.776	5.8628	7.8595	7.8866	0.215	0.4407	0.450
−0.7377	3.5667	3.1953	−0.265	−1.000	3.1915	0.301	12.833	5.9073	7.8789	7.9140	0.235	0.4587	0.467
−0.6976	3.5663	3.2000	−0.256	−0.928	3.1961	0.295	12.837	5.9096	7.8799	7.9155	0.235	0.4597	0.468
−0.2507	3.5640	3.2541	−0.145	0.000	3.2501	0.231	12.868	5.9353	7.8915	7.9339	0.230	0.4708	0.478
−0.0226	3.5628	3.2752	−0.067	1.000	3.2710	0.206	12.881	5.9436	7.8954	7.9569	0.170	0.4771	0.484
0.0000	3.5629	3.2736	−0.046	2.000	3.2693	0.207	12.880	5.9406	7.8934	7.9959	0.156	0.4777	0.485
				$M = 0.70$ $Y = 0.30$ $Z = 0.001$ $F_\nu = 2.0$									
−228.0203	3.6758	1.0000	−3.430	–	0.9986	2.933	11.518	4.9625	7.5029	7.5029	0.000	0.1999	0.360
−188.2750	3.6719	1.1000	−3.271	–	1.0985	2.817	11.575	5.0254	7.5124	7.5124	0.000	0.2090	0.338
−155.5502	3.6676	1.2000	−3.115	–	1.1984	2.700	11.634	5.0813	7.5241	7.5241	0.000	0.2181	0.324
−128.7350	3.6635	1.3000	−2.963	–	1.2983	2.583	11.692	5.1322	7.5371	7.5371	0.000	0.2271	0.314
−106.7266	3.6592	1.4000	−2.813	–	1.3983	2.466	11.751	5.1797	7.5510	7.5510	0.000	0.2362	0.309
−88.5958	3.6549	1.5000	−2.666	–	1.4982	2.349	11.809	5.2246	7.5654	7.5654	0.000	0.2454	0.307
−73.6793	3.6501	1.6000	−2.519	–	1.5981	2.230	11.869	5.2673	7.5802	7.5802	0.000	0.2546	0.310
−61.3485	3.6452	1.7000	−2.372	–	1.6981	2.110	11.929	5.3087	7.5956	7.5956	0.000	0.2640	0.311
−51.1346	3.6402	1.8000	−2.225	–	1.7980	1.990	11.989	5.3490	7.6113	7.6113	0.001	0.2737	0.314
−42.3478	3.6354	1.9000	−2.066	–	1.8978	1.871	12.048	5.3879	7.6286	7.6296	0.043	0.2840	0.320
−34.8852	3.6306	2.0000	−1.905	–	1.9977	1.752	12.108	5.4279	7.6472	7.6491	0.061	0.2949	0.326
−26.0985	3.6258	2.1000	−1.683	–	2.0978	1.633	12.168	5.4860	7.6732	7.6757	0.064	0.3104	0.338
−21.5484	3.6205	2.2000	−1.561	–	2.1977	1.512	12.228	5.5205	7.6867	7.6894	0.066	0.3199	0.345
−17.6435	3.6152	2.3000	−1.434	−7.962	2.2976	1.390	12.289	5.5559	7.7001	7.7040	0.083	0.3302	0.352
−14.3611	3.6098	2.4000	−1.301	−7.467	2.3975	1.269	12.350	5.5918	7.7140	7.7199	0.106	0.3410	0.361
−11.6220	3.6045	2.5000	−1.165	−6.984	2.4974	1.147	12.410	5.6281	7.7283	7.7372	0.130	0.3524	0.371
−9.3132	3.5991	2.6000	−1.023	−6.481	2.5972	1.026	12.471	5.6653	7.7432	7.7562	0.153	0.3645	0.381
−7.3627	3.5937	2.7000	−0.876	−5.958	2.6971	0.904	12.532	5.7036	7.7586	7.7767	0.175	0.3774	0.392
−5.7172	3.5881	2.8000	−0.725	−5.418	2.7969	0.782	12.593	5.7431	7.7743	7.7984	0.196	0.3911	0.404
−4.3112	3.5825	2.9000	−0.569	−4.851	2.8968	0.659	12.654	5.7841	7.7902	7.8217	0.216	0.4057	0.418
−3.1126	3.5770	3.0000	−0.408	−4.218	2.9966	0.538	12.715	5.8270	7.8061	7.8465	0.235	0.4215	0.432
−2.0832	3.5717	3.1000	−0.241	−3.327	3.0964	0.416	12.776	5.8721	7.8221	7.8729	0.255	0.4386	0.448
−1.1956	3.5664	3.2000	−0.068	−2.037	3.1962	0.295	12.836	5.9200	7.8379	7.9009	0.276	0.4572	0.465
−0.6440	3.5629	3.2699	0.056	−1.000	3.2659	0.211	12.878	5.9554	7.8487	7.9220	0.289	0.4712	0.478
−0.4206	3.5618	3.3000	0.112	−0.516	3.2960	0.177	12.896	5.9711	7.8533	7.9319	0.292	0.4775	0.484

TABLE 2—*Continued*

$t - t_f$	$\log T_{eff}$	$\log L$	$\log L_\nu$	$\log L_{He}$	$\log L_H$	$\log g$	$\log R$	$\log \rho_c$	$\log T_c$	$\log T_{max}$	$M_r(T_{max})$	M_{SH}	M_{CE}
				$M = 0.70$ $Y = 0.30$ $Z = 0.001$ $F_\nu = 2.0$									
−0.2201	3.5608	3.3276	0.166	0.000	3.3234	0.145	12.911	5.9856	7.8571	7.9426	0.291	0.4837	0.490
−0.0211	3.5595	3.3503	0.225	1.000	3.3459	0.117	12.925	5.9971	7.8588	7.9672	0.262	0.4901	0.496
0.0000	3.5596	3.3490	0.234	2.000	3.3445	0.119	12.924	5.9952	7.8570	8.0045	0.251	0.4908	0.497
				$M = 0.90$ $Y = 0.30$ $Z = 0.001$ $F_\nu = 1.0$									
−82.9403	3.6625	1.5000	−2.959	–	1.4981	2.489	11.794	5.1463	7.6007	7.6007	0.000	0.2388	0.339
−69.5893	3.6581	1.6000	−2.810	–	1.5978	2.371	11.853	5.1969	7.6131	7.6131	0.000	0.2482	0.329
−58.3692	3.6532	1.7000	−2.660	–	1.6978	2.252	11.913	5.2446	7.6264	7.6264	0.000	0.2579	0.324
−49.0153	3.6482	1.8000	−2.509	–	1.7978	2.131	11.973	5.2899	7.6409	7.6409	0.000	0.2678	0.323
−41.1902	3.6433	1.9000	−2.357	–	1.8977	2.012	12.032	5.3335	7.6565	7.6565	0.000	0.2779	0.325
−34.6336	3.6383	2.0000	−2.204	–	1.9976	1.892	12.093	5.3760	7.6729	7.6729	0.000	0.2884	0.329
−29.1038	3.6329	2.1000	−2.048	–	2.0975	1.770	12.153	5.4180	7.6902	7.6902	0.000	0.2994	0.334
−24.2042	3.6278	2.2000	−1.880	−8.102	2.1974	1.650	12.213	5.4620	7.7091	7.7091	0.000	0.3114	0.340
−21.7811*	3.6262	2.2312	−1.785	−7.720	2.2285	1.612	12.232	5.4869	7.7199	7.7199	0.000	0.3182	0.346
−20.0122*	3.6281	2.2042	−1.712	−7.444	2.2010	1.647	12.215	5.5042	7.7274	7.7280	0.049	0.3232	0.353
−16.6830	3.6227	2.3000	−1.593	−7.024	2.2975	1.529	12.274	5.5363	7.7418	7.7427	0.033	0.3321	0.359
−13.5094	3.6171	2.4000	−1.463	−6.579	2.3974	1.407	12.335	5.5726	7.7573	7.7580	0.029	0.3427	0.366
−10.7895	3.6119	2.5000	−1.326	−6.114	2.4973	1.286	12.395	5.6094	7.7722	7.7737	0.049	0.3541	0.375
−8.4924	3.6063	2.6000	−1.185	−5.630	2.5972	1.164	12.457	5.6467	7.7877	7.7907	0.072	0.3663	0.385
−6.5586	3.6006	2.7000	−1.040	−5.126	2.6971	1.041	12.518	5.6851	7.8040	7.8089	0.091	0.3792	0.396
−4.9266	3.5951	2.8000	−0.891	−4.590	2.7969	0.919	12.579	5.7243	7.8208	7.8280	0.114	0.3928	0.407
−3.5323	3.5895	2.9000	−0.735	−3.931	2.8967	0.796	12.640	5.7651	7.8381	7.8492	0.140	0.4076	0.421
−2.3392	3.5836	3.0000	−0.573	−2.997	2.9966	0.673	12.702	5.8076	7.8557	7.8719	0.168	0.4234	0.435
−1.3113	3.5779	3.1000	−0.403	−1.780	3.0964	0.550	12.763	5.8523	7.8740	7.8969	0.193	0.4407	0.451
−0.7820	3.5742	3.1577	−0.300	−1.000	3.1539	0.478	12.800	5.8790	7.8850	7.9124	0.206	0.4513	0.461
−0.4175	3.5721	3.2000	−0.219	−0.361	3.1962	0.427	12.825	5.8988	7.8938	7.9251	0.207	0.4595	0.468
−0.2528	3.5710	3.2195	−0.177	0.000	3.2156	0.403	12.837	5.9078	7.8982	7.9320	0.201	0.4635	0.472
−0.0204	3.5697	3.2396	−0.096	1.000	3.2354	0.378	12.850	5.9148	7.9027	7.9552	0.132	0.4694	0.478
0.0000	3.5698	3.2383	−0.071	2.000	3.2337	0.380	12.849	5.9115	7.9007	7.9952	0.119	0.4700	0.478
				$M = 0.70$ $Y = 0.40$ $Z = 0.001$ $F_\nu = 1.0$									
−125.1549	3.6783	1.2000	−3.491	–	1.1981	2.743	11.613	4.9606	7.5585	7.5585	0.000	0.2089	0.380
−103.9000	3.6736	1.3000	−3.330	–	1.2980	2.624	11.672	5.0229	7.5687	7.5687	0.000	0.2177	0.357
−86.2386	3.6691	1.4000	−3.176	–	1.3980	2.506	11.731	5.0782	7.5799	7.5799	0.000	0.2265	0.340
−71.5581	3.6644	1.5000	−3.023	–	1.4979	2.387	11.790	5.1290	7.5927	7.5927	0.000	0.2356	0.329
−59.3924	3.6594	1.6000	−2.871	–	1.5979	2.267	11.850	5.1763	7.6068	7.6068	0.000	0.2447	0.324
−49.3044	3.6543	1.7000	−2.719	–	1.6977	2.147	11.911	5.2209	7.6218	7.6218	0.000	0.2540	0.321
−40.9026	3.6492	1.8000	−2.567	–	1.7977	2.026	11.971	5.2639	7.6377	7.6377	0.000	0.2635	0.322
−33.9311	3.6439	1.9000	−2.415	–	1.8976	1.905	12.031	5.3053	7.6543	7.6543	0.000	0.2733	0.324
−28.1148	3.6386	2.0000	−2.262	–	1.9975	1.784	12.092	5.3458	7.6715	7.6715	0.000	0.2834	0.327
−23.2457	3.6331	2.1000	−2.107	–	2.0974	1.662	12.153	5.3859	7.6892	7.6892	0.000	0.2939	0.332
−19.0952	3.6278	2.2000	−1.947	−8.219	2.1973	1.541	12.213	5.4263	7.7079	7.7079	0.000	0.3050	0.338
−14.1615	3.6225	2.3000	−1.714	−7.297	2.2973	1.419	12.274	5.4823	7.7346	7.7357	0.045	0.3214	0.352
−11.4752	3.6169	2.4000	−1.574	−6.788	2.3972	1.297	12.335	5.5173	7.7524	7.7537	0.039	0.3317	0.359
−9.1440	3.6114	2.5000	−1.429	−6.268	2.4970	1.175	12.396	5.5537	7.7703	7.7720	0.048	0.3430	0.367
−7.1675	3.6058	2.6000	−1.279	−5.733	2.5969	1.053	12.458	5.5908	7.7884	7.7912	0.059	0.3551	0.377
−5.4912	3.5999	2.7000	−1.125	−5.182	2.6967	0.929	12.519	5.6285	7.8067	7.8113	0.083	0.3680	0.388
−4.0857	3.5941	2.8000	−0.969	−4.594	2.7966	0.806	12.581	5.6674	7.8256	7.8323	0.100	0.3816	0.399
−2.8853	3.5887	2.9000	−0.806	−3.857	2.8964	0.684	12.642	5.7076	7.8448	7.8545	0.120	0.3963	0.411
−1.8582	3.5828	3.0000	−0.639	−2.798	2.9962	0.561	12.703	5.7497	7.8644	7.8784	0.143	0.4120	0.426
−0.9725	3.5775	3.1000	−0.462	−1.494	3.0960	0.439	12.764	5.7937	7.8847	7.9042	0.165	0.4292	0.441
−0.6912	3.5753	3.1351	−0.399	−1.000	3.1310	0.396	12.786	5.8096	7.8922	7.9140	0.171	0.4355	0.447
−0.2277	3.5724	3.1961	−0.275	0.000	3.1919	0.323	12.823	5.8369	7.9070	7.9333	0.163	0.4473	0.458
−0.1969	3.5721	3.2000	−0.265	0.087	3.1957	0.318	12.825	5.8384	7.9081	7.9350	0.160	0.4481	0.459
−0.0179	3.5714	3.2164	−0.192	1.000	3.2119	0.299	12.835	5.8427	7.9135	7.9569	0.094	0.4531	0.463
0.0000	3.5715	3.2151	−0.166	2.000	3.2106	0.300	12.834	5.8390	7.9116	7.9983	0.082	0.4536	0.464
				$M = 0.90$ $Y = 0.20$ $Z = 0.004$ $F_\nu = 1.0$									
−174.4995	3.6468	1.2000	−3.476	–	1.1985	2.726	11.676	5.0903	7.5109	7.5109	0.000	0.2167	0.280
−147.5387	3.6426	1.3000	−3.336	–	1.2982	2.609	11.734	5.1391	7.5222	7.5222	0.000	0.2253	0.277
−125.2037	3.6381	1.4000	−3.193	–	1.3983	2.491	11.793	5.1845	7.5353	7.5353	0.000	0.2340	0.279
−106.4645	3.6332	1.5000	−3.046	–	1.4983	2.371	11.853	5.2282	7.5499	7.5499	0.000	0.2429	0.280
−90.8476	3.6284	1.6000	−2.898	–	1.5983	2.252	11.912	5.2704	7.5654	7.5654	0.000	0.2521	0.283
−77.2390	3.6230	1.7000	−2.739	–	1.6982	2.131	11.973	5.3133	7.5826	7.5826	0.000	0.2620	0.289
−66.8171*	3.6202	1.7554	−2.597	–	1.7533	2.064	12.006	5.3516	7.5985	7.5985	0.000	0.2709	0.295
−59.6516*	3.6233	1.7059	−2.497	–	1.7035	2.126	11.976	5.3793	7.6099	7.6099	0.000	0.2770	0.305
−51.3801	3.6181	1.8000	−2.418	–	1.7983	2.011	12.033	5.4071	7.6183	7.6183	0.000	0.2832	0.308
−42.7197	3.6126	1.9000	−2.318	–	1.8982	1.889	12.094	5.4403	7.6272	7.6272	0.000	0.2912	0.312
−35.3447	3.6070	2.0000	−2.207	–	1.9982	1.766	12.155	5.4734	7.6378	7.6378	0.000	0.2999	0.319
−29.1613	3.6010	2.1000	−2.087	–	2.0981	1.643	12.217	5.5063	7.6502	7.6502	0.000	0.3090	0.326
−23.9910	3.5952	2.2000	−1.957	–	2.1980	1.519	12.279	5.5390	7.6642	7.6643	0.016	0.3186	0.334
−19.6306	3.5892	2.3000	−1.819	–	2.2979	1.395	12.341	5.5719	7.6801	7.6812	0.059	0.3288	0.343
−15.9968	3.5829	2.4000	−1.676	–	2.3978	1.270	12.403	5.6053	7.6970	7.6993	0.081	0.3395	0.352
−12.9653	3.5766	2.5000	−1.530	−6.794	2.4977	1.145	12.466	5.6394	7.7148	7.7184	0.103	0.3508	0.362
−10.4057	3.5701	2.6000	−1.379	−6.229	2.5976	1.019	12.529	5.6747	7.7333	7.7388	0.125	0.3627	0.373
−8.2482	3.5635	2.7000	−1.223	−5.652	2.6974	0.893	12.592	5.7109	7.7522	7.7604	0.150	0.3754	0.385
−6.4196	3.5568	2.8000	−1.062	−5.055	2.7973	0.766	12.656	5.7485	7.7718	7.7835	0.169	0.3890	0.397

TABLE 2—*Continued*

$t - t_f$	log T_{eff}	log L	log L_ν	log L_{He}	log L_H	log g	log R	log ρ_c	log T_c	log T_{max}	$M_r(T_{max})$	M_{SH}	M_{CE}
				$M = 0.90$ $Y = 0.20$ $Z = 0.004$ $F_\nu = 1.0$									
−4.8611	3.5501	2.9000	−0.895	−4.441	2.8972	0.639	12.719	5.7875	7.7920	7.8080	0.190	0.4035	0.411
−3.5248	3.5432	3.0000	−0.722	−3.802	2.9970	0.511	12.783	5.8285	7.8127	7.8339	0.211	0.4193	0.426
−2.3732	3.5362	3.1000	−0.543	−3.083	3.0969	0.383	12.847	5.8715	7.8337	7.8614	0.232	0.4363	0.442
−1.3747	3.5296	3.2000	−0.356	−2.057	3.1966	0.257	12.910	5.9175	7.8551	7.8908	0.250	0.4549	0.460
−0.7141	3.5243	3.2742	−0.210	−1.000	3.2707	0.161	12.958	5.9538	7.8713	7.9140	0.265	0.4700	0.475
−0.4995	3.5229	3.3000	−0.158	−0.582	3.2964	0.130	12.973	5.9667	7.8770	7.9227	0.267	0.4755	0.480
−0.2475	3.5209	3.3307	−0.090	0.000	3.3270	0.092	12.993	5.9821	7.8838	7.9346	0.263	0.4823	0.487
−0.0243	3.5196	3.3517	−0.015	1.000	3.3479	0.065	13.006	5.9917	7.8877	7.9576	0.209	0.4889	0.493
0.0000	3.5199	3.3486	0.003	2.000	3.3448	0.070	13.004	5.9889	7.8858	7.9955	0.193	0.4896	0.494
				$M = 0.70$ $Y = 0.30$ $Z = 0.004$ $F_\nu = 1.0$									
−263.9623	3.6603	0.9000	−3.965	–	0.8987	2.971	11.498	4.9328	7.4655	7.4655	0.000	0.1907	0.293
−218.5718	3.6564	1.0000	−3.816	–	0.9984	2.855	11.556	4.9899	7.4756	7.4756	0.000	0.1989	0.283
−181.1339	3.6522	1.1000	−3.668	–	1.0984	2.738	11.615	5.0413	7.4877	7.4877	0.000	0.2072	0.276
−150.4779	3.6476	1.2000	−3.521	–	1.1984	2.620	11.674	5.0885	7.5010	7.5010	0.000	0.2154	0.274
−125.3127	3.6430	1.3000	−3.375	–	1.2984	2.502	11.733	5.1329	7.5153	7.5153	0.000	0.2238	0.274
−104.6051	3.6383	1.4000	−3.229	–	1.3983	2.383	11.793	5.1750	7.5303	7.5303	0.000	0.2321	0.275
−87.5001	3.6332	1.5000	−3.083	–	1.4982	2.262	11.853	5.2155	7.5459	7.5459	0.000	0.2407	0.279
−73.3214	3.6281	1.6000	−2.937	–	1.5981	2.142	11.913	5.2548	7.5621	7.5621	0.000	0.2494	0.282
−61.2236	3.6225	1.7000	−2.783	–	1.6981	2.020	11.974	5.2945	7.5794	7.5794	0.000	0.2586	0.287
−48.2890*	3.6183	1.7819	−2.583	–	1.7797	1.921	12.023	5.3455	7.6028	7.6028	0.000	0.2707	0.296
−46.0817*	3.6186	1.7802	−2.546	–	1.7778	1.924	12.022	5.3550	7.6071	7.6071	0.000	0.2730	0.299
−44.4221	3.6172	1.8000	−2.521	–	1.7982	1.898	12.035	5.3617	7.6101	7.6101	0.000	0.2745	0.300
−37.1744	3.6115	1.9000	−2.411	–	1.8981	1.775	12.096	5.3926	7.6229	7.6229	0.000	0.2822	0.306
−30.7491	3.6055	2.0000	−2.289	–	1.9980	1.651	12.158	5.4251	7.6363	7.6363	0.000	0.2907	0.312
−25.3534	3.5994	2.1000	−2.161	–	2.0980	1.527	12.220	5.4576	7.6507	7.6507	0.000	0.2997	0.319
−20.8208	3.5934	2.2000	−2.025	–	2.1978	1.403	12.282	5.4903	7.6663	7.6664	0.012	0.3092	0.327
−17.0228	3.5871	2.3000	−1.883	–	2.2977	1.278	12.345	5.5229	7.6831	7.6842	0.052	0.3193	0.335
−13.8524	3.5805	2.4000	−1.736	−7.388	2.3976	1.152	12.408	5.5561	7.7010	7.7033	0.076	0.3298	0.345
−11.1984	3.5742	2.5000	−1.587	−6.784	2.4974	1.026	12.471	5.5903	7.7198	7.7232	0.089	0.3410	0.355
−8.9727	3.5675	2.6000	−1.433	−6.205	2.5974	0.899	12.534	5.6251	7.7391	7.7440	0.109	0.3527	0.365
−7.0887	3.5608	2.7000	−1.274	−5.612	2.6972	0.773	12.598	5.6611	7.7588	7.7662	0.129	0.3653	0.376
−5.4902	3.5540	2.8000	−1.111	−5.001	2.7971	0.645	12.661	5.6985	7.7791	7.7897	0.150	0.3787	0.389
−4.1269	3.5472	2.9000	−0.942	−4.373	2.8969	0.518	12.725	5.7373	7.8000	7.8145	0.168	0.3930	0.402
−2.9562	3.5404	3.0000	−0.767	−3.714	2.9967	0.391	12.788	5.7778	7.8214	7.8408	0.188	0.4086	0.417
−1.9480	3.5338	3.1000	−0.585	−2.935	3.0965	0.265	12.851	5.8206	7.8434	7.8688	0.206	0.4255	0.433
−1.0732	3.5276	3.2000	−0.396	−1.777	3.1963	0.140	12.914	5.8660	7.8659	7.8985	0.226	0.4439	0.450
−0.6579	3.5246	3.2526	−0.292	−1.000	3.2488	0.075	12.946	5.8910	7.8779	7.9151	0.235	0.4544	0.460
−0.3039	3.5219	3.3000	−0.192	−0.190	3.2961	0.017	12.975	5.9141	7.8891	7.9317	0.235	0.4644	0.470
−0.2357	3.5211	3.3092	−0.170	0.000	3.3053	0.005	12.982	5.9186	7.8914	7.9355	0.233	0.4665	0.472
−0.0237	3.5205	3.3309	−0.091	1.000	3.3268	−0.019	12.994	5.9277	7.8960	7.9585	0.176	0.4731	0.478
0.0000	3.5207	3.3282	−0.070	2.000	3.3240	−0.016	12.992	5.9246	7.8939	7.9973	0.161	0.4739	0.479
				$M = 0.90$ $Y = 0.10$ $Z = 0.01$ $F_\nu = 1.0$									
−368.8606	3.6323	0.9000	−3.893	–	0.8989	2.968	11.555	5.0388	7.4451	7.4451	0.000	0.2003	0.252
−313.2402	3.6290	1.0000	−3.764	–	0.9985	2.855	11.611	5.0888	7.4541	7.4541	0.000	0.2084	0.252
−266.3720	3.6251	1.1000	−3.625	–	1.0987	2.739	11.669	5.1355	7.4662	7.4662	0.000	0.2169	0.253
−227.3797	3.6210	1.2000	−3.482	–	1.1987	2.622	11.727	5.1800	7.4799	7.4799	0.000	0.2254	0.256
−194.0468	3.6168	1.3000	−3.334	–	1.2985	2.506	11.786	5.2240	7.4949	7.4949	0.000	0.2343	0.259
−163.6756*	3.6137	1.3720	−3.171	–	1.3703	2.421	11.828	5.2709	7.5121	7.5121	0.000	0.2442	0.265
−142.3967*	3.6178	1.3022	−3.063	–	1.3002	2.508	11.785	5.3062	7.5236	7.5236	0.000	0.2510	0.276
−122.8836	3.6129	1.4000	−3.015	–	1.3988	2.390	11.843	5.3334	7.5260	7.5260	0.000	0.2561	0.278
−102.3681	3.6078	1.5000	−2.940	–	1.4987	2.270	11.904	5.3648	7.5299	7.5299	0.000	0.2629	0.282
−84.7885	3.6027	1.6000	−2.844	–	1.5986	2.149	11.964	5.3957	7.5382	7.5382	0.000	0.2702	0.287
−70.1240	3.5972	1.7000	−2.733	–	1.6986	2.027	12.025	5.4261	7.5494	7.5494	0.000	0.2779	0.293
−58.0342	3.5914	1.8000	−2.613	–	1.7985	1.904	12.086	5.4560	7.5626	7.5626	0.000	0.2859	0.300
−47.9753	3.5855	1.9000	−2.485	–	1.8984	1.781	12.148	5.4859	7.5773	7.5775	0.031	0.2943	0.307
−39.6304	3.5796	2.0000	−2.351	–	1.9983	1.657	12.210	5.5158	7.5936	7.5941	0.057	0.3031	0.315
−32.7173	3.5733	2.1000	−2.213	–	2.0982	1.532	12.273	5.5460	7.6104	7.6115	0.076	0.3122	0.323
−26.9812	3.5669	2.2000	−2.073	–	2.1982	1.406	12.335	5.5765	7.6277	7.6295	0.096	0.3218	0.331
−22.1785	3.5603	2.3000	−1.928	–	2.2981	1.280	12.399	5.6078	7.6458	7.6487	0.117	0.3318	0.340
−18.1740	3.5535	2.4000	−1.779	–	2.3980	1.153	12.462	5.6398	7.6644	7.6688	0.135	0.3424	0.350
−14.8174	3.5466	2.5000	−1.625	–	2.4979	1.025	12.526	5.6726	7.6836	7.6899	0.155	0.3535	0.361
−11.9942	3.5395	2.6000	−1.468	−6.494	2.5978	0.897	12.590	5.7065	7.7035	7.7121	0.173	0.3653	0.372
−9.6110	3.5323	2.7000	−1.306	−5.872	2.6977	0.768	12.655	5.7416	7.7238	7.7353	0.190	0.3779	0.384
−7.5833	3.5249	2.8000	−1.139	−5.238	2.7975	0.638	12.719	5.7782	7.7448	7.7597	0.206	0.3914	0.397
−5.8559	3.5177	2.9000	−0.967	−4.588	2.8974	0.509	12.784	5.8165	7.7662	7.7854	0.220	0.4059	0.411
−4.3720	3.5100	3.0000	−0.789	−3.923	2.9973	0.378	12.849	5.8568	7.7881	7.8124	0.237	0.4215	0.426
−3.0883	3.5025	3.1000	−0.604	−3.235	3.0971	0.249	12.914	5.8995	7.8104	7.8409	0.255	0.4386	0.442
−1.9718	3.4950	3.2000	−0.413	−2.478	3.1969	0.119	12.979	5.9451	7.8329	7.8712	0.275	0.4572	0.461
−0.9941	3.4874	3.3000	−0.213	−1.409	3.2968	−0.012	13.044	5.9943	7.8557	7.9035	0.293	0.4778	0.481
−0.7364	3.4854	3.3286	−0.153	−1.000	3.3253	−0.049	13.063	6.0091	7.8623	7.9132	0.299	0.4841	0.487
−0.2499	3.4815	3.3847	−0.028	0.000	3.3813	−0.120	13.099	6.0388	7.8751	7.9349	0.297	0.4972	0.500
−0.1082	3.4805	3.4000	0.012	0.452	3.3965	−0.139	13.108	6.0464	7.8781	7.9444	0.282	0.5013	0.504
−0.0251	3.4802	3.4049	0.044	1.000	3.4014	−0.146	13.111	6.0492	7.8789	7.9581	0.249	0.5038	0.506
0.0000	3.4808	3.3993	0.060	2.000	3.3958	−0.138	13.107	6.0467	7.8770	7.9952	0.233	0.5046	0.507

TABLE 2—*Continued*

$t - t_f$	$\log T_{eff}$	$\log L$	$\log L_\nu$	$\log L_{He}$	$\log L_H$	$\log g$	$\log R$	$\log \rho_c$	$\log T_c$	$\log T_{max}$	$M_r(T_{max})$	M_{SH}	M_{CE}
				$M = 1.10$ $Y = 0.10$ $Z = 0.01$ $F_\nu = 1.0$									
−293.0734	3.6372	1.0000	−3.816	–	0.9985	2.974	11.595	5.0186	7.4667	7.4667	0.000	0.2010	0.265
−251.4164	3.6335	1.1000	−3.676	–	1.0988	2.860	11.652	5.0712	7.4771	7.4771	0.000	0.2094	0.259
−216.6426	3.6293	1.2000	−3.532	–	1.1984	2.743	11.711	5.1200	7.4894	7.4894	0.000	0.2179	0.258
−188.0967	3.6252	1.3000	−3.387	–	1.2986	2.626	11.769	5.1654	7.5031	7.5031	0.000	0.2263	0.260
−163.8084	3.6207	1.4000	−3.237	–	1.3983	2.508	11.828	5.2098	7.5182	7.5182	0.000	0.2353	0.262
−141.2329	3.6158	1.5000	−3.066	–	1.4982	2.389	11.888	5.2580	7.5361	7.5361	0.000	0.2455	0.267
−132.8414*	3.6147	1.5199	−2.995	–	1.5180	2.365	11.900	5.2781	7.5438	7.5438	0.000	0.2498	0.269
−115.5898*	3.6220	1.3950	−2.863	–	1.3928	2.519	11.823	5.3197	7.5582	7.5582	0.000	0.2576	0.285
−114.9323	3.6218	1.4000	−2.860	–	1.3991	2.513	11.826	5.3209	7.5585	7.5585	0.000	0.2578	0.286
−99.4630	3.6166	1.5000	−2.817	–	1.4986	2.392	11.886	5.3496	7.5599	7.5599	0.000	0.2630	0.286
−83.1303	3.6114	1.6000	−2.752	–	1.5986	2.271	11.946	5.3825	7.5615	7.5615	0.000	0.2699	0.289
−69.0223	3.6058	1.7000	−2.665	–	1.6986	2.149	12.008	5.4147	7.5675	7.5675	0.000	0.2774	0.295
−57.1865	3.6001	1.8000	−2.561	–	1.7985	2.026	12.069	5.4460	7.5770	7.5770	0.000	0.2853	0.301
−47.3706	3.5943	1.9000	−2.446	–	1.8984	1.903	12.131	5.4770	7.5889	7.5889	0.000	0.2936	0.308
−39.1895	3.5884	2.0000	−2.322	–	1.9984	1.779	12.192	5.5078	7.6027	7.6027	0.000	0.3022	0.315
−32.3182	3.5820	2.1000	−2.188	–	2.0982	1.654	12.255	5.5384	7.6181	7.6187	0.052	0.3114	0.322
−26.6422	3.5756	2.2000	−2.051	–	2.1982	1.528	12.318	5.5692	7.6347	7.6358	0.073	0.3209	0.331
−21.8921	3.5692	2.3000	−1.909	–	2.2981	1.402	12.381	5.6008	7.6521	7.6542	0.096	0.3309	0.340
−17.9229	3.5624	2.4000	−1.763	–	2.3979	1.275	12.444	5.6330	7.6701	7.6735	0.119	0.3415	0.350
−14.6079	3.5554	2.5000	−1.613	–	2.4979	1.147	12.508	5.6661	7.6887	7.6940	0.140	0.3526	0.360
−11.8165	3.5484	2.6000	−1.457	−6.387	2.5978	1.019	12.572	5.7002	7.7081	7.7156	0.159	0.3644	0.371
−9.4580	3.5411	2.7000	−1.297	−5.779	2.6977	0.890	12.637	5.7354	7.7280	7.7384	0.180	0.3770	0.383
−7.4586	3.5339	2.8000	−1.132	−5.157	2.7975	0.761	12.701	5.7721	7.7486	7.7624	0.197	0.3903	0.396
−5.7512	3.5264	2.9000	−0.961	−4.517	2.8974	0.631	12.766	5.8104	7.7697	7.7878	0.214	0.4048	0.410
−4.2873	3.5188	3.0000	−0.785	−3.862	2.9973	0.501	12.832	5.8507	7.7912	7.8145	0.232	0.4204	0.425
−3.0183	3.5113	3.1000	−0.602	−3.181	3.0971	0.371	12.897	5.8933	7.8132	7.8428	0.252	0.4374	0.441
−1.9171	3.5034	3.2000	−0.412	−2.424	3.1969	0.239	12.962	5.9388	7.8355	7.8728	0.270	0.4559	0.459
−0.9526	3.4959	3.3000	−0.213	−1.343	3.2968	0.109	13.027	5.9880	7.8581	7.9049	0.288	0.4764	0.479
−0.7382	3.4939	3.3240	−0.163	−1.000	3.3208	0.077	13.043	6.0004	7.8636	7.9131	0.292	0.4817	0.485
−0.2505	3.4897	3.3807	−0.037	0.000	3.3773	0.004	13.080	6.0301	7.8766	7.9347	0.293	0.4948	0.498
−0.0646	3.4883	3.4000	0.019	0.670	3.3965	−0.021	13.092	6.0397	7.8803	7.9491	0.263	0.5002	0.503
−0.0252	3.4883	3.4011	0.036	1.000	3.3975	−0.022	13.093	6.0405	7.8804	7.9580	0.243	0.5014	0.504
0.0000	3.4888	3.3956	0.052	2.000	3.3921	−0.015	13.089	6.0380	7.8785	7.9952	0.226	0.5022	0.505
				$M = 0.90$ $Y = 0.20$ $Z = 0.01$ $F_\nu = 1.0$									
−247.7838	3.6391	1.0000	−3.816	–	0.9984	2.895	11.591	5.0104	7.4692	7.4692	0.000	0.2004	0.261
−209.5623	3.6349	1.1000	−3.677	–	1.0984	2.778	11.649	5.0617	7.4803	7.4803	0.000	0.2083	0.257
−178.1922	3.6305	1.2000	−3.541	–	1.1984	2.661	11.708	5.1079	7.4916	7.4916	0.000	0.2163	0.257
−151.9270	3.6259	1.3000	−3.401	–	1.2985	2.542	11.767	5.1517	7.5048	7.5048	0.000	0.2246	0.260
−129.9152	3.6212	1.4000	−3.256	–	1.3984	2.423	11.827	5.1940	7.5193	7.5193	0.000	0.2330	0.262
−110.7378	3.6159	1.5000	−3.103	–	1.4983	2.302	11.887	5.2369	7.5356	7.5356	0.000	0.2421	0.266
−95.9469*	3.6131	1.5555	−2.962	–	1.5535	2.235	11.921	5.2752	7.5511	7.5511	0.000	0.2504	0.271
−84.4817*	3.6167	1.4989	−2.852	–	1.4965	2.307	11.885	5.3067	7.5634	7.5634	0.000	0.2567	0.282
−83.9913	3.6167	1.5000	−2.848	–	1.4980	2.305	11.886	5.3080	7.5638	7.5638	0.000	0.2569	0.282
−72.3328	3.6112	1.6000	−2.779	–	1.5985	2.183	11.947	5.3354	7.5704	7.5704	0.000	0.2625	0.284
−60.2985	3.6053	1.7000	−2.691	–	1.6984	2.060	12.009	5.3673	7.5773	7.5773	0.000	0.2696	0.289
−50.0367	3.5993	1.8000	−2.587	–	1.7984	1.936	12.071	5.3989	7.5866	7.5866	0.000	0.2772	0.294
−41.4484	3.5933	1.9000	−2.473	–	1.8983	1.812	12.133	5.4302	7.5982	7.5982	0.000	0.2853	0.301
−34.3021	3.5870	2.0000	−2.351	–	1.9982	1.686	12.195	5.4612	7.6116	7.6116	0.000	0.2937	0.308
−28.3375	3.5804	2.1000	−2.221	–	2.0981	1.560	12.258	5.4921	7.6263	7.6264	0.010	0.3026	0.315
−23.3213	3.5738	2.2000	−2.083	–	2.1981	1.434	12.322	5.5231	7.6428	7.6436	0.052	0.3120	0.323
−19.1566	3.5670	2.3000	−1.941	–	2.2980	1.307	12.385	5.5544	7.6603	7.6619	0.073	0.3218	0.332
−15.6761	3.5600	2.4000	−1.795	–	2.3978	1.179	12.449	5.5866	7.6784	7.6811	0.093	0.3322	0.342
−12.7520	3.5528	2.5000	−1.645	−7.179	2.4977	1.050	12.514	5.6196	7.6971	7.7014	0.117	0.3432	0.352
−10.2969	3.5456	2.6000	−1.491	−6.297	2.5976	0.921	12.578	5.6535	7.7165	7.7229	0.135	0.3547	0.363
−8.2189	3.5380	2.7000	−1.331	−5.688	2.6975	0.791	12.643	5.6886	7.7366	7.7456	0.156	0.3671	0.374
−6.4535	3.5307	2.8000	−1.166	−5.064	2.7974	0.661	12.708	5.7250	7.7573	7.7697	0.173	0.3803	0.387
−4.9476	3.5230	2.9000	−0.995	−4.421	2.8972	0.530	12.773	5.7631	7.7786	7.7951	0.191	0.3945	0.400
−3.6528	3.5154	3.0000	−0.818	−3.759	2.9970	0.400	12.838	5.8031	7.8005	7.8219	0.208	0.4099	0.415
−2.5349	3.5076	3.1000	−0.635	−3.069	3.0969	0.269	12.904	5.8453	7.8229	7.8504	0.226	0.4266	0.431
−1.5627	3.4998	3.2000	−0.444	−2.261	3.1967	0.138	12.970	5.8902	7.8458	7.8805	0.244	0.4449	0.449
−0.7097	3.4919	3.3000	−0.243	−1.050	3.2965	0.006	13.035	5.9385	7.8691	7.9129	0.263	0.4651	0.469
−0.6830	3.4917	3.3033	−0.236	−1.000	3.2998	0.002	13.037	5.9402	7.8699	7.9140	0.263	0.4658	0.470
−0.2393	3.4875	3.3603	−0.110	0.000	3.3567	−0.072	13.074	5.9689	7.8836	7.9355	0.262	0.4786	0.482
−0.0246	3.4863	3.3811	−0.033	1.000	3.3773	−0.097	13.087	5.9791	7.8880	7.9588	0.211	0.4853	0.489
0.0000	3.4868	3.3765	−0.015	2.000	3.3727	−0.091	13.084	5.9763	7.8861	7.9968	0.195	0.4861	0.490
				$M = 1.10$ $Y = 0.20$ $Z = 0.01$ $F_\nu = 1.0$									
−197.5140	3.6434	1.1000	−3.713	–	1.0984	2.899	11.632	5.0151	7.4888	7.4888	0.000	0.2037	0.276
−167.9287	3.6388	1.2000	−3.572	–	1.1985	2.781	11.691	5.0656	7.5003	7.5003	0.000	0.2118	0.269
−143.4733	3.6343	1.3000	−3.430	–	1.2983	2.663	11.751	5.1122	7.5127	7.5127	0.000	0.2200	0.266
−123.1959	3.6295	1.4000	−3.286	–	1.3984	2.544	11.810	5.1561	7.5265	7.5265	0.000	0.2284	0.267
−106.2664	3.6245	1.5000	−3.139	–	1.4982	2.424	11.870	5.1983	7.5416	7.5416	0.000	0.2369	0.269
−91.9620	3.6191	1.6000	−2.988	–	1.5983	2.302	11.931	5.2399	7.5578	7.5578	0.000	0.2459	0.272
−75.8526*	3.6135	1.6992	−2.777	–	1.6971	2.181	11.992	5.2959	7.5813	7.5813	0.000	0.2584	0.279
−67.0197*	3.6191	1.6103	−2.656	–	1.6076	2.292	11.936	5.3294	7.5953	7.5953	0.000	0.2653	0.292
−58.8568	3.6140	1.7000	−2.591	–	1.6984	2.182	11.991	5.3544	7.6022	7.6022	0.000	0.2702	0.293
−49.2104	3.6080	1.8000	−2.503	–	1.7984	2.058	12.053	5.3870	7.6091	7.6091	0.000	0.2774	0.297

TABLE 2—*Continued*

$t - t_f$	log T_{eff}	log L	log L_ν	log L_{He}	log L_H	log g	log R	log ρ_c	log T_c	log T_{max}	$M_r(T_{max})$	M_{SH}	M_{CE}
				M = 1.10	Y = 0.20	Z = 0.01	F_ν = 1.0						
−40.8611	3.6020	1.9000	−2.403	–	1.8983	1.934	12.115	5.4196	7.6175	7.6175	0.000	0.2854	0.302
−33.8470	3.5957	2.0000	−2.292	–	1.9982	1.808	12.178	5.4518	7.6281	7.6281	0.000	0.2937	0.309
−27.9839	3.5892	2.1000	−2.172	–	2.0982	1.682	12.241	5.4837	7.6408	7.6408	0.000	0.3025	0.316
−23.0779	3.5827	2.2000	−2.044	–	2.1980	1.557	12.304	5.5157	7.6550	7.6550	0.000	0.3117	0.324
−18.9353	3.5759	2.3000	−1.906	–	2.2979	1.429	12.367	5.5476	7.6707	7.6715	0.048	0.3216	0.333
−15.4759	3.5689	2.4000	−1.764	–	2.3978	1.301	12.431	5.5800	7.6878	7.6896	0.077	0.3319	0.342
−12.5814	3.5619	2.5000	−1.617	−6.698	2.4977	1.173	12.495	5.6133	7.7058	7.7090	0.095	0.3428	0.352
−10.1436	3.5546	2.6000	−1.466	−6.119	2.5976	1.044	12.560	5.6476	7.7245	7.7295	0.119	0.3544	0.363
−8.0873	3.5471	2.7000	−1.309	−5.531	2.6975	0.914	12.625	5.6829	7.7439	7.7514	0.139	0.3667	0.374
−6.3389	3.5397	2.8000	−1.147	−4.925	2.7974	0.785	12.690	5.7195	7.7639	7.7747	0.160	0.3799	0.387
−4.8491	3.5321	2.9000	−0.980	−4.300	2.8972	0.654	12.755	5.7576	7.7846	7.7994	0.180	0.3940	0.400
−3.5646	3.5244	3.0000	−0.806	−3.654	2.9970	0.523	12.820	5.7977	7.8060	7.8257	0.201	0.4094	0.415
−2.4578	3.5164	3.1000	−0.624	−2.972	3.0969	0.391	12.886	5.8399	7.8278	7.8535	0.219	0.4261	0.431
−1.4956	3.5085	3.2000	−0.435	−2.156	3.1967	0.260	12.952	5.8849	7.8502	7.8833	0.238	0.4443	0.448
−0.6943	3.5009	3.2947	−0.247	−1.000	3.2912	0.135	13.015	5.9305	7.8720	7.9136	0.256	0.4633	0.467
−0.6517	3.5004	3.3000	−0.236	−0.920	3.2965	0.127	13.018	5.9332	7.8732	7.9153	0.257	0.4644	0.468
−0.2424	3.4965	3.3527	−0.120	0.000	3.3491	0.059	13.053	5.9596	7.8857	7.9350	0.254	0.4761	0.479
−0.0248	3.4948	3.3737	−0.042	1.000	3.3700	0.031	13.066	5.9695	7.8902	7.9583	0.201	0.4828	0.486
0.0000	3.4954	3.3688	−0.022	2.000	3.3650	0.038	13.063	5.9665	7.8882	7.9964	0.185	0.4836	0.487
				M = 1.40	Y = 0.20	Z = 0.01	F_ν = 1.0						
−159.7279	3.6488	1.2000	−3.545	–	1.1985	2.926	11.672	5.0490	7.5134	7.5134	0.000	0.2111	0.307
−134.8380	3.6443	1.3000	−3.410	–	1.2985	2.808	11.731	5.0999	7.5223	7.5223	0.000	0.2193	0.289
−114.4866	3.6396	1.4000	−3.273	–	1.3986	2.689	11.790	5.1459	7.5336	7.5336	0.000	0.2276	0.282
−97.6935	3.6346	1.5000	−3.133	–	1.4984	2.569	11.850	5.1891	7.5467	7.5467	0.000	0.2361	0.279
−83.8705	3.6291	1.6000	−2.991	–	1.5984	2.447	11.911	5.2300	7.5611	7.5611	0.000	0.2447	0.281
−72.3685	3.6235	1.7000	−2.845	–	1.6983	2.325	11.972	5.2697	7.5768	7.5768	0.000	0.2535	0.283
−62.5956	3.6177	1.8000	−2.694	–	1.7982	2.201	12.034	5.3092	7.5936	7.5936	0.000	0.2628	0.286
−54.2922*	3.6138	1.8714	−2.538	–	1.8692	2.114	12.077	5.3487	7.6114	7.6114	0.000	0.2724	0.292
−48.5878*	3.6197	1.7808	−2.427	–	1.7781	2.228	12.020	5.3776	7.6245	7.6245	0.000	0.2788	0.305
−47.6314	3.6182	1.8000	−2.415	–	1.7986	2.203	12.033	5.3815	7.6260	7.6260	0.000	0.2796	0.305
−40.5097	3.6123	1.9000	−2.324	–	1.8983	2.080	12.095	5.4116	7.6362	7.6362	0.000	0.2863	0.307
−33.6881	3.6061	2.0000	−2.223	–	1.9982	1.955	12.157	5.4447	7.6460	7.6460	0.000	0.2945	0.313
−27.8765	3.5995	2.1000	−2.111	–	2.0981	1.829	12.220	5.4777	7.6568	7.6568	0.000	0.3032	0.319
−22.9964	3.5931	2.2000	−1.991	–	2.1980	1.703	12.283	5.5106	7.6691	7.6691	0.000	0.3123	0.327
−18.9049	3.5865	2.3000	−1.863	–	2.2979	1.576	12.346	5.5436	7.6830	7.6830	0.001	0.3221	0.335
−15.4381	3.5795	2.4000	−1.724	–	2.3979	1.448	12.410	5.5765	7.6985	7.6993	0.047	0.3324	0.344
−12.5313	3.5727	2.5000	−1.582	−6.476	2.4978	1.321	12.474	5.6102	7.7154	7.7175	0.074	0.3433	0.353
−10.0861	3.5655	2.6000	−1.434	−5.924	2.5976	1.192	12.538	5.6448	7.7332	7.7370	0.098	0.3549	0.364
−8.0273	3.5580	2.7000	−1.281	−5.360	2.6975	1.062	12.603	5.6803	7.7518	7.7578	0.125	0.3672	0.375
−6.2809	3.5507	2.8000	−1.123	−4.775	2.7974	0.933	12.668	5.7172	7.7711	7.7802	0.147	0.3803	0.388
−4.7874	3.5430	2.9000	−0.957	−4.168	2.8972	0.803	12.733	5.7556	7.7910	7.8041	0.170	0.3945	0.401
−3.5058	3.5355	3.0000	−0.786	−3.541	2.9971	0.672	12.798	5.7956	7.8116	7.8295	0.191	0.4097	0.415
−2.4004	3.5276	3.1000	−0.608	−2.870	3.0969	0.541	12.864	5.8381	7.8328	7.8568	0.212	0.4263	0.431
−1.4380	3.5196	3.2000	−0.421	−2.043	3.1967	0.409	12.930	5.8832	7.8546	7.8860	0.233	0.4446	0.449
−0.7099	3.5128	3.2856	−0.253	−1.000	3.2821	0.296	12.986	5.9244	7.8738	7.9129	0.249	0.4616	0.465
−0.5945	3.5115	3.3000	−0.224	−0.786	3.2965	0.276	12.996	5.9315	7.8771	7.9177	0.252	0.4646	0.468
−0.2445	3.5080	3.3448	−0.125	0.000	3.3413	0.218	13.026	5.9537	7.8875	7.9344	0.246	0.4745	0.478
−0.0245	3.5064	3.3658	−0.046	1.000	3.3620	0.190	13.039	5.9635	7.8921	7.9576	0.192	0.4812	0.485
0.0000	3.5066	3.3608	−0.025	2.000	3.3571	0.196	13.036	5.9603	7.8900	7.9960	0.176	0.4819	0.485
				M = 1.75	Y = 0.20	Z = 0.01	F_ν = 1.0						
−129.5756	3.6537	1.3000	−3.204	–	1.2986	2.942	11.712	5.0881	7.5764	7.5764	0.000	0.2237	0.384
−109.2505	3.6490	1.4000	−3.109	–	1.3988	2.823	11.771	5.1444	7.5735	7.5735	0.000	0.2315	0.330
−92.1292	3.6439	1.5000	−3.002	–	1.4987	2.703	11.831	5.1934	7.5761	7.5761	0.000	0.2396	0.304
−77.9442	3.6387	1.6000	−2.887	–	1.5986	2.582	11.892	5.2375	7.5829	7.5829	0.000	0.2479	0.298
−66.2119	3.6330	1.7000	−2.764	–	1.6985	2.459	11.953	5.2786	7.5928	7.5928	0.000	0.2565	0.294
−56.4855	3.6271	1.8000	−2.634	–	1.7984	2.336	12.015	5.3176	7.6050	7.6050	0.000	0.2652	0.296
−48.4112	3.6215	1.9000	−2.499	–	1.8983	2.213	12.076	5.3553	7.6188	7.6188	0.000	0.2742	0.299
−41.3230	3.6153	2.0000	−2.351	–	1.9981	2.088	12.139	5.3943	7.6349	7.6349	0.000	0.2842	0.304
−38.2686*	3.6136	2.0292	−2.277	–	2.0269	2.053	12.156	5.4133	7.6433	7.6433	0.000	0.2891	0.308
−34.8876*	3.6181	1.9633	−2.192	–	1.9606	2.137	12.115	5.4351	7.6530	7.6530	0.000	0.2945	0.319
−33.3696	3.6156	2.0000	−2.163	–	1.9983	2.090	12.138	5.4434	7.6563	7.6563	0.000	0.2964	0.318
−27.9636	3.6091	2.1000	−2.058	–	2.0982	1.964	12.201	5.4752	7.6683	7.6683	0.000	0.3044	0.323
−23.1125	3.6028	2.2000	−1.942	–	2.1981	1.838	12.264	5.5087	7.6806	7.6806	0.000	0.3135	0.329
−19.0035	3.5961	2.3000	−1.819	–	2.2981	1.712	12.327	5.5424	7.6936	7.6936	0.000	0.3231	0.337
−15.5213	3.5892	2.4000	−1.686	−6.809	2.3979	1.584	12.391	5.5760	7.7079	7.7083	0.029	0.3334	0.345
−12.5851	3.5825	2.5000	−1.546	−6.280	2.4978	1.457	12.454	5.6102	7.7238	7.7254	0.063	0.3444	0.355
−10.1147	3.5754	2.6000	−1.400	−5.749	2.5977	1.329	12.518	5.6451	7.7409	7.7441	0.087	0.3560	0.365
−8.0360	3.5682	2.7000	−1.251	−5.204	2.6975	1.200	12.583	5.6810	7.7588	7.7638	0.109	0.3682	0.377
−6.2769	3.5609	2.8000	−1.095	−4.639	2.7974	1.071	12.647	5.7181	7.7774	7.7852	0.134	0.3814	0.389
−4.7713	3.5533	2.9000	−0.934	−4.051	2.8973	0.941	12.713	5.7567	7.7966	7.8083	0.159	0.3955	0.402
−3.4793	3.5457	3.0000	−0.765	−3.439	2.9971	0.810	12.778	5.7970	7.8165	7.8331	0.183	0.4108	0.417
−2.3656	3.5380	3.1000	−0.589	−2.779	3.0969	0.679	12.843	5.8396	7.8370	7.8597	0.207	0.4274	0.432
−1.3961	3.5301	3.2000	−0.405	−1.941	3.1968	0.548	12.909	5.8848	7.8583	7.8884	0.229	0.4456	0.450
−0.7302	3.5237	3.2775	−0.255	−1.000	3.2741	0.445	12.961	5.9220	7.8751	7.9122	0.245	0.4609	0.465
−0.5474	3.5219	3.3000	−0.209	−0.666	3.2966	0.415	12.975	5.9332	7.8802	7.9197	0.246	0.4656	0.469

TABLE 2—*Continued*

$t - t_f$	$\log T_{eff}$	$\log L$	$\log L_\nu$	$\log L_{He}$	$\log L_H$	$\log g$	$\log R$	$\log \rho_c$	$\log T_c$	$\log T_{max}$	$M_r(T_{max})$	M_{SH}	M_{CE}
$M = 1.75$ $Y = 0.20$ $Z = 0.01$ $F_\nu = 1.0$													
−0.2485	3.5191	3.3377	−0.126	0.000	3.3342	0.366	13.000	5.9518	7.8889	7.9337	0.243	0.4738	0.477
−0.0243	3.5173	3.3585	−0.046	1.000	3.3548	0.338	13.014	5.9613	7.8934	7.9569	0.185	0.4805	0.484
0.0000	3.5178	3.3537	−0.025	2.000	3.3499	0.345	13.010	5.9582	7.8913	7.9953	0.169	0.4812	0.485
$M = 2.20$ $Y = 0.20$ $Z = 0.01$ $F_\nu = 1.0$													
−37.3166	3.6252	2.0000	−1.958	−5.582	1.9974	2.228	12.119	5.2521	7.8026	7.8026	0.000	0.2884	0.325
−31.0343	3.6188	2.1000	−1.787	−5.316	2.0972	2.102	12.181	5.3301	7.8046	7.8046	0.000	0.3009	0.329
−26.9146	3.6128	2.2000	−1.668	−5.108	2.1974	1.978	12.244	5.3820	7.8073	7.8073	0.000	0.3105	0.332
−25.2485*	3.6112	2.2248	−1.614	−5.000	2.2220	1.947	12.259	5.4042	7.8092	7.8092	0.000	0.3149	0.335
−22.0962*	3.6170	2.1426	−1.519	−4.820	2.1394	2.052	12.206	5.4449	7.8119	7.8119	0.000	0.3224	0.347
−20.3898	3.6130	2.2000	−1.483	−4.779	2.1978	1.979	12.243	5.4639	7.8115	7.8115	0.000	0.3257	0.348
−16.9981	3.6065	2.3000	−1.405	−4.671	2.2978	1.853	12.306	5.5034	7.8114	7.8114	0.000	0.3336	0.352
−13.9082	3.5996	2.4000	−1.316	−4.508	2.3977	1.725	12.370	5.5432	7.8135	7.8135	0.000	0.3426	0.358
−11.2208	3.5928	2.5000	−1.218	−4.288	2.4977	1.598	12.434	5.5823	7.8177	7.8177	0.000	0.3525	0.365
−8.9016	3.5856	2.6000	−1.110	−4.010	2.5976	1.469	12.498	5.6215	7.8243	7.8243	0.000	0.3633	0.374
−6.8942	3.5782	2.7000	−0.990	−3.670	2.6975	1.340	12.563	5.6607	7.8328	7.8330	0.013	0.3752	0.385
−5.1583	3.5714	2.8000	−0.860	−3.264	2.7973	1.212	12.626	5.7001	7.8433	7.8454	0.054	0.3879	0.396
−3.6674	3.5638	2.9000	−0.722	−2.793	2.8972	1.082	12.692	5.7406	7.8558	7.8612	0.087	0.4018	0.409
−2.3991	3.5564	3.0000	−0.575	−2.210	2.9970	0.952	12.756	5.7828	7.8700	7.8788	0.112	0.4167	0.423
−1.3005	3.5489	3.1000	−0.420	−1.407	3.0970	0.822	12.821	5.8271	7.8855	7.8989	0.141	0.4329	0.438
−0.9021	3.5457	3.1400	−0.354	−1.000	3.1369	0.770	12.848	5.8453	7.8924	7.9079	0.148	0.4398	0.445
−0.3331	3.5411	3.2000	−0.242	−0.212	3.1967	0.691	12.887	5.8727	7.9055	7.9238	0.147	0.4509	0.455
−0.2289	3.5403	3.2110	−0.217	0.000	3.2077	0.677	12.894	5.8775	7.9092	7.9278	0.137	0.4531	0.458
−0.0131	3.5391	3.2251	−0.133	1.000	3.2215	0.658	12.903	5.8813	7.9186	7.9529	0.057	0.4578	0.462
0.0000	3.5394	3.2215	−0.104	2.000	3.2180	0.663	12.901	5.8777	7.9172	7.9940	0.047	0.4581	0.463
$M = 0.70$ $Y = 0.30$ $Z = 0.01$ $F_\nu = 1.0$													
−311.2336	3.6488	0.8000	−4.144	–	0.7987	3.024	11.472	4.9088	7.4377	7.4377	0.000	0.1838	0.265
−257.9168	3.6449	0.9000	−4.002	–	0.8986	2.909	11.529	4.9634	7.4473	7.4473	0.000	0.1916	0.258
−214.0025	3.6405	1.0000	−3.859	–	0.9986	2.791	11.588	5.0128	7.4592	7.4592	0.000	0.1993	0.254
−178.1563	3.6358	1.1000	−3.717	–	1.0986	2.673	11.648	5.0583	7.4723	7.4723	0.000	0.2071	0.253
−148.7362	3.6310	1.2000	−3.575	–	1.1985	2.553	11.707	5.1009	7.4863	7.4863	0.000	0.2149	0.255
−124.5821	3.6261	1.3000	−3.433	–	1.2984	2.434	11.767	5.1416	7.5010	7.5010	0.000	0.2228	0.258
−104.5660	3.6211	1.4000	−3.290	–	1.3984	2.314	11.827	5.1808	7.5164	7.5164	0.000	0.2308	0.261
−87.2864	3.6157	1.5000	−3.139	–	1.4982	2.192	11.888	5.2208	7.5332	7.5332	0.000	0.2394	0.265
−69.9687*	3.6120	1.5688	−2.954	–	1.5667	2.109	11.930	5.2686	7.5542	7.5542	0.000	0.2498	0.273
−65.8434*	3.6125	1.5651	−2.909	–	1.5629	2.114	11.927	5.2809	7.5596	7.5596	0.000	0.2524	0.277
−62.3334	3.6104	1.6000	−2.876	–	1.5984	2.071	11.948	5.2905	7.5634	7.5634	0.000	0.2545	0.278
−52.3409	3.6042	1.7000	−2.775	–	1.6983	1.946	12.011	5.3202	7.5744	7.5744	0.000	0.2612	0.282
−43.4309	3.5978	1.8000	−2.662	–	1.7982	1.821	12.073	5.3513	7.5863	7.5863	0.000	0.2688	0.288
−35.9691	3.5916	1.9000	−2.541	–	1.8981	1.696	12.136	5.3823	7.5996	7.5996	0.000	0.2767	0.294
−29.7458	3.5848	2.0000	−2.413	–	1.9980	1.569	12.200	5.4131	7.6141	7.6141	0.000	0.2850	0.301
−24.5617	3.5780	2.1000	−2.280	–	2.0979	1.441	12.263	5.4441	7.6299	7.6299	0.002	0.2937	0.308
−20.2127	3.5713	2.2000	−2.140	–	2.1978	1.315	12.327	5.4748	7.6467	7.6475	0.044	0.3030	0.316
−16.5849	3.5641	2.3000	−1.995	–	2.2977	1.186	12.391	5.5061	7.6646	7.6662	0.068	0.3127	0.325
−13.5613	3.5569	2.4000	−1.848	–	2.3977	1.057	12.455	5.5382	7.6834	7.6861	0.083	0.3228	0.334
−11.0256	3.5497	2.5000	−1.697	−6.884	2.4975	0.928	12.520	5.5709	7.7027	7.7067	0.100	0.3336	0.344
−8.8853	3.5421	2.6000	−1.540	−6.267	2.5974	0.798	12.585	5.6047	7.7226	7.7285	0.119	0.3451	0.355
−7.0732	3.5346	2.7000	−1.379	−5.648	2.6973	0.668	12.650	5.6396	7.7432	7.7516	0.137	0.3573	0.366
−5.5328	3.5268	2.8000	−1.214	−5.013	2.7971	0.537	12.715	5.6759	7.7643	7.7759	0.155	0.3703	0.378
−4.2190	3.5191	2.9000	−1.042	−4.360	2.8970	0.406	12.781	5.7137	7.7862	7.8015	0.171	0.3844	0.392
−3.0895	3.5111	3.0000	−0.864	−3.689	2.9968	0.274	12.847	5.7532	7.8086	7.8286	0.189	0.3995	0.406
−2.1133	3.5039	3.1000	−0.680	−2.979	3.0966	0.145	12.911	5.7949	7.8316	7.8573	0.204	0.4161	0.422
−1.2638	3.4966	3.2000	−0.487	−2.101	3.1964	0.016	12.976	5.8394	7.8554	7.8877	0.223	0.4343	0.439
−0.6251	3.4908	3.2848	−0.315	−1.000	3.2810	−0.092	13.030	5.8796	7.8760	7.9154	0.236	0.4510	0.455
−0.5176	3.4894	3.3000	−0.283	−0.761	3.2961	−0.113	13.040	5.8870	7.8797	7.9206	0.237	0.4542	0.459
−0.2273	3.4876	3.3418	−0.189	0.000	3.3378	−0.162	13.065	5.9075	7.8904	7.9368	0.235	0.4635	0.468
−0.0245	3.4865	3.3634	−0.109	1.000	3.3593	−0.188	13.078	5.9174	7.8956	7.9600	0.182	0.4704	0.475
0.0000	3.4868	3.3592	−0.089	2.000	3.3551	−0.183	13.075	5.9142	7.8935	7.9987	0.167	0.4712	0.475
$M = 0.90$ $Y = 0.30$ $Z = 0.01$ $F_\nu = 1.0$													
−167.0055	3.6460	1.1000	−3.742	–	1.0985	2.822	11.627	4.9925	7.4912	7.4912	0.000	0.2014	0.273
−140.4025	3.6411	1.2000	−3.601	–	1.1985	2.703	11.687	5.0416	7.5028	7.5028	0.000	0.2092	0.268
−118.4103	3.6363	1.3000	−3.459	–	1.2984	2.584	11.747	5.0871	7.5155	7.5155	0.000	0.2171	0.265
−100.2773	3.6312	1.4000	−3.316	–	1.3984	2.463	11.807	5.1297	7.5294	7.5294	0.000	0.2252	0.267
−85.2105	3.6257	1.5000	−3.171	–	1.4982	2.341	11.868	5.1707	7.5445	7.5445	0.000	0.2334	0.268
−72.5981	3.6200	1.6000	−3.024	–	1.5981	2.219	11.929	5.2106	7.5604	7.5604	0.000	0.2418	0.272
−61.6011	3.6141	1.7000	−2.868	–	1.6980	2.095	11.991	5.2515	7.5779	7.5779	0.000	0.2509	0.276
−53.1198*	3.6111	1.7537	−2.724	–	1.7514	2.029	12.024	5.2882	7.5946	7.5946	0.000	0.2593	0.282
−47.6887*	3.6135	1.7193	−2.628	–	1.7167	2.073	12.002	5.3132	7.6058	7.6058	0.000	0.2647	0.290
−42.2093	3.6084	1.8000	−2.554	–	1.7981	1.972	12.052	5.3354	7.6144	7.6144	0.000	0.2695	0.292
−35.2155	3.6021	1.9000	−2.449	–	1.8981	1.847	12.115	5.3672	7.6258	7.6258	0.000	0.2770	0.297
−29.1789	3.5954	2.0000	−2.334	–	1.9980	1.720	12.178	5.3994	7.6377	7.6377	0.000	0.2852	0.303
−24.1082	3.5886	2.1000	−2.212	–	2.0979	1.593	12.242	5.4317	7.6509	7.6509	0.000	0.2938	0.310
−19.8784	3.5820	2.2000	−2.082	–	2.1979	1.466	12.305	5.4638	7.6654	7.6654	0.000	0.3028	0.318
−16.3242	3.5748	2.3000	−1.947	–	2.2977	1.338	12.369	5.4960	7.6809	7.6810	0.008	0.3125	0.326
−13.3099	3.5676	2.4000	−1.802	–	2.3976	1.209	12.434	5.5286	7.6979	7.6991	0.055	0.3227	0.335

TABLE 2—*Continued*

$t - t_f$	$\log T_{eff}$	$\log L$	$\log L_\nu$	$\log L_{He}$	$\log L_H$	$\log g$	$\log R$	$\log \rho_c$	$\log T_c$	$\log T_{max}$	$M_r(T_{max})$	M_{SH}	M_{CE}
$M = 0.90$ $Y = 0.30$ $Z = 0.01$ $F_\nu = 1.0$													
−10.7911	3.5604	2.5000	−1.655	−6.565	2.4974	1.080	12.498	5.5616	7.7161	7.7188	0.077	0.3335	0.345
−8.6823	3.5529	2.6000	−1.504	−5.989	2.5974	0.950	12.563	5.5957	7.7351	7.7392	0.093	0.3448	0.355
−6.8948	3.5453	2.7000	−1.347	−5.400	2.6973	0.820	12.629	5.6310	7.7548	7.7609	0.114	0.3570	0.366
−5.3787	3.5375	2.8000	−1.185	−4.793	2.7971	0.688	12.694	5.6674	7.7751	7.7840	0.133	0.3700	0.378
−4.0798	3.5296	2.9000	−1.017	−4.166	2.8969	0.557	12.760	5.7054	7.7961	7.8086	0.154	0.3839	0.391
−2.9639	3.5215	3.0000	−0.843	−3.517	2.9968	0.425	12.826	5.7450	7.8177	7.8348	0.173	0.3991	0.406
−2.0010	3.5135	3.1000	−0.662	−2.815	3.0966	0.293	12.892	5.7870	7.8400	7.8626	0.191	0.4155	0.422
−1.1636	3.5054	3.2000	−0.473	−1.909	3.1964	0.160	12.958	5.8314	7.8629	7.8923	0.211	0.4335	0.439
−0.6406	3.5002	3.2701	−0.334	−1.000	3.2663	0.069	13.004	5.8643	7.8795	7.9145	0.224	0.4472	0.452
−0.4294	3.4976	3.3000	−0.270	−0.532	3.2962	0.029	13.024	5.8788	7.8869	7.9247	0.225	0.4535	0.458
−0.2303	3.4950	3.3286	−0.206	0.000	3.3247	−0.010	13.043	5.8926	7.8941	7.9358	0.220	0.4597	0.464
−0.0239	3.4941	3.3502	−0.123	1.000	3.3462	−0.035	13.056	5.9021	7.8996	7.9591	0.165	0.4666	0.471
0.0000	3.4944	3.3462	−0.101	2.000	3.3421	−0.030	13.054	5.8987	7.8974	7.9982	0.150	0.4674	0.472
$M = 1.10$ $Y = 0.30$ $Z = 0.01$ $F_\nu = 1.0$													
−161.8833	3.6542	1.1000	−3.745	–	1.0985	2.943	11.611	4.9614	7.5031	7.5031	0.000	0.1995	0.316
−135.4950	3.6494	1.2000	−3.598	–	1.1984	2.823	11.670	5.0165	7.5135	7.5135	0.000	0.2074	0.295
−113.7280	3.6445	1.3000	−3.458	–	1.2985	2.704	11.730	5.0657	7.5245	7.5245	0.000	0.2154	0.281
−95.9271	3.6395	1.4000	−3.317	–	1.3984	2.584	11.790	5.1107	7.5370	7.5370	0.000	0.2235	0.276
−81.2602	3.6341	1.5000	−3.175	–	1.4983	2.462	11.851	5.1529	7.5508	7.5508	0.000	0.2316	0.275
−69.1030	3.6284	1.6000	−3.031	–	1.5981	2.339	11.912	5.1934	7.5658	7.5658	0.000	0.2399	0.277
−58.9977	3.6225	1.7000	−2.884	–	1.6981	2.216	11.974	5.2327	7.5817	7.5817	0.000	0.2485	0.280
−50.4573	3.6165	1.8000	−2.734	–	1.7980	2.092	12.036	5.2715	7.5987	7.5987	0.000	0.2575	0.284
−41.2584*	3.6109	1.8932	−2.533	–	1.8908	1.976	12.094	5.3218	7.6221	7.6221	0.000	0.2696	0.292
−37.1316*	3.6142	1.8471	−2.435	–	1.8443	2.035	12.064	5.3465	7.6337	7.6337	0.000	0.2752	0.301
−34.5425	3.6108	1.9000	−2.389	–	1.8981	1.969	12.098	5.3599	7.6394	7.6394	0.000	0.2782	0.301
−28.8994	3.6041	2.0000	−2.279	–	1.9980	1.842	12.161	5.3916	7.6520	7.6520	0.000	0.2858	0.306
−23.9192	3.5974	2.1000	−2.162	–	2.0979	1.715	12.224	5.4245	7.6648	7.6648	0.000	0.2943	0.312
−19.7239	3.5908	2.2000	−2.039	–	2.1979	1.589	12.288	5.4574	7.6782	7.6782	0.000	0.3033	0.320
−16.1976	3.5837	2.3000	−1.908	–	2.2978	1.461	12.352	5.4905	7.6929	7.6929	0.000	0.3128	0.327
−13.2171	3.5767	2.4000	−1.770	−6.924	2.3976	1.332	12.416	5.5237	7.7085	7.7087	0.018	0.3230	0.336
−10.7049	3.5694	2.5000	−1.625	−6.359	2.4975	1.203	12.480	5.5572	7.7255	7.7269	0.056	0.3337	0.345
−8.5840	3.5620	2.6000	−1.475	−5.798	2.5974	1.074	12.545	5.5914	7.7436	7.7469	0.082	0.3452	0.356
−6.8046	3.5544	2.7000	−1.322	−5.227	2.6972	0.943	12.610	5.6270	7.7628	7.7677	0.097	0.3573	0.367
−5.2916	3.5466	2.8000	−1.163	−4.639	2.7971	0.812	12.676	5.6636	7.7826	7.7899	0.120	0.3702	0.379
−4.0012	3.5387	2.9000	−0.997	−4.031	2.8969	0.681	12.742	5.7016	7.8029	7.8137	0.142	0.3841	0.392
−2.8895	3.5306	3.0000	−0.826	−3.397	2.9968	0.548	12.808	5.7414	7.8239	7.8391	0.162	0.3992	0.406
−1.9298	3.5226	3.1000	−0.647	−2.698	3.0966	0.416	12.874	5.7834	7.8457	7.8663	0.183	0.4156	0.422
−1.0964	3.5143	3.2000	−0.460	−1.765	3.1964	0.283	12.941	5.8280	7.8681	7.8955	0.203	0.4336	0.439
−0.6540	3.5098	3.2590	−0.344	−1.000	3.2553	0.206	12.979	5.8556	7.8818	7.9139	0.213	0.4450	0.450
−0.3636	3.5063	3.3000	−0.258	−0.356	3.2962	0.151	13.007	5.8753	7.8918	7.9277	0.217	0.4535	0.458
−0.2319	3.5046	3.3187	−0.216	0.000	3.3148	0.125	13.019	5.8842	7.8965	7.9351	0.212	0.4575	0.462
−0.0235	3.5030	3.3400	−0.131	1.000	3.3360	0.098	13.033	5.8932	7.9021	7.9583	0.153	0.4644	0.469
0.0000	3.5033	3.3361	−0.108	2.000	3.3320	0.103	13.031	5.8898	7.9000	7.9978	0.138	0.4652	0.470
$M = 1.40$ $Y = 0.30$ $Z = 0.01$ $F_\nu = 1.0$													
−109.9497	3.6546	1.3000	−3.314	–	1.2986	2.849	11.710	5.0446	7.5684	7.5684	0.000	0.2177	0.344
−92.2075	3.6495	1.4000	−3.199	–	1.3985	2.729	11.770	5.0983	7.5710	7.5710	0.000	0.2254	0.311
−77.4950	3.6442	1.5000	−3.080	–	1.4985	2.607	11.831	5.1457	7.5773	7.5773	0.000	0.2333	0.299
−65.2655	3.6387	1.6000	−2.954	–	1.5984	2.485	11.892	5.1892	7.5866	7.5866	0.000	0.2415	0.292
−55.1484	3.6327	1.7000	−2.823	–	1.6982	2.361	11.954	5.2300	7.5982	7.5982	0.000	0.2499	0.291
−46.7576	3.6266	1.8000	−2.688	–	1.7981	2.237	12.016	5.2690	7.6114	7.6114	0.000	0.2584	0.293
−39.7602	3.6205	1.9000	−2.549	–	1.8980	2.112	12.078	5.3068	7.6261	7.6261	0.000	0.2673	0.296
−33.8013	3.6142	2.0000	−2.403	–	1.9979	1.987	12.141	5.3447	7.6423	7.6423	0.000	0.2768	0.300
−28.9939*	3.6103	2.0648	−2.260	–	2.0623	1.907	12.181	5.3806	7.6588	7.6588	0.000	0.2860	0.306
−26.5549*	3.6130	2.0261	−2.182	–	2.0233	1.956	12.156	5.4001	7.6679	7.6679	0.000	0.2908	0.314
−23.7504	3.6078	2.1000	−2.109	–	2.0980	1.862	12.204	5.4203	7.6766	7.6766	0.000	0.2957	0.316
−19.6893	3.6012	2.2000	−1.988	–	2.1979	1.735	12.267	5.4531	7.6906	7.6906	0.000	0.3044	0.323
−16.1776	3.5942	2.3000	−1.862	−7.225	2.2978	1.607	12.331	5.4868	7.7050	7.7050	0.000	0.3138	0.330
−13.2073	3.5871	2.4000	−1.729	−6.653	2.3977	1.479	12.395	5.5208	7.7201	7.7201	0.000	0.3239	0.338
−10.6825	3.5802	2.5000	−1.587	−6.130	2.4975	1.351	12.459	5.5548	7.7359	7.7367	0.034	0.3346	0.348
−8.5511	3.5728	2.6000	−1.441	−5.591	2.5974	1.222	12.524	5.5894	7.7531	7.7553	0.068	0.3460	0.357
−6.7488	3.5654	2.7000	−1.288	−5.035	2.6972	1.092	12.588	5.6252	7.7715	7.7756	0.087	0.3583	0.368
−5.2328	3.5577	2.8000	−1.132	−4.465	2.7971	0.961	12.654	5.6622	7.7907	7.7970	0.105	0.3711	0.380
−3.9339	3.5500	2.9000	−0.970	−3.876	2.8970	0.830	12.719	5.7005	7.8104	7.8198	0.128	0.3850	0.393
−2.8192	3.5419	3.0000	−0.802	−3.257	2.9968	0.698	12.785	5.7404	7.8308	7.8443	0.152	0.4001	0.407
−1.8570	3.5338	3.1000	−0.626	−2.559	3.0966	0.566	12.851	5.7826	7.8518	7.8707	0.175	0.4165	0.423
−1.0207	3.5256	3.2000	−0.441	−1.593	3.1964	0.433	12.918	5.8272	7.8736	7.8991	0.196	0.4344	0.440
−0.6732	3.5220	3.2458	−0.352	−1.000	3.2421	0.372	12.948	5.8486	7.8841	7.9130	0.204	0.4432	0.448
−0.2824	3.5175	3.3000	−0.238	−0.135	3.2962	0.300	12.984	5.8744	7.8972	7.9315	0.203	0.4543	0.459
−0.2339	3.5171	3.3068	−0.222	0.000	3.3030	0.292	12.988	5.8775	7.8990	7.9342	0.201	0.4557	0.460
−0.0227	3.5153	3.3276	−0.137	1.000	3.3236	0.264	13.002	5.8861	7.9048	7.9574	0.139	0.4624	0.467
0.0000	3.5157	3.3238	−0.112	2.000	3.3197	0.269	13.000	5.8825	7.9026	7.9973	0.125	0.4632	0.468

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TABLE 2—*Continued*

$t - t_f$	$\log T_{eff}$	$\log L$	$\log L_\nu$	$\log L_{He}$	$\log L_H$	$\log g$	$\log R$	$\log \rho_c$	$\log T_c$	$\log T_{max}$	$M_r(T_{max})$	M_{SH}	M_{CE}
				$M = 1.75$	$Y = 0.30$	$Z = 0.01$	$F_\nu = 1.0$						
−59.5011	3.6484	1.6000	−2.605	–	1.5981	2.621	11.872	5.1408	7.6968	7.6968	0.000	0.2499	0.348
−50.5150	3.6425	1.7000	−2.513	–	1.6982	2.497	11.934	5.1951	7.6917	7.6917	0.000	0.2571	0.327
−42.7277	3.6364	1.8000	−2.416	–	1.7981	2.373	11.996	5.2433	7.6912	7.6912	0.000	0.2648	0.316
−36.0707	3.6304	1.9000	−2.310	–	1.8980	2.249	12.058	5.2877	7.6944	7.6944	0.000	0.2730	0.313
−30.4445	3.6240	2.0000	−2.198	−9.099	1.9979	2.123	12.121	5.3292	7.7008	7.7008	0.000	0.2816	0.315
−25.6852	3.6176	2.1000	−2.079	−7.560	2.0978	1.998	12.184	5.3689	7.7097	7.7097	0.000	0.2907	0.317
−21.6057	3.6111	2.2000	−1.951	−7.020	2.1977	1.872	12.247	5.4083	7.7210	7.7210	0.000	0.3004	0.323
−18.7099*	3.6071	2.2586	−1.840	−6.642	2.2560	1.797	12.284	5.4404	7.7317	7.7317	0.000	0.3088	0.328
−17.3730*	3.6089	2.2339	−1.784	−6.457	2.2310	1.829	12.268	5.4561	7.7372	7.7372	0.000	0.3127	0.334
−15.6658	3.6042	2.3000	−1.722	−6.253	2.2978	1.744	12.311	5.4750	7.7433	7.7433	0.000	0.3175	0.336
−12.8337	3.5971	2.4000	−1.603	−5.866	2.3976	1.616	12.375	5.5100	7.7552	7.7552	0.000	0.3270	0.344
−10.3754	3.5902	2.5000	−1.476	−5.447	2.4975	1.488	12.439	5.5458	7.7684	7.7684	0.000	0.3374	0.352
−8.2746	3.5829	2.6000	−1.342	−4.992	2.5974	1.359	12.503	5.5820	7.7825	7.7827	0.010	0.3486	0.361
−6.4752	3.5757	2.7000	−1.199	−4.497	2.6973	1.230	12.568	5.6186	7.7979	7.7994	0.044	0.3606	0.372
−4.9336	3.5682	2.8000	−1.049	−3.974	2.7971	1.100	12.633	5.6560	7.8145	7.8183	0.078	0.3737	0.383
−3.6334	3.5605	2.9000	−0.894	−3.429	2.8970	0.969	12.698	5.6950	7.8323	7.8388	0.097	0.3875	0.396
−2.5179	3.5526	3.0000	−0.733	−2.833	2.9968	0.838	12.764	5.7356	7.8509	7.8608	0.123	0.4025	0.410
−1.5555	3.5446	3.1000	−0.564	−2.080	3.0967	0.706	12.830	5.7783	7.8702	7.8848	0.147	0.4187	0.425
−0.7247	3.5367	3.1991	−0.386	−1.000	3.1956	0.575	12.895	5.8230	7.8906	7.9112	0.170	0.4363	0.442
−0.7177	3.5365	3.2000	−0.384	−0.989	3.1965	0.573	12.896	5.8234	7.8908	7.9115	0.171	0.4365	0.442
−0.2308	3.5315	3.2636	−0.253	0.000	3.2599	0.490	12.938	5.8526	7.9066	7.9319	0.164	0.4490	0.454
−0.0186	3.5301	3.2816	−0.167	1.000	3.2777	0.466	12.950	5.8588	7.9139	7.9553	0.091	0.4550	0.460
0.0000	3.5305	3.2782	−0.138	2.000	3.2744	0.471	12.947	5.8549	7.9120	7.9968	0.080	0.4555	0.461
				$M = 2.20$	$Y = 0.30$	$Z = 0.01$	$F_\nu = 1.0$						
−4.7661	3.6146	2.3000	−1.568	−2.593	2.2959	1.885	12.290	5.2272	7.9213	7.9213	0.000	0.3204	0.356
−2.1808*	3.6085	2.3899	−1.371	−1.891	2.3857	1.771	12.347	5.3033	7.9341	7.9341	0.000	0.3326	0.361
−1.7566*	3.6088	2.3872	−1.337	−1.740	2.3828	1.775	12.345	5.3156	7.9376	7.9376	0.000	0.3347	0.363
−1.4914	3.6076	2.4000	−1.317	−1.644	2.3965	1.757	12.354	5.3229	7.9401	7.9401	0.000	0.3359	0.363
−0.4872	3.6046	2.4504	−1.240	−1.000	2.4470	1.695	12.385	5.3464	7.9613	7.9613	0.000	0.3409	0.365
−0.1220	3.6036	2.4656	−1.202	0.000	2.4621	1.676	12.395	5.3470	7.9852	7.9852	0.000	0.3429	0.365
−0.0233	3.6038	2.4621	−1.171	1.000	2.4571	1.680	12.393	5.3326	8.0099	8.0099	0.000	0.3434	0.366
0.0000	3.6045	2.4537	−1.136	2.000	2.4422	1.691	12.387	5.3050	8.0368	8.0368	0.000	0.3435	0.367
				$M = 0.70$	$Y = 0.40$	$Z = 0.01$	$F_\nu = 1.0$						
−168.9710	3.6532	1.0000	−3.920	–	1.0014	2.842	11.563	4.9206	7.4798	7.4798	0.000	0.1919	0.276
−141.3232	3.6487	1.1000	−3.774	–	1.0984	2.724	11.622	4.9711	7.4922	7.4922	0.000	0.1990	0.267
−117.6548	3.6435	1.2000	−3.634	–	1.1983	2.603	11.682	5.0180	7.5041	7.5041	0.000	0.2066	0.264
−98.1714	3.6382	1.3000	−3.494	–	1.2982	2.482	11.743	5.0615	7.5172	7.5172	0.000	0.2142	0.263
−82.0714	3.6325	1.4000	−3.352	–	1.3981	2.359	11.804	5.1027	7.5314	7.5314	0.000	0.2219	0.265
−68.7488	3.6266	1.5000	−3.210	–	1.4981	2.236	11.866	5.1422	7.5466	7.5466	0.000	0.2298	0.267
−57.6913	3.6206	1.6000	−3.065	–	1.5979	2.112	11.928	5.1804	7.5626	7.5626	0.000	0.2378	0.271
−48.3304	3.6145	1.7000	−2.916	–	1.6979	1.988	11.990	5.2186	7.5795	7.5795	0.000	0.2464	0.275
−38.5058	3.6083	1.8000	−2.722	–	1.7976	1.862	12.053	5.2667	7.6023	7.6023	0.000	0.2575	0.282
−29.9046	3.6019	1.9000	−2.538	–	1.8978	1.737	12.115	5.3134	7.6244	7.6244	0.000	0.2683	0.292
−24.8282	3.5948	2.0000	−2.415	–	1.9978	1.609	12.180	5.3449	7.6390	7.6390	0.000	0.2763	0.297
−20.5114	3.5877	2.1000	−2.287	–	2.0977	1.480	12.244	5.3769	7.6541	7.6541	0.000	0.2848	0.304
−16.8977	3.5808	2.2000	−2.153	–	2.1976	1.353	12.308	5.4090	7.6699	7.6699	0.000	0.2938	0.311
−13.8671	3.5734	2.3000	−2.014	–	2.2975	1.223	12.372	5.4414	7.6867	7.6867	0.001	0.3032	0.319
−11.2970	3.5661	2.4000	−1.867	−7.154	2.3973	1.094	12.437	5.4737	7.7042	7.7051	0.040	0.3133	0.328
−9.1376	3.5586	2.5000	−1.717	−6.528	2.4972	0.964	12.502	5.5067	7.7228	7.7252	0.068	0.3241	0.338
−7.3281	3.5508	2.6000	−1.563	−5.937	2.5971	0.832	12.568	5.5408	7.7425	7.7463	0.080	0.3353	0.348
−5.8023	3.5427	2.7000	−1.405	−5.333	2.6969	0.700	12.634	5.5758	7.7630	7.7686	0.095	0.3474	0.358
−4.5051	3.5349	2.8000	−1.241	−4.716	2.7968	0.569	12.699	5.6122	7.7840	7.7919	0.112	0.3602	0.370
−3.3929	3.5269	2.9000	−1.072	−4.081	2.8966	0.437	12.765	5.6498	7.8056	7.8166	0.130	0.3740	0.383
−2.4377	3.5186	3.0000	−0.898	−3.419	2.9964	0.304	12.832	5.6891	7.8279	7.8429	0.150	0.3890	0.397
−1.6134	3.5110	3.1000	−0.715	−2.684	3.0962	0.173	12.897	5.7305	7.8508	7.8708	0.168	0.4053	0.413
−0.8956	3.5030	3.2000	−0.524	−1.665	3.1960	0.042	12.963	5.7745	7.8747	7.9007	0.184	0.4232	0.430
−0.5791	3.4995	3.2486	−0.427	−1.000	3.2445	−0.021	12.994	5.7968	7.8867	7.9162	0.194	0.4325	0.438
−0.2609	3.4962	3.3000	−0.317	−0.147	3.2957	−0.086	13.027	5.8209	7.9001	7.9342	0.192	0.4431	0.449
−0.2158	3.4960	3.3073	−0.300	0.000	3.3030	−0.094	13.031	5.8243	7.9022	7.9372	0.190	0.4447	0.450
−0.0232	3.4937	3.3291	−0.214	1.000	3.3246	−0.125	13.046	5.8333	7.9088	7.9604	0.133	0.4518	0.457
0.0000	3.4942	3.3262	−0.190	2.000	3.3217	−0.120	13.044	5.8295	7.9066	8.0009	0.119	0.4527	0.458
				$M = 1.10$	$Y = 0.40$	$Z = 0.01$	$F_\nu = 1.0$						
−92.0150	3.6563	1.3000	−3.412	–	1.2984	2.751	11.707	4.9977	7.5650	7.5650	0.000	0.2123	0.324
−76.8838	3.6510	1.4000	−3.283	–	1.3983	2.630	11.767	5.0492	7.5718	7.5718	0.000	0.2199	0.304
−64.2771	3.6453	1.5000	−3.152	–	1.4982	2.507	11.828	5.0958	7.5808	7.5808	0.000	0.2276	0.293
−53.8362	3.6393	1.6000	−3.018	–	1.5980	2.383	11.890	5.1390	7.5920	7.5920	0.000	0.2356	0.289
−45.1907	3.6332	1.7000	−2.882	–	1.6979	2.258	11.953	5.1796	7.6049	7.6049	0.000	0.2437	0.288
−38.0182	3.6269	1.8000	−2.743	–	1.7978	2.133	12.015	5.2185	7.6190	7.6190	0.000	0.2522	0.290
−32.0324	3.6205	1.9000	−2.602	–	1.8977	2.008	12.078	5.2563	7.6343	7.6343	0.000	0.2609	0.294
−26.9957	3.6139	2.0000	−2.455	–	1.9976	1.881	12.141	5.2936	7.6508	7.6508	0.000	0.2700	0.298
−22.2674	3.6071	2.1000	−2.287	–	2.0973	1.754	12.205	5.3354	7.6705	7.6705	0.000	0.2807	0.304
−20.7357*	3.6063	2.1140	−2.225	–	2.1112	1.737	12.214	5.3507	7.6779	7.6779	0.000	0.2847	0.308
−19.3481*	3.6072	2.1034	−2.167	–	2.1003	1.751	12.206	5.3649	7.6848	7.6848	0.000	0.2882	0.313
−16.4746	3.6003	2.2000	−2.057	–	2.1976	1.627	12.269	5.3931	7.6981	7.6981	0.000	0.2955	0.317

TABLE 2—*Continued*

$t - t_f$	log T_{eff}	log L	log L_ν	log L_{He}	log L_H	log g	log R	log ρ_c	log T_c	log T_{max}	$M_r(T_{max})$	M_{SH}	M_{CE}
				M = 1.10	Y = 0.40	Z = 0.01	F_ν = 1.0						
−13.5377	3.5930	2.3000	−1.925	−7.058	2.2975	1.498	12.333	5.4265	7.7141	7.7141	0.000	0.3046	0.324
−11.0351	3.5859	2.4000	−1.789	−6.540	2.3974	1.369	12.397	5.4605	7.7304	7.7304	0.000	0.3145	0.332
−8.9120	3.5784	2.5000	−1.646	−6.016	2.4973	1.239	12.462	5.4947	7.7473	7.7474	0.009	0.3250	0.340
−7.1062	3.5708	2.6000	−1.498	−5.466	2.5971	1.109	12.528	5.5295	7.7651	7.7662	0.038	0.3363	0.350
−5.5704	3.5629	2.7000	−1.343	−4.896	2.6969	0.977	12.593	5.5649	7.7837	7.7866	0.068	0.3484	0.361
−4.2770	3.5550	2.8000	−1.185	−4.315	2.7967	0.846	12.659	5.6016	7.8033	7.8084	0.085	0.3612	0.372
−3.1749	3.5470	2.9000	−1.022	−3.716	2.8966	0.714	12.725	5.6397	7.8238	7.8313	0.100	0.3749	0.385
−2.2276	3.5384	3.0000	−0.853	−3.079	2.9965	0.579	12.792	5.6794	7.8449	7.8557	0.120	0.3898	0.399
−1.4110	3.5306	3.1000	−0.676	−2.309	3.0962	0.448	12.858	5.7210	7.8668	7.8819	0.142	0.4059	0.414
−0.6993	3.5222	3.2000	−0.489	−1.192	3.1960	0.314	12.925	5.7651	7.8897	7.9103	0.161	0.4237	0.431
−0.6067	3.5210	3.2140	−0.462	−1.000	3.2100	0.296	12.934	5.7715	7.8930	7.9145	0.164	0.4263	0.433
−0.2133	3.5154	3.2755	−0.332	0.000	3.2713	0.212	12.976	5.7994	7.9095	7.9353	0.159	0.4385	0.445
−0.0199	3.5143	3.2954	−0.244	1.000	3.2911	0.188	12.988	5.8064	7.9176	7.9586	0.093	0.4452	0.451
0.0000	3.5145	3.2931	−0.217	2.000	3.2887	0.191	12.987	5.8023	7.9156	8.0004	0.080	0.4459	0.452
				M = 0.90	Y = 0.20	Z = 0.04	F_ν = 1.0						
−347.8985	3.6168	0.8000	−4.124	–	0.7977	3.006	11.536	4.9621	7.4249	7.4249	0.000	0.1877	0.232
−295.6238	3.6129	0.9000	−3.998	–	0.8983	2.890	11.593	5.0100	7.4341	7.4341	0.000	0.1949	0.231
−251.9840	3.6086	1.0000	−3.865	–	0.9982	2.773	11.652	5.0546	7.4456	7.4456	0.000	0.2023	0.233
−215.3331	3.6038	1.1000	−3.726	–	1.0983	2.654	11.712	5.0974	7.4590	7.4590	0.000	0.2099	0.235
−182.9057	3.5986	1.2000	−3.574	–	1.1982	2.533	11.772	5.1413	7.4744	7.4744	0.000	0.2182	0.239
−162.1777*	3.5969	1.2422	−3.461	–	1.2404	2.484	11.797	5.1734	7.4864	7.4864	0.000	0.2244	0.243
−139.0742*	3.6013	1.1717	−3.342	–	1.1693	2.572	11.752	5.2109	7.4992	7.4992	0.000	0.2310	0.254
−134.8414	3.5995	1.2000	−3.331	–	1.1992	2.536	11.770	5.2166	7.5002	7.5002	0.000	0.2319	0.253
−116.4617	3.5942	1.3000	−3.283	–	1.2987	2.415	11.831	5.2421	7.5027	7.5027	0.000	0.2365	0.254
−97.1148	3.5887	1.4000	−3.210	–	1.3986	2.293	11.892	5.2720	7.5070	7.5070	0.000	0.2425	0.258
−80.4514	3.5827	1.5000	−3.117	–	1.4985	2.169	11.954	5.3015	7.5148	7.5148	0.000	0.2490	0.263
−66.6018	3.5765	1.6000	−3.011	–	1.5985	2.045	12.016	5.3304	7.5254	7.5254	0.000	0.2557	0.269
−55.1832	3.5702	1.7000	−2.897	–	1.6984	1.919	12.079	5.3588	7.5378	7.5378	0.000	0.2627	0.274
−45.7519	3.5634	1.8000	−2.776	–	1.7983	1.792	12.142	5.3869	7.5517	7.5517	0.000	0.2701	0.281
−37.9393	3.5565	1.9000	−2.649	–	1.8983	1.664	12.206	5.4150	7.5668	7.5668	0.006	0.2778	0.287
−31.4204	3.5494	2.0000	−2.515	–	1.9982	1.536	12.270	5.4429	7.5831	7.5837	0.046	0.2858	0.294
−26.0075	3.5420	2.1000	−2.378	–	2.0980	1.406	12.335	5.4713	7.6003	7.6015	0.070	0.2942	0.302
−21.5019	3.5345	2.2000	−2.238	–	2.1979	1.276	12.400	5.5002	7.6181	7.6199	0.085	0.3030	0.310
−17.7390	3.5268	2.3000	−2.094	–	2.2979	1.146	12.466	5.5296	7.6364	7.6395	0.105	0.3123	0.319
−14.5946	3.5188	2.4000	−1.946	–	2.3978	1.014	12.532	5.5596	7.6553	7.6599	0.123	0.3220	0.328
−11.9521	3.5107	2.5000	−1.794	–	2.4976	0.882	12.598	5.5906	7.6748	7.6815	0.140	0.3323	0.338
−9.7249	3.5024	2.6000	−1.637	−6.534	2.5976	0.748	12.664	5.6225	7.6951	7.7042	0.156	0.3434	0.348
−7.8300	3.4938	2.7000	−1.475	−5.686	2.6975	0.614	12.732	5.6557	7.7161	7.7281	0.171	0.3551	0.360
−6.2188	3.4850	2.8000	−1.308	−5.029	2.7973	0.478	12.799	5.6903	7.7378	7.7533	0.187	0.3677	0.372
−4.8362	3.4759	2.9000	−1.134	−4.351	2.8972	0.342	12.867	5.7266	7.7603	7.7798	0.200	0.3813	0.385
−3.6426	3.4666	3.0000	−0.953	−3.652	2.9970	0.205	12.936	5.7649	7.7836	7.8079	0.215	0.3960	0.400
−2.6032	3.4575	3.1000	−0.765	−2.929	3.0969	0.069	13.004	5.8054	7.8076	7.8376	0.228	0.4123	0.415
−1.6927	3.4481	3.2000	−0.567	−2.164	3.1967	−0.069	13.073	5.8489	7.8325	7.8693	0.244	0.4301	0.433
−0.8903	3.4384	3.3000	−0.359	−1.266	3.2965	−0.208	13.142	5.8958	7.8583	7.9030	0.259	0.4500	0.453
−0.7151	3.4365	3.3234	−0.308	−1.000	3.3198	−0.239	13.158	5.9072	7.8645	7.9113	0.263	0.4550	0.457
−0.2465	3.4309	3.3885	−0.158	0.000	3.3848	−0.326	13.202	5.9402	7.8822	7.9367	0.265	0.4698	0.472
−0.1605	3.4300	3.4000	−0.128	0.265	3.3963	−0.341	13.209	5.9455	7.8851	7.9426	0.259	0.4727	0.475
−0.0286	3.4291	3.4103	−0.072	1.000	3.4065	−0.355	13.216	5.9515	7.8883	7.9604	0.211	0.4774	0.480
0.0000	3.4306	3.3990	−0.053	2.000	3.3952	−0.338	13.208	5.9479	7.8859	7.9978	0.191	0.4784	0.481
				M = 1.75	Y = 0.20	Z = 0.04	F_ν = 1.0						
−222.4780	3.6391	1.0000	−3.775	–	0.9992	3.184	11.591	5.0042	7.4834	7.4834	0.000	0.1996	0.348
−184.5373	3.6343	1.1000	−3.671	–	1.0990	3.065	11.650	5.0600	7.4847	7.4847	0.000	0.2073	0.292
−153.7574	3.6293	1.2000	−3.557	–	1.1992	2.944	11.711	5.1076	7.4906	7.4906	0.000	0.2149	0.273
−128.9025	3.6243	1.3000	−3.435	–	1.2989	2.824	11.771	5.1501	7.5001	7.5001	0.000	0.2226	0.265
−108.7713	3.6189	1.4000	−3.308	–	1.3988	2.703	11.831	5.1891	7.5119	7.5119	0.000	0.2302	0.263
−92.3715	3.6132	1.5000	−3.177	–	1.4987	2.580	11.893	5.2260	7.5252	7.5252	0.000	0.2380	0.264
−78.8384	3.6073	1.6000	−3.042	–	1.5985	2.457	11.955	5.2618	7.5399	7.5399	0.000	0.2460	0.268
−66.6643	3.6014	1.7000	−2.890	–	1.6983	2.333	12.016	5.3001	7.5571	7.5571	0.000	0.2548	0.272
−63.3451*	3.6006	1.7143	−2.842	–	1.7123	2.315	12.025	5.3118	7.5627	7.5627	0.000	0.2577	0.274
−57.0134*	3.6046	1.6486	−2.751	–	1.6460	2.397	11.984	5.3346	7.5735	7.5735	0.000	0.2627	0.283
−54.2107	3.6017	1.7000	−2.721	–	1.6987	2.334	12.016	5.3432	7.5770	7.5770	0.000	0.2645	0.283
−45.8757	3.5953	1.8000	−2.627	–	1.7986	2.209	12.078	5.3713	7.5879	7.5879	0.000	0.2709	0.286
−38.1489	3.5887	1.9000	−2.521	–	1.8984	2.082	12.142	5.4016	7.5992	7.5992	0.000	0.2784	0.292
−31.6312	3.5819	2.0000	−2.405	–	1.9983	1.955	12.205	5.4319	7.6114	7.6114	0.000	0.2865	0.298
−26.2079	3.5750	2.1000	−2.284	–	2.0982	1.827	12.269	5.4620	7.6250	7.6250	0.000	0.2947	0.305
−21.6629	3.5677	2.2000	−2.154	–	2.1981	1.698	12.334	5.4923	7.6399	7.6399	0.007	0.3036	0.312
−17.8207	3.5603	2.3000	−2.017	–	2.2980	1.568	12.399	5.5226	7.6562	7.6572	0.056	0.3130	0.321
−14.6185	3.5526	2.4000	−1.874	–	2.3979	1.438	12.464	5.5535	7.6737	7.6759	0.081	0.3228	0.330
−11.9439	3.5448	2.5000	−1.728	–	2.4977	1.307	12.530	5.5852	7.6921	7.6956	0.099	0.3332	0.339
−9.6854	3.5368	2.6000	−1.577	−5.930	2.5976	1.174	12.596	5.6179	7.7111	7.7165	0.122	0.3442	0.350
−7.7760	3.5286	2.7000	−1.421	−5.329	2.6975	1.042	12.662	5.6515	7.7308	7.7388	0.145	0.3559	0.361
−6.1514	3.5204	2.8000	−1.259	−4.709	2.7974	0.909	12.728	5.6865	7.7513	7.7627	0.161	0.3685	0.373
−4.7635	3.5119	2.9000	−1.091	−4.071	2.8973	0.775	12.795	5.7231	7.7725	7.7878	0.181	0.3821	0.386
−3.5664	3.5031	3.0000	−0.916	−3.408	2.9971	0.640	12.863	5.7615	7.7946	7.8147	0.198	0.3968	0.400
−2.5273	3.4941	3.1000	−0.733	−2.721	3.0969	0.504	12.931	5.8021	7.8174	7.8433	0.215	0.4129	0.416
−1.6196	3.4851	3.2000	−0.542	−1.989	3.1968	0.368	12.999	5.8455	7.8411	7.8737	0.233	0.4306	0.433

TABLE 2—*Continued*

$t - t_f$	log T_{eff}	log L	log L_ν	log L_{He}	log L_H	log g	log R	log ρ_c	log T_c	log T_{max}	$M_r(T_{max})$	M_{SH}	M_{CE}
				$M = 1.75$	$Y = 0.20$		$Z = 0.04$	$F_\nu = 1.0$					
−0.8199	3.4758	3.3000	−0.339	−1.097	3.2966	0.230	13.068	5.8921	7.8658	7.9064	0.249	0.4502	0.453
−0.7544	3.4750	3.3086	−0.320	−1.000	3.3052	0.219	13.073	5.8964	7.8681	7.9094	0.252	0.4520	0.454
−0.2542	3.4684	3.3777	−0.165	0.000	3.3741	0.123	13.121	5.9304	7.8862	7.9353	0.253	0.4672	0.469
−0.0284	3.4663	3.3995	−0.076	1.000	3.3958	0.093	13.136	5.9415	7.8926	7.9589	0.195	0.4749	0.477
0.0000	3.4674	3.3878	−0.055	2.000	3.3840	0.109	13.128	5.9376	7.8900	7.9968	0.175	0.4758	0.478
				$M = 0.70$	$Y = 0.30$		$Z = 0.04$	$F_\nu = 1.0$					
−288.8665	3.6188	0.8000	−4.126	–	0.7982	2.905	11.532	4.9594	7.4252	7.4252	0.000	0.1873	0.229
−241.4569	3.6143	0.9000	−4.005	–	0.8985	2.786	11.591	5.0040	7.4345	7.4345	0.000	0.1942	0.229
−202.0493	3.6094	1.0000	−3.877	–	0.9985	2.667	11.650	5.0456	7.4459	7.4459	0.000	0.2011	0.232
−169.4177	3.6043	1.1000	−3.744	–	1.0985	2.546	11.711	5.0851	7.4589	7.4589	0.000	0.2083	0.234
−141.2003	3.5987	1.2000	−3.603	–	1.1983	2.424	11.772	5.1250	7.4737	7.4737	0.000	0.2159	0.238
−113.0049*	3.5956	1.2687	−3.428	–	1.2667	2.343	11.812	5.1723	7.4928	7.4928	0.000	0.2251	0.245
−102.8368*	3.5963	1.2603	−3.364	–	1.2581	2.354	11.807	5.1907	7.5000	7.5000	0.000	0.2286	0.249
−97.5529	3.5939	1.3000	−3.338	–	1.2987	2.305	11.831	5.1994	7.5028	7.5028	0.000	0.2302	0.250
−83.1580	3.5879	1.4000	−3.261	–	1.3985	2.181	11.893	5.2250	7.5104	7.5104	0.000	0.2353	0.253
−69.1166	3.5815	1.5000	−3.164	–	1.4984	2.055	11.956	5.2539	7.5197	7.5197	0.000	0.2416	0.257
−57.3075	3.5750	1.6000	−3.056	–	1.5983	1.929	12.019	5.2825	7.5308	7.5308	0.000	0.2481	0.262
−47.5028	3.5682	1.7000	−2.941	–	1.6982	1.802	12.083	5.3110	7.5437	7.5437	0.000	0.2550	0.268
−39.3799	3.5610	1.8000	−2.819	–	1.7982	1.674	12.147	5.3392	7.5578	7.5578	0.000	0.2622	0.274
−32.6927	3.5539	1.9000	−2.692	–	1.8981	1.545	12.211	5.3672	7.5730	7.5730	0.000	0.2697	0.281
−27.0945	3.5465	2.0000	−2.557	–	1.9980	1.415	12.276	5.3952	7.5891	7.5895	0.041	0.2775	0.288
−22.4232	3.5388	2.1000	−2.420	–	2.0978	1.285	12.342	5.4234	7.6064	7.6075	0.063	0.2858	0.295
−18.5429	3.5311	2.2000	−2.280	–	2.1978	1.154	12.407	5.4521	7.6244	7.6263	0.073	0.2944	0.303
−15.2998	3.5231	2.3000	−2.137	–	2.2977	1.022	12.473	5.4815	7.6429	7.6457	0.091	0.3035	0.311
−12.5856	3.5148	2.4000	−1.989	–	2.3976	0.889	12.540	5.5115	7.6619	7.6663	0.106	0.3131	0.320
−10.3019	3.5062	2.5000	−1.838	–	2.4974	0.754	12.607	5.5423	7.6816	7.6878	0.124	0.3233	0.330
−8.3669	3.4976	2.6000	−1.681	−6.276	2.5973	0.620	12.674	5.5741	7.7020	7.7107	0.140	0.3341	0.340
−6.7254	3.4885	2.7000	−1.519	−5.627	2.6972	0.483	12.742	5.6072	7.7232	7.7347	0.155	0.3457	0.351
−5.3292	3.4798	2.8000	−1.352	−4.966	2.7970	0.349	12.810	5.6416	7.7450	7.7599	0.169	0.3582	0.363
−4.1283	3.4706	2.9000	−1.179	−4.284	2.8969	0.212	12.878	5.6777	7.7678	7.7866	0.182	0.3716	0.376
−3.0911	3.4609	3.0000	−0.998	−3.579	2.9967	0.073	12.947	5.7157	7.7913	7.8149	0.197	0.3863	0.391
−2.1896	3.4520	3.1000	−0.810	−2.851	3.0966	−0.063	13.015	5.7557	7.8157	7.8446	0.211	0.4024	0.406
−1.3982	3.4429	3.2000	−0.612	−2.073	3.1964	−0.199	13.083	5.7988	7.8411	7.8764	0.223	0.4201	0.423
−0.7003	3.4354	3.3000	−0.403	−1.109	3.2961	−0.329	13.148	5.8450	7.8677	7.9104	0.239	0.4397	0.443
−0.6421	3.4346	3.3088	−0.383	−1.000	3.3050	−0.341	13.154	5.8492	7.8701	7.9135	0.240	0.4416	0.445
−0.2310	3.4304	3.3737	−0.236	0.000	3.3697	−0.423	13.195	5.8809	7.8881	7.9386	0.240	0.4559	0.459
−0.0283	3.4298	3.3960	−0.147	1.000	3.3919	−0.447	13.207	5.8922	7.8949	7.9622	0.188	0.4637	0.467
0.0000	3.4309	3.3857	−0.128	2.000	3.3815	−0.433	13.200	5.8883	7.8925	8.0002	0.169	0.4648	0.468
				$M = 1.75$	$Y = 0.30$		$Z = 0.04$	$F_\nu = 1.0$					
−121.1313	3.6411	1.2000	−3.319	–	1.2035	2.992	11.687	5.0153	7.5839	7.5839	0.000	0.2141	0.342
−102.1071	3.6355	1.3000	−3.232	–	1.2989	2.869	11.748	5.0736	7.5769	7.5769	0.000	0.2207	0.301
−85.5211	3.6298	1.4000	−3.142	–	1.3987	2.747	11.810	5.1235	7.5753	7.5753	0.000	0.2277	0.284
−71.6113	3.6238	1.5000	−3.041	–	1.4987	2.623	11.871	5.1677	7.5785	7.5785	0.000	0.2350	0.276
−60.1190	3.6176	1.6000	−2.933	–	1.5984	2.498	11.934	5.2078	7.5851	7.5851	0.000	0.2424	0.275
−50.6152	3.6112	1.7000	−2.818	–	1.6983	2.372	11.997	5.2452	7.5945	7.5945	0.000	0.2501	0.277
−42.7221	3.6046	1.8000	−2.696	–	1.7982	2.246	12.060	5.2811	7.6059	7.6059	0.000	0.2580	0.280
−35.8363	3.5978	1.9000	−2.562	–	1.8980	2.118	12.124	5.3176	7.6198	7.6198	0.000	0.2667	0.285
−32.7654*	3.5960	1.9271	−2.492	–	1.9247	2.084	12.141	5.3359	7.6274	7.6274	0.000	0.2711	0.288
−30.2528*	3.5978	1.9041	−2.432	–	1.9015	2.114	12.126	5.3515	7.6340	7.6340	0.000	0.2748	0.294
−26.7345	3.5910	2.0000	−2.356	–	1.9982	1.992	12.187	5.3724	7.6426	7.6426	0.000	0.2798	0.295
−22.2891	3.5839	2.1000	−2.241	–	2.0980	1.863	12.251	5.4027	7.6555	7.6555	0.000	0.2876	0.301
−18.4297	3.5764	2.2000	−2.120	–	2.1979	1.733	12.316	5.4339	7.6695	7.6695	0.000	0.2962	0.308
−15.1961	3.5690	2.3000	−1.992	–	2.2978	1.603	12.381	5.4652	7.6843	7.6843	0.000	0.3051	0.316
−12.4595	3.5611	2.4000	−1.857	–	2.3977	1.472	12.447	5.4969	7.7000	7.7001	0.011	0.3148	0.324
−10.1259	3.5533	2.5000	−1.713	−6.062	2.4975	1.340	12.513	5.5288	7.7168	7.7182	0.058	0.3250	0.333
−8.1659	3.5452	2.6000	−1.566	−5.498	2.5974	1.208	12.579	5.5618	7.7350	7.7382	0.078	0.3360	0.343
−6.5206	3.5368	2.7000	−1.414	−4.926	2.6973	1.075	12.646	5.5955	7.7541	7.7590	0.097	0.3475	0.354
−5.1214	3.5285	2.8000	−1.257	−4.336	2.7971	0.941	12.712	5.6306	7.7740	7.7812	0.117	0.3599	0.366
−3.9225	3.5198	2.9000	−1.094	−3.724	2.8970	0.807	12.780	5.6672	7.7945	7.8051	0.138	0.3731	0.378
−2.8880	3.5107	3.0000	−0.925	−3.089	2.9969	0.670	12.848	5.7053	7.8158	7.8306	0.158	0.3876	0.392
−1.9904	3.5019	3.1000	−0.746	−2.420	3.0966	0.535	12.915	5.7457	7.8382	7.8581	0.179	0.4034	0.407
−1.2069	3.4926	3.2000	−0.558	−1.679	3.1964	0.398	12.984	5.7887	7.8615	7.8875	0.197	0.4208	0.424
−0.7042	3.4856	3.2715	−0.416	−1.000	3.2678	0.298	13.034	5.8212	7.8791	7.9101	0.210	0.4345	0.438
−0.5154	3.4831	3.3000	−0.357	−0.655	3.2963	0.260	13.053	5.8345	7.8865	7.9196	0.214	0.4402	0.443
−0.2410	3.4790	3.3423	−0.262	0.000	3.3384	0.201	13.082	5.8544	7.8980	7.9354	0.210	0.4492	0.452
−0.0263	3.4769	3.3636	−0.168	1.000	3.3596	0.171	13.097	5.8644	7.9057	7.9588	0.144	0.4569	0.460
0.0000	3.4778	3.3541	−0.142	2.000	3.3501	0.184	13.091	5.8602	7.9033	7.9981	0.126	0.4578	0.461

TABLE 3

PROPERTIES OF SELECTED RED-GIANT MODELS WITH (M, Y, Z, F_ν) = (0.90, 0.20, 0.00001, 1.0)

Parameter	$t - t_f$, Time Before Helium-Core Flash (10^6 yrs)						
	-60.220	-40.511	-23.709	-13.512	-6.025	-1.333	0.000
Center:							
log P	21.636	21.790	21.979	22.155	22.338	22.534	22.602
log T	7.724	7.743	7.770	7.799	7.827	7.858	7.867
log ρ	5.481	5.579	5.700	5.813	5.931	6.058	6.102
η	14.337	15.802	17.634	19.378	21.485	23.870	24.870
Location of T maximum:							
log P	-	21.535	21.548	21.463	21.452	21.460	21.802
log T	-	7.744	7.774	7.812	7.854	7.912	8.000
log ρ	-	5.414	5.420	5.360	5.348	5.345	5.563
M_r	-	0.050	0.104	0.189	0.259	0.332	0.270
log r	-	8.631	8.719	8.799	8.827	8.843	8.768
η	-	12.493	11.811	9.993	8.960	7.827	8.899
Y	-	1.000	1.000	1.000	1.000	1.000	0.998
Middle of hydrogen shell:							
log P	18.180	18.149	18.101	18.070	18.009	17.959	17.937
log T	7.625	7.655	7.692	7.724	7.764	7.806	7.820
log ρ	2.535	2.475	2.389	2.324	2.219	2.119	2.079
M_r	0.318	0.342	0.376	0.412	0.452	0.500	0.521
log r	9.279	9.266	9.253	9.237	9.228	9.216	9.216
log L_r	1.531	1.707	1.951	2.147	2.430	2.704	2.823
β	0.995	0.993	0.988	0.983	0.972	0.954	0.945
Edge of conv. envelope:							
log P	12.111	11.904	11.621	11.299	10.990	10.640	10.467
log T	6.122	6.111	6.093	6.046	6.025	5.995	5.970
log ρ	-2.159	-2.355	-2.636	-2.914	-3.207	-3.538	-3.690
M_r	0.420	0.413	0.422	0.446	0.476	0.516	0.536
log r	11.113	11.119	11.135	11.193	11.223	11.263	11.296
log L_r	1.815	2.016	2.280	2.490	2.762	3.041	3.138
β	0.994	0.991	0.986	0.980	0.967	0.945	0.935
∇_{ad}	0.393	0.390	0.384	0.379	0.367	0.351	0.344
Total star:							
log L_ν	-1.775	-1.509	-1.168	-0.831	-0.488	-0.097	0.101
log L_{He}	-9.622	-8.883	-7.879	-6.459	-4.155	-1.148	2.087
log L_H	1.813	2.013	2.277	2.487	2.759	3.038	3.133
log L	1.815	2.016	2.280	2.490	2.762	3.041	3.138
M_{bol}	0.183	-0.320	-0.979	-1.505	-2.185	-2.883	-3.126
log T_{eff}	3.671	3.663	3.652	3.644	3.633	3.621	3.617
log R	11.934	12.051	12.204	12.327	12.485	12.647	12.704
log g	2.208	1.975	1.669	1.423	1.107	0.782	0.670

between the ZAMS and the subgiant branch has been obtained from the earlier results of Mengel *et al.* (1978). Unimportant differences in the version of the computer program used for these earlier calculations are responsible for the minor fluctuation sometimes noticeable on the subgiant branch.

The morphology of the tracks in Figures 1*a*–1*c* shows the expected dependences on composition and mass. For constant M and Z, there is a blueward shift in the tracks with increasing Y, in agreement with Rood (1972). As anticipated, the present tracks are particularly sensitive to changes in the heavy-element abundance. Increasing Z causes a pronounced redward shift as well as a decrease in the slope, a result consistent with previous investigations. There is, furthermore, a significant dependence of the tracks on mass. In Figure 1*c* the change in log T_{eff} is approximately proportional to the change in log M. Rood (1972) has

TABLE 4

PROPERTIES OF SELECTED RED-GIANT MODELS WITH (M, Y, Z, F_ν) = (0.90, 0.20, 0.001, 1.0)

	$t - t_f$, Time Before Helium-Core Flash (10^6 yrs)						
Parameter	-98.758	-54.550	-20.336	-6.904	-2.492	-0.671	0.000
Center:							
log P	21.251	21.495	21.819	22.093	22.287	22.417	22.461
log T	7.578	7.633	7.714	7.788	7.841	7.875	7.884
log ρ	5.242	5.396	5.600	5.773	5.897	5.980	6.008
η	13.937	15.384	17.229	18.784	19.920	20.831	21.216
Location of T maximum:							
log P	-	-	21.637	21.490	21.483	21.533	21.860
log T	-	-	7.715	7.798	7.868	7.918	7.997
log ρ	-	-	5.482	5.379	5.366	5.393	5.602
M_r	-	-	0.032	0.160	0.234	0.272	0.193
log r	-	-	8.552	8.777	8.815	8.819	8.728
η	-	-	14.624	10.584	8.913	8.313	9.490
Y	-	-	0.999	0.999	0.999	0.999	0.997
Middle of hydrogen shell:							
log P	17.792	17.723	17.638	17.522	17.458	17.427	17.411
log T	7.495	7.540	7.597	7.660	7.701	7.727	7.736
log ρ	2.282	2.167	2.023	1.836	1.721	1.654	1.626
M_r	0.250	0.285	0.340	0.398	0.445	0.478	0.495
log r	9.329	9.313	9.286	9.278	9.270	9.262	9.263
log L_r	1.275	1.584	1.965	2.432	2.725	2.897	2.978
β	0.996	0.993	0.986	0.967	0.944	0.923	0.914
Edge of conv. envelope:							
log P	12.740	12.323	11.737	11.159	10.754	10.448	10.301
log T	6.274	6.234	6.157	6.098	6.051	6.006	5.981
log ρ	-1.661	-2.069	-2.582	-3.113	-3.483	-3.755	-3.882
M_r	0.313	0.320	0.361	0.410	0.453	0.485	0.501
log r	10.885	10.912	11.009	11.084	11.146	11.200	11.231
log L_r	1.525	1.876	2.293	2.763	3.059	3.235	3.298
β	0.994	0.990	0.980	0.957	0.929	0.905	0.894
∇_{ad}	0.393	0.388	0.379	0.359	0.341	0.328	0.324
Total star:							
log L_ν	-2.883	-2.350	-1.615	-0.952	-0.470	-0.155	0.031
log L_{He}	-	-	-7.573	-5.242	-3.152	-0.786	2.074
log L_H	1.523	1.874	2.290	2.760	3.056	3.231	3.294
log L	1.525	1.876	2.293	2.763	3.059	3.235	3.298
M_{bol}	0.907	0.031	-1.011	-2.188	-2.929	-3.367	-3.526
log T_{eff}	3.653	3.637	3.617	3.592	3.575	3.566	3.562
log R	11.826	12.033	12.282	12.568	12.748	12.855	12.895
log g	2.426	2.011	1.513	0.942	0.580	0.366	0.288

pointed out that this effect would cause a widening of the giant branch if differential mass loss occurred. The tracks for $Z = 0.0004$ and 0.004 show how changes in M and Y can compensate to give identical giant branches, although there are differences around the main-sequence turnoff. None of these dependences should be qualitatively altered by the uncertainties in the mixing-length theory used in the convective envelope.

The surface luminosity L_f at the onset of the helium-core flash is also affected by variations in the composition and mass. Two opposing effects govern the dependence of L_f on the helium abundance. An increase in Y raises the surface luminosity for a given value of M_{SH} (Refsdal and Weigert 1970). However, this effect is more than offset by the subsequent reduction in the core mass M_c (see § IV*b*), leading therefore to a net decrease in L_f. The sensitivity of L_f

TABLE 5

PROPERTIES OF SELECTED RED-GIANT MODELS WITH $(M, Y, Z, F_\nu) = (0.90, 0.30, 0.001, 1.0)$

	$t - t_f$, Time Before Helium-Core Flash (10^6 yrs)						
Parameter	-56.108	-39.862	-25.472	-12.484	-3.796	-0.787	0.000
Center:							
log P	21.276	21.414	21.586	21.802	22.072	22.263	22.314
log T	7.630	7.660	7.704	7.763	7.834	7.885	7.901
log ρ	5.255	5.342	5.450	5.586	5.757	5.879	5.911
η	12.723	13.497	14.320	15.295	16.694	17.795	18.014
Location of T maximum:							
log P	-	-	-	21.614	21.562	21.564	21.909
log T	-	-	-	7.763	7.845	7.912	7.999
log ρ	-	-	-	5.464	5.422	5.415	5.635
M_r	-	-	-	0.034	0.134	0.206	0.118
log r	-	-	-	8.564	8.747	8.791	8.665
η	-	-	-	12.865	10.175	8.689	9.907
Y	-	-	-	0.999	0.999	0.999	0.997
Middle of hydrogen shell:							
log P	17.738	17.698	17.643	17.591	17.484	17.429	17.408
log T	7.516	7.542	7.575	7.611	7.671	7.711	7.721
log ρ	2.228	2.163	2.072	1.982	1.806	1.700	1.664
M_r	0.260	0.280	0.308	0.347	0.404	0.451	0.470
log r	9.346	9.337	9.328	9.309	9.301	9.292	9.294
log L_r	1.460	1.633	1.867	2.108	2.549	2.821	2.921
β	0.995	0.993	0.989	0.982	0.960	0.935	0.924
Edge of conv. envelope:							
log P	12.379	12.113	11.821	11.455	10.927	10.538	10.390
log T	6.222	6.187	6.162	6.115	6.064	6.017	5.994
log ρ	-1.943	-2.201	-2.470	-2.793	-3.283	-3.639	-3.771
M_r	0.324	0.327	0.338	0.369	0.417	0.460	0.479
log r	10.976	11.006	11.024	11.087	11.150	11.208	11.237
log L_r	1.723	1.919	2.174	2.436	2.880	3.157	3.238
β	0.992	0.989	0.983	0.974	0.946	0.915	0.902
∇_{ad}	0.391	0.388	0.382	0.374	0.352	0.333	0.327
Total star:							
log L_ν	-2.626	-2.329	-1.927	-1.415	-0.767	-0.302	-0.070
log L_{He}	-	-	-8.382	-6.416	-4.082	-1.009	2.094
log L_H	1.721	1.917	2.172	2.433	2.877	3.153	3.234
log L	1.723	1.919	2.174	2.436	2.880	3.157	3.238
M_{bol}	0.413	-0.077	-0.716	-1.370	-2.480	-3.173	-3.375
log T_{eff}	3.652	3.642	3.629	3.615	3.590	3.574	3.570
log R	11.926	12.044	12.198	12.357	12.628	12.799	12.849
log g	2.225	1.989	1.680	1.363	0.820	0.478	0.380

on Y is more pronounced at the smaller Z values. Similarly, an increase in Z both raises the surface luminosity for fixed M_{SH} and reduces the core mass M_c. Since in this case the first effect easily dominates, a model for a larger value of Z evolves to a higher luminosity before the flash. Over the interval from $Z = 0.00001$ to 0.01, $\log L_f$ increases by approximately 0.2 to 0.3, with the change in $\log L_f$ being roughly proportional to the change in $\log Z$. At larger Z values L_f is somewhat less sensitive to Z.

Figure 1*c* illustrates the relatively weak dependence of L_f on mass, until one approaches the critical mass separating the stars which undergo the helium-core flash from the stars which ignite helium quietly in a nondegenerate core. For the composition $(Y, Z) = (0.30, 0.01)$ the critical mass is in the neighborhood of

TABLE 6

PROPERTIES OF SELECTED RED-GIANT MODELS WITH $(M, Y, Z, F_\nu) = (0.90, 0.30, 0.01, 1.0)$

	$t - t_f$, Time Before Helium-Core Flash (10^6 yrs)						
Parameter	-108.851	-50.415	-23.049	-7.515	-3.309	-0.499	0.000
Center:							
log P	21.036	21.343	21.564	21.850	22.031	22.256	22.294
log T	7.522	7.600	7.654	7.748	7.811	7.884	7.897
log ρ	5.109	5.301	5.439	5.618	5.732	5.874	5.899
η	12.990	14.442	15.641	16.501	16.951	17.698	17.825
Location of T maximum:							
log P	-	-	-	21.393	21.388	21.488	21.791
log T	-	-	-	7.753	7.826	7.921	8.002
log ρ	-	-	-	5.320	5.309	5.362	5.556
M_r	-	-	-	0.104	0.167	0.224	0.149
log r	-	-	-	8.750	8.802	8.814	8.716
η	-	-	-	10.726	8.989	7.880	8.774
Y	-	-	-	0.990	0.990	0.990	0.988
Middle of hydrogen shell:							
log P	17.636	17.564	17.453	17.308	17.233	17.168	17.157
log T	7.436	7.484	7.527	7.594	7.634	7.679	7.688
log ρ	2.210	2.090	1.934	1.714	1.591	1.463	1.438
M_r	0.221	0.262	0.296	0.352	0.394	0.451	0.467
log r	9.356	9.331	9.323	9.322	9.318	9.309	9.311
log L_r	1.098	1.444	1.797	2.332	2.634	2.952	3.021
β	0.997	0.994	0.989	0.970	0.949	0.911	0.901
Edge of conv. envelope:							
log P	13.083	12.502	11.934	11.212	10.801	10.137	10.018
log T	6.401	6.314	6.229	6.135	6.082	5.965	5.949
log ρ	-1.405	-1.936	-2.423	-3.064	-3.437	-4.008	-4.120
M_r	0.265	0.286	0.312	0.362	0.401	0.456	0.472
log r	10.737	10.823	10.916	11.027	11.091	11.224	11.242
log L_r	1.350	1.743	2.123	2.663	2.967	3.290	3.346
β	0.992	0.986	0.976	0.947	0.915	0.866	0.849
∇_{ad}	0.390	0.384	0.375	0.352	0.334	0.313	0.307
Total star:							
log L_ν	-3.388	-2.675	-2.182	-1.405	-0.901	-0.292	-0.102
log L_{He}	-	-	-	-5.618	-3.732	-0.694	2.078
log L_H	1.349	1.740	2.121	2.661	2.964	3.286	3.342
log L	1.350	1.743	2.123	2.663	2.967	3.290	3.346
M_{bol}	1.344	0.364	-0.588	-1.939	-2.699	-3.505	-3.645
log T_{eff}	3.634	3.612	3.587	3.548	3.524	3.499	3.494
log R	11.777	12.017	12.257	12.605	12.805	13.017	13.053
log g	2.522	2.043	1.564	0.867	0.467	0.043	-0.030

2.2 $M_\odot$, a value in agreement with Iben (1967). Comparison of the tracks for $(M, Z) = (2.20, 0.01)$ and $(1.40, 0.0001)$ at $Y = 0.20$ and 0.30 indicates that the critical mass decreases for lower values of Z and larger values of Y, confirming the similar conclusion reached by Wagner (1974) for extremely metal-poor stars.

b) Core Mass M_c

An essential quantity to be derived from red giant sequences is the value of the core mass M_c as a function of the various model parameters. Values of M_c for the present sequences have been previously quoted in Table 1. When comparing these results with other investigations, it is convenient to define a "reference" case by $(M, Y, Z, F_\nu) = (0.80, 0.30, 0.001, 1.0)$. Tarbell and Rood (1976) find for the reference case that $M_c = 0.470\ M_\odot$, while interpolation in Table 1 yields $0.474\ M_\odot$. The agreement between these numbers is quite satisfactory in view of the extensive calculations involved. However, there are considerably greater

TABLE 7

PROPERTIES OF SELECTED RED-GIANT MODELS WITH (M, Y, Z, F_ν) = (1.75, 0.30, 0.01, 1.0)

	$t - t_f$, Time Before Helium-Core Flash (10^6 yrs)						
Parameter	-46.517	-30.028	-17.604	-7.737	-2.732	-0.866	0.000
Center:							
log P	21.230	21.404	21.595	21.814	22.028	22.166	22.229
log T	7.691	7.701	7.736	7.787	7.847	7.887	7.912
log ρ	5.220	5.332	5.453	5.592	5.727	5.815	5.855
η	10.603	12.188	13.435	14.679	15.612	16.230	16.280
Location of T maximum:							
log P	-	-	-	21.682	21.570	21.570	21.931
log T	-	-	-	7.787	7.856	7.906	8.001
log ρ	-	-	-	5.506	5.426	5.420	5.650
M_r	-	-	-	0.021	0.117	0.168	0.078
log r	-	-	-	8.488	8.731	8.771	8.611
η	-	-	-	12.988	9.988	8.870	10.090
Y	-	-	-	0.990	0.990	0.990	0.988
Middle of hydrogen shell:							
log P	17.535	17.473	17.426	17.313	17.228	17.186	17.165
log T	7.478	7.511	7.542	7.588	7.635	7.663	7.677
log ρ	2.065	1.969	1.889	1.725	1.582	1.502	1.461
M_r	0.261	0.282	0.312	0.352	0.399	0.433	0.456
log r	9.361	9.350	9.334	9.328	9.322	9.316	9.317
log L_r	1.450	1.694	1.914	2.301	2.648	2.845	2.958
β	0.994	0.991	0.986	0.972	0.948	0.926	0.912
Edge of conv. envelope:							
log P	12.621	12.284	11.994	11.496	11.138	10.960	10.917
log T	6.338	6.295	6.262	6.197	6.165	6.153	6.160
log ρ	-1.844	-2.141	-2.402	-2.843	-3.186	-3.366	-3.426
M_r	0.319	0.315	0.332	0.364	0.407	0.439	0.461
log r	10.970	10.962	10.974	11.018	11.042	11.052	11.044
log L_r	1.750	2.008	2.240	2.628	2.980	3.181	3.278
β	0.986	0.980	0.971	0.951	0.916	0.887	0.866
∇_{ad}	0.385	0.379	0.371	0.355	0.334	0.321	0.313
Total star:							
log L_ν	-2.466	-2.189	-1.794	-1.302	-0.767	-0.420	-0.137
log L_{He}	-	-8.711	-6.488	-4.855	-2.963	-1.224	2.101
log L_H	1.747	2.006	2.237	2.626	2.977	3.178	3.274
log L	1.749	2.008	2.240	2.628	2.980	3.181	3.278
M_{bol}	0.347	-0.300	-0.880	-1.850	-2.729	-3.233	-3.475
log T_{eff}	3.639	3.623	3.609	3.581	3.554	3.538	3.530
log R	11.965	12.126	12.272	12.522	12.751	12.884	12.947
log g	2.436	2.113	1.822	1.323	0.864	0.598	0.471

differences between the present M_c value for the reference case and those estimated from the earlier computations of Eggleton (1968), Iben (1968*a*), and Demarque and Mengel (1971) (see Table 8 of Rood 1972).

Figure 2 shows how M_c depends on Y for several values of M and Z. The physical reasons for the dependences of M_c on composition and mass have already been discussed by Eggleton (1968), Refsdal and Weigert (1970), and Rood (1972), and consequently will not be repeated here. Two things can be immediately noted from Figure 2, namely, the almost linear variation of M_c with Y, especially for the larger Z values, and the greater sensitivity of M_c on Y for the lower Z values. For $(M, Y) = (0.90, 0.20)$, $\partial M_c/\partial Y$ varies from -0.32 to -0.19 as Z goes from 0.00001 to

0.01. The reference case gives $\partial M_c/\partial Y = -0.24$, which is practically identical to the value of -0.23 found by Rood (1972).

The dependence of M_c on Z, illustrated in Figure 3, has been explained by Rood (1972) in terms of a competition between the tendency of the hydrogen-burning shell to expand and cool with an increase in Z and the dominance of the shell by the core. The first effect partially compensates for the enhanced energy output of the shell resulting from an increase in Z. Since this effect becomes more important at lower values of M_{SH}, one would expect M_c to be less sensitive to Z at the smaller M_c values associated with the larger values of Y. This expectation is substantiated in Figure 3, where M_c is seen to depend only mildly on Z at $Y = 0.40$. For the cases plotted in Figure 3, $\partial M_c/\partial \log Z$ ranges from -0.001 to -0.016. In the reference case $\partial M_c/\partial \log Z$ has the approximate value -0.007, while Rood (1972) obtained -0.010.

The core mass M_c is a monotonically decreasing function of M, as indicated in Figure 4 for the composition $(Y, Z) = (0.30, 0.01)$. With increasing M in Figure 4, the derivative $|\partial M_c/\partial M|$ at first decreases. This behavior is not surprising, since a given increment in M represents a smaller relative perturbation when the envelope mass is large. However, the core becomes progressively less degenerate at the time of helium ignition as M approaches the critical mass for the flash. This trend leads to a more rapid drop in M_c and hence to a corresponding increase in $|\partial M_c/\partial M|$. Such an effect is evident in Figure 4 for $M > 1.3\ M_\odot$. The minimum value of $|\partial M_c/\partial M|$ in Figure 4 is 0.006. In

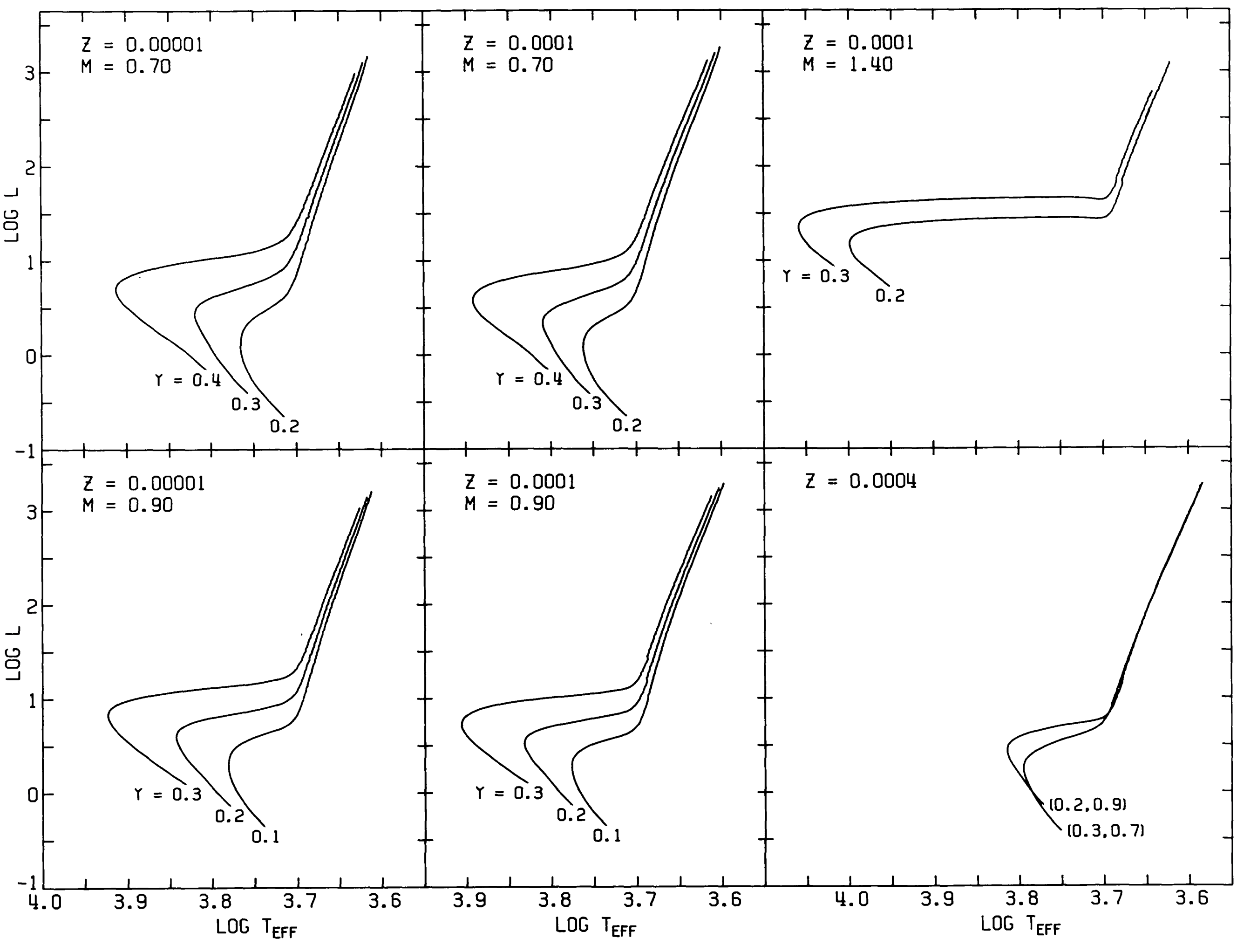

FIG. 1a

FIG. 1.—Evolutionary tracks for red giant sequences covering the ranges $0.70 \leq M \leq 2.20$, $0.10 \leq Y \leq 0.40$, and $0.00001 \leq Z \leq 0.04$. Each track extends from the zero-age main sequence (ZAMS) to the point when $L_{\text{He}} \approx 100\ L_\odot$. Neutrino emission according to the rates of Beaudet, Petrosian, and Salpeter (1967) has been included during the red giant phase of all plotted sequences. M and L are in solar units. The ZAMS position of each track is labeled by the value of Y in (*a*) and (*b*) and the value of M in (*c*), except for the tracks with $Z = 0.0004$ and 0.004, where the ZAMS position is labeled by the value of (Y, M). The upper left-hand corner of each panel gives the values of M and Z in (*a*) and (*b*) and the values of Y and Z in (*c*) applying to all of the tracks within the panel. The only exception is for the tracks with $Z = 0.0004$ and 0.004, where just the value of Z is indicated.

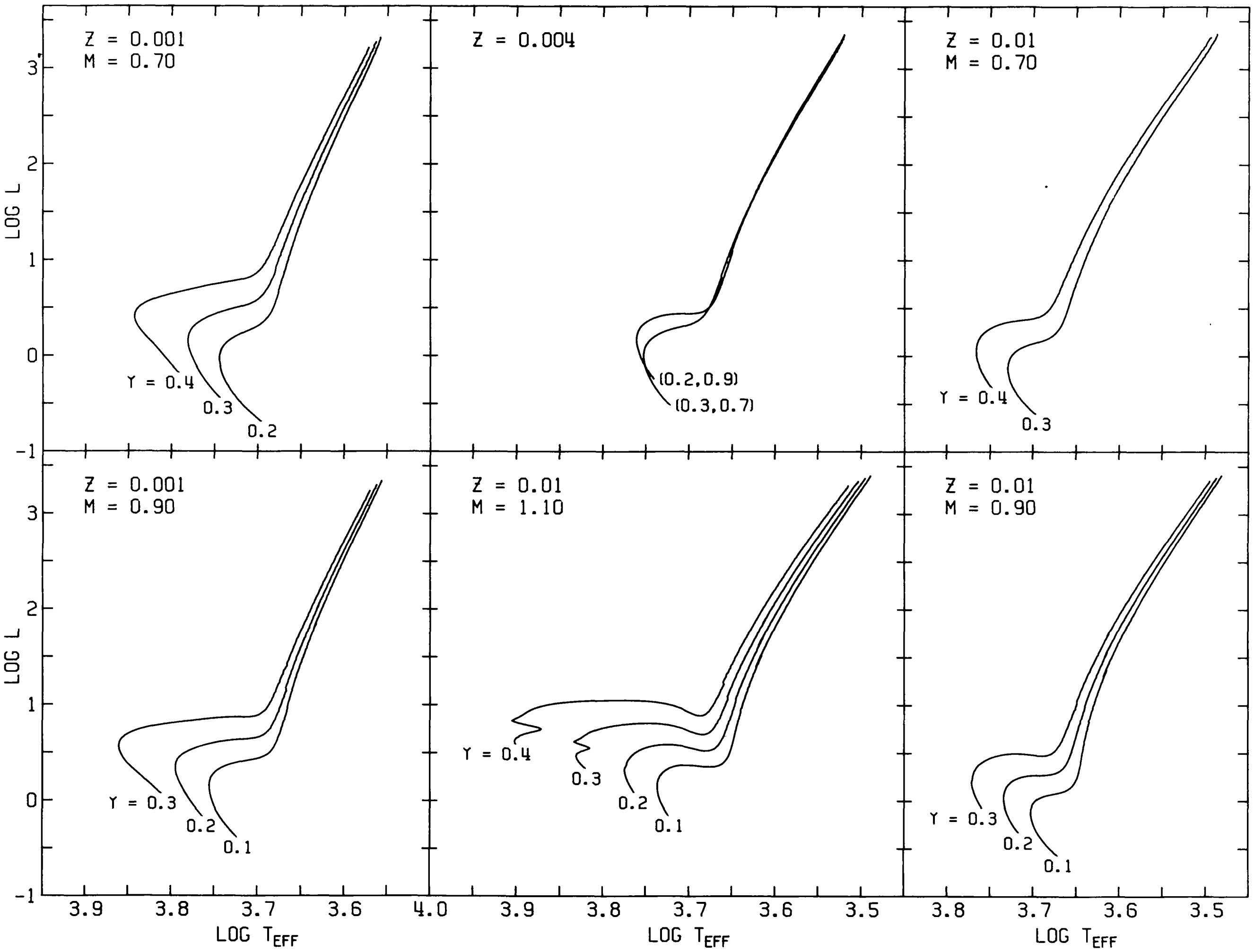

FIG. 1*b*

the reference case $\partial M_c/\partial M$ equals -0.038, again in close agreement with the value of -0.035 from Rood (1972).

c) *Thermal Structure of the Core*

During the red giant phase the thermal structure of the core is governed by a competition between the energy losses due to the assumed neutrino emission and the energy gains due to both the release of gravitational energy from the contraction of the core and the later ignition of helium burning. For masses less than the critical mass for the flash, neutrino emission creates a temperature inversion throughout the inner part of the core. The location $M_r(T_{\max})$ of the resulting temperature maximum gradually shifts outward in mass until the temperature inversion reaches its largest extent shortly before the onset of the flash (see Table 2). Due to the density dependence of the helium-burning reactions, the point of greatest energy generation within the core lies slightly inside the temperature maximum. This effect forces the temperature maximum to move inward once the helium burning becomes important. However, this inward movement slows down considerably as the flash progresses and the *e*-folding time of the instability decreases (Iben 1968*a*). By following the sequence with $(M, Y, Z, F_\nu) = (0.70, 0.20, 0.001, 1.0)$ through the flash, Mengel and Sweigart (1978*a*) found that the location of the temperature maximum did not change appreciably from its value at the end of the present calculations. Therefore the values of $M_r(T_{\max})$ given in Table 2 at $\log L_{\text{He}} = 2$ should probably represent the approximate site of the flash, assuming, of course, the adopted neutrino rates. In most of the present sequences neutrino emission thus produces a noncentral flash.

According to Paczyński and Tremaine (1977), the convective envelope might penetrate inward through the hydrogen-burning shell during the core-cooling phase following the flash, provided the flash is sufficiently noncentral. Judging from their results, one would not predict such mixing for the present sequences, although it cannot be ruled out in a few of the more extreme cases (Mengel and Sweigart 1978*a*).

The temperature distribution within the core at the time when the helium burning is approximately $100\,L_\odot$ is presented in Figure 5 for several sequences with

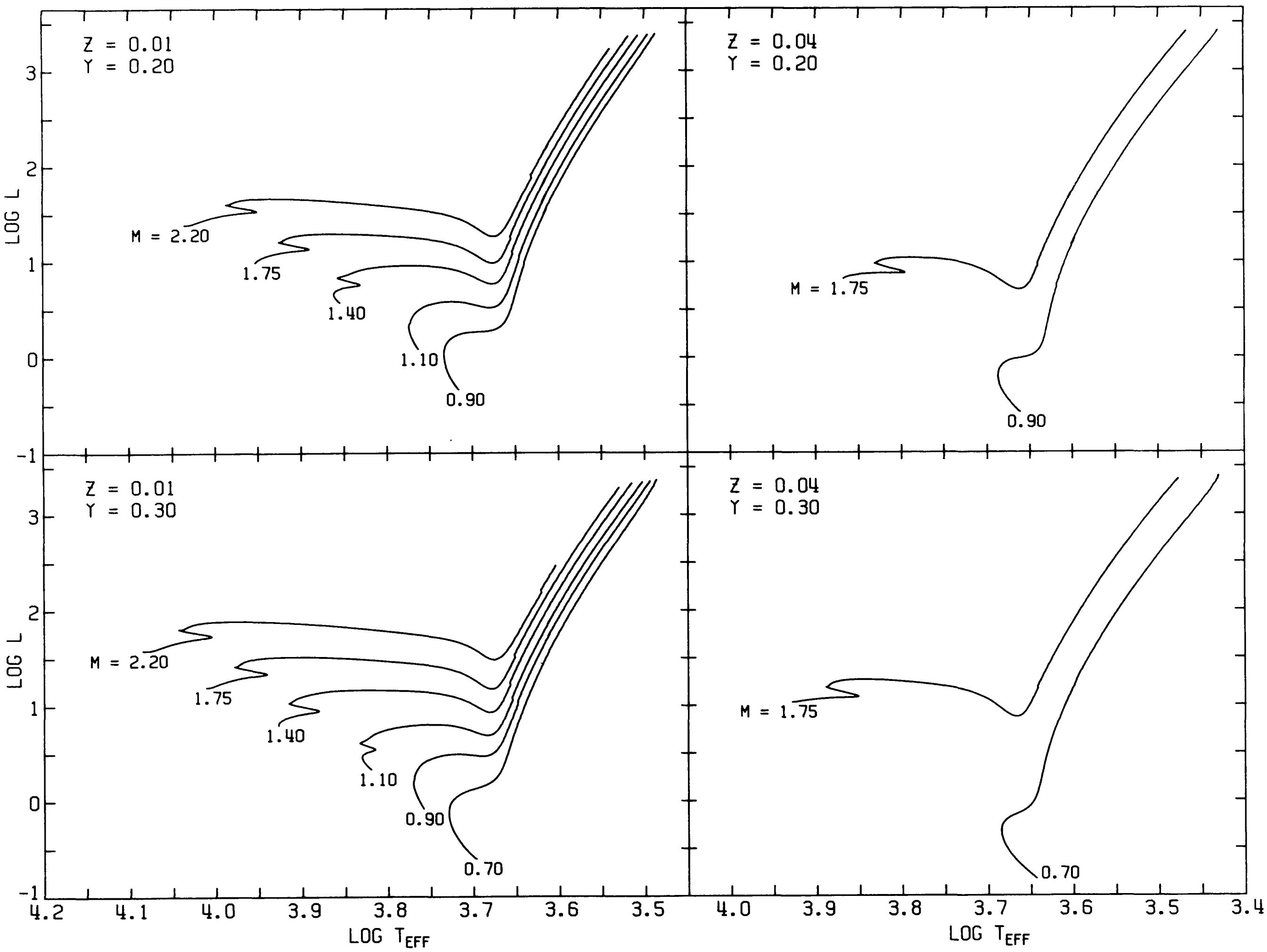

FIG. 1*c*

different values of the helium abundance. As noted previously by Iben (1968*a*), most of the temperature drop occurs in the outer part of the core. For lower values of Y the hydrogen-burning shell advances outward more slowly in mass, and consequently the rate at which the core contracts and liberates gravitational energy is somewhat reduced. Neutrino losses are then relatively more effective in cooling the inner part of the core, thus causing the outward shift of the temperature maximum with decreasing Y. For each of the cases plotted in Figure 5, convection has broken out in the region just exterior to the temperature maximum.

The dependence of the core-temperature distribution on mass is depicted in Figure 6. The curves for 0.70, 1.40, and 1.75 $M_\odot$ are qualitatively similar to those shown in the previous figure. However, the curve for 2.20 $M_\odot$ is markedly different, since this mass is near the critical mass for the flash. In this case helium burning commences at the center, leading to the formation of a convective core. A decrease in M enhances the relative importance of neutrino cooling as compared with the release of gravitational energy. The outward shift of the temperature maximum with decreasing M can be attributed to this effect.

d) *Importance of Neutrino Emission*

The occurrence of neutrino emission through a direct electron-neutrino interaction has not been definitely established at the present time, although its existence seems highly plausible from theoretical considerations. This introduces a basic uncertainty into red giant calculations because of the major role played by neutrino losses in determining the thermal structure of the core.

The effects of varying the rate of neutrino emission have been studied here by constructing three additional sequences with F_ν = 0, 0.5, and 2 for the case (M, Y, Z) = (0.70, 0.30, 0.001). The results, given in Tables 1 and 2, show a reduction of 0.03 $M_\odot$ in M_c when neutrino losses are neglected. This number probably depends somewhat on the specific values of the sequence parameters. Previous calculations without neutrino losses have found a similar reduction in M_c (Eggleton 1968; Iben 1968*a*; Demarque and

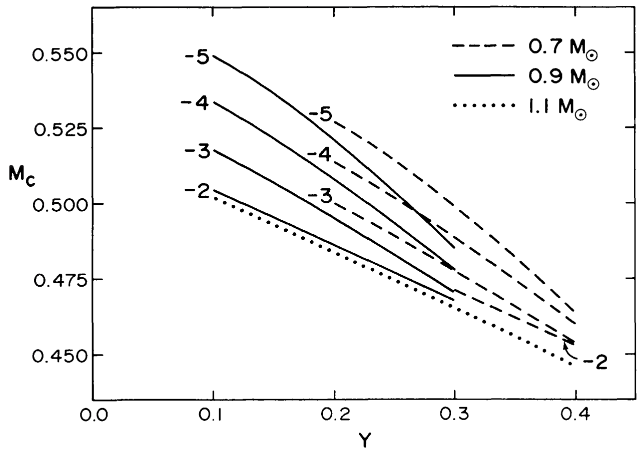

FIG. 2.—Dependence of the core mass M_c on the helium abundance Y for red giant sequences with masses of 0.70, 0.90, and 1.10 $M_\odot$. Each curve is labeled by its value of log Z. M_c is in units of $M_\odot$.

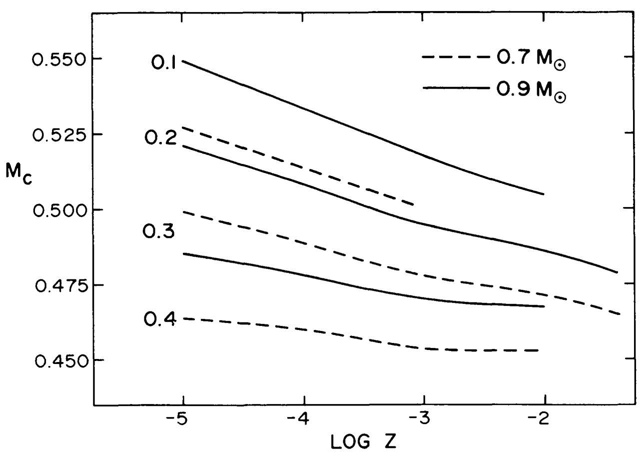

FIG. 3.—Dependence of the core mass M_c on log Z for red giant sequences with masses of 0.70 and 0.90 $M_\odot$. Each curve is labeled by its value of Y. M_c is in units of $M_\odot$.

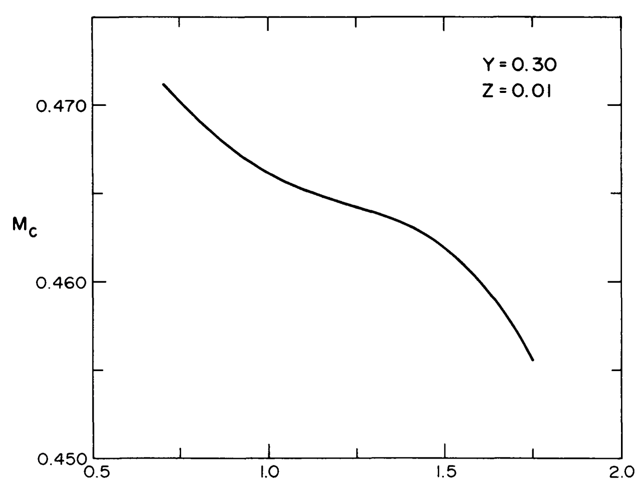

FIG. 4.—Dependence of the core mass M_c on the mass M for red giant sequences with the composition (Y, Z) = (0.30, 0.01). Both M_c and M are in units of $M_\odot$.

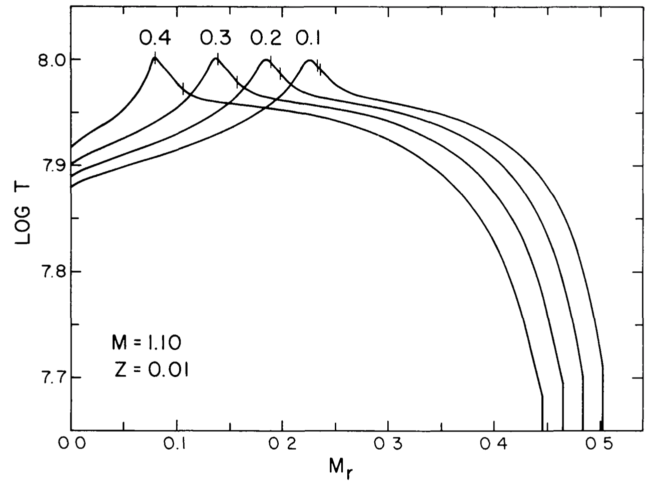

FIG. 5.—Temperature distribution within the core at the onset of the helium-core flash for red giant sequences with (M, Z, F_ν) = (1.10, 0.01, 1.0). Each curve is labeled by its value of the helium abundance Y. The results shown in this figure correspond to the evolutionary phase when $L_{He} \approx 100\, L_\odot$. The tick marks along each curve denote the edges of the convective zone produced by the flash. All curves extend out to the hydrogen-burning shell. M_r is in units of $M_\odot$.

Mengel 1971). A change of 0.03 $M_\odot$ in M_c significantly influences the structure of horizontal-branch models (Demarque and Mengel 1972; Sweigart and Gross 1976).

The location of the flash site is particularly sensitive to changes in F_ν, as is indicated in Figure 7. Decreasing F_ν shifts the temperature maximum inward appreciably, until a central flash results. A minor temperature inversion occurred briefly along the $F_\nu = 0$ sequence

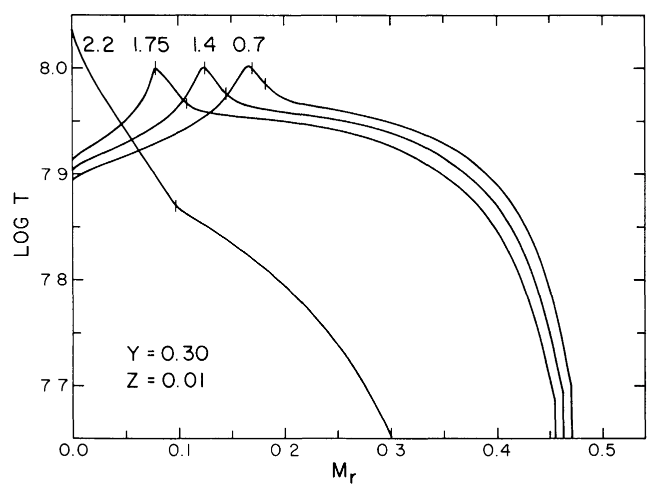

FIG. 6.—Temperature distribution within the core at the onset of the helium-core flash for red giant sequences with (Y, Z, F_ν) = (0.30, 0.01, 1.0). Each curve is labeled by its value of the mass M. The results shown in this figure correspond to the evolutionary phase when $L_{He} \approx 100\, L_\odot$. The tick marks along each curve denote the edges of the convective zone produced by the flash. In the 2.20 $M_\odot$ case a convective core has formed. The curves for 0.70, 1.40, and 1.75 $M_\odot$ extend out to the hydrogen-burning shell. M_r is in units of $M_\odot$.

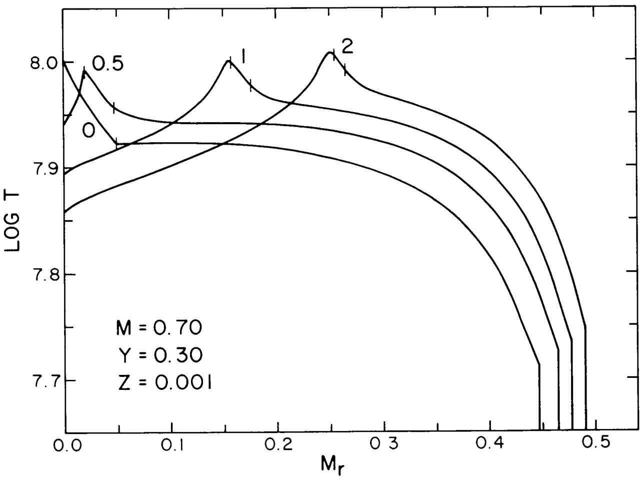

FIG. 7.—Temperature distribution within the core at the onset of the helium-core flash for red giant sequences with $(M, Y, Z) = (0.70, 0.30, 0.001)$. Each curve is labeled by its value of the factor F_ν by which the neutrino emission rates of Beaudet, Petrosian, and Salpeter (1967) have been multiplied in constructing the sequence. The results shown in this figure correspond to the evolutionary phase when $L_{He} \approx 100\ L_\odot$. The tick marks along each curve denote the edges of the convective zone produced by the flash. In the $F_\nu = 0$ case a convective core has formed. All curves extend out to the hydrogen-burning shell. M_r is in units of $M_\odot$.

(see Table 2). Eggleton (1968) has reported a similar effect.

The rates of neutrino emission used in red giant calculations (including the present one) have generally been taken from Beaudet, Petrosian, and Salpeter (1967) and are therefore based on the charged-current theory for the weak interaction (Feynman and Gell-Mann 1958). More recent developments have suggested that neutral currents can also contribute to this interaction (Weinberg 1967; Salam 1968). If the gauge theory of Weinberg (1967) and Salam (1968) is in fact the correct description of the neutral-current interactions, then the rates of neutrino emission by the plasma, photoneutrino, and pair annihilation processes have to be modified by amounts that depend on the value of the Weinberg angle (Dicus 1972). In the degenerate helium cores of red giant stars, neutrino losses arise primarily from the plasma process. Using the available experimental evidence on the Weinberg angle, Ramadurai (1976) showed that the neutral-current interactions enhance the rate of the plasma process by a factor of 1.48 over the corresponding rate of Beaudet, Petrosian, and Salpeter (1967). The consequences of an overall increase in the rate of neutrino emission can be estimated from the sequences with $(M, Y, Z) = (0.70, 0.30, 0.001)$. For these parameter values, a change in F_ν from 1 to 1.48 increases M_c by $0.007\ M_\odot$ and shifts the flash site outward from $0.156\ M_\odot$ to $0.202\ M_\odot$. These results are in reasonable agreement with those obtained by Ramadurai (1976), who found an increase in M_c of $0.004\ M_\odot$ and an outward shift of the flash site from $0.150\ M_\odot$ to $0.193\ M_\odot$ when the effects of the neutral-current interactions were included in red giant sequences for $(M, Y, Z) = (0.9192, 0.28, 0.02)$.

Variations in the rate of neutrino emission also affect the surface luminosity at the onset of the helium-core flash. Without neutrino losses the value of $\log L$ at the flash is reduced by 0.16, while an increase in F_ν from 1 to 1.48 raises $\log L$ by 0.04 (see Table 1).

e) *Interior Structure*

The general features of the interior structure of red giant stars have been extensively discussed elsewhere (Iben 1967, 1968*a*; Rood 1972), and hence only a few remarks will be made here. The drop in the surface luminosity, mentioned in § III, is correlated with the composition, as an inspection of Table 1 demonstrates. A decrease in Y or an increase in Z enhances the size of the drop $\Delta \log L_d$ and lowers the luminosity $\log L_d$ at which it occurs. Such composition changes favor a deeper penetration of the convective envelope during the subgiant-branch phase. The hydrogen-burning shell then encounters a more pronounced hydrogen discontinuity at an earlier point in the evolution, thus producing this correlation. The hesitation in the rate of evolution associated with the luminosity drop also has a stronger effect on the luminosity function for the low-Y or high-Z compositions (Rood 1972; Sweigart 1978*a*). Furthermore, a deeper penetration of the convective envelope causes a greater enrichment ΔY_s in the surface helium abundance.

Most of the mass exterior to the hydrogen-burning shell is contained within the convective envelope. Over the range of parameters considered here, the temperature at the base of the convective envelope is only about 1 to 2×10^6 K (see Tables 3–7). The radiative region separating the convective envelope from the top of the hydrogen-burning shell spans an interval of roughly five orders of magnitude in pressure. The mixing of material from the base of this region into the convective envelope is necessary if the products of partial CNO processing are to be observed at the surface (Mengel and Sweigart 1978*b*).

V. SUMMARY

This paper has presented the results of some extensive stellar-evolution calculations for stars ascending the red-giant branch for the first time. The data compiled in Tables 1–7 for these red giant sequences should permit one to reexamine a number of interesting astrophysical problems in more detail than previously possible.

The main conclusions, which are in good agreement with most previous investigations, can be summarized as follows:

1. The red giant branch shifts to higher effective temperatures with increases in Y or M or decreases in Z. The present sequences show the well-known reduction in the slope of the red giant branch at the larger Z values.

2. The luminosity L_f at the onset of the helium-core flash is reduced by increases (decreases) in $Y(Z)$.

There is only a mild dependence of L_f on M until one approaches the critical mass below which the flash takes place and above which helium burning begins under nondegenerate conditions.

3. The critical mass for the flash is lowered by increases (decreases) in $Y(Z)$.

4. An increase in Y, Z, or M reduces the core mass M_c at the onset of the flash. For the case $(M, Y, Z, F_\nu) = (0.80, 0.30, 0.001, 1.0)$, M_c equals 0.474 $M_\odot$. In the immediate neighborhood of these parameter values, the various derivatives of M_c are given by

$$\partial M_c/\partial Y = -0.24\,, \quad \partial M_c/\partial \log Z = -0.007\,,$$

$$\partial M_c/\partial M = -0.038\,. \qquad (9)$$

There is a significant dependence of these derivatives on composition and mass.

5. When neutrino emission is neglected, M_c decreases by 0.03 $M_\odot$ and $\log L$ at the flash decreases by 0.16. The additional neutrino emission which could result from neutral-current interactions (Weinberg 1967; Salam 1968) increases M_c by 0.007 $M_\odot$.

6. The location at which the flash begins within the degenerate core shifts outward in mass with decreases in Y or M or increases in the rate of neutrino emission.

7. For many of the present sequences a temporary period of decreasing luminosity occurs during the early part of the red giant phase. The size of this luminosity drop is enhanced and the luminosity at which it occurs is lowered by decreases (increases) in $Y(Z)$.

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