Software Manual

THE VICTORIA-REGINA STELLAR MODELS

This manual is intended as a guide to the software accompanying the Victoria-Regina grids of stellar models described in "The Victoria-Regina Stellar Models: Evolutionary Tracks and Isochrones for a Wide Range in Mass and Metallicity that Allow for Empirically Constrained Amounts of Convective Core Overshooting" by VandenBerg, D.A., Bergbusch, P.A., & Dowler, P.D., 2006 ApJS, in press. All the software discussed in this manual is written in FORTRAN 77 (or is at least compatible with it) and has been tested on a variety of operating systems and FORTRAN compilers.

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A. BRIEF DESCRIPTION OF THE MODEL GRIDS

The Victoria–Regina stellar models are comprised of seventy-two grids of stellar evolutionary tracks accompanied by complementary zero-age horizontal branches. Sixty of the grids encompass and extend the sets of models reported by VandenBerg et al. (2000, ApJ, 532, 430) for twenty iron abundance values over the range $-2.31 \leq$ [Fe/H] ≤ 0.00 with 3 α-element enhancements at each iron abundance (specifically, $[\alpha/\mathrm{Fe}] = 0.0$, 0.3, and 0.6). These grids extend to sufficiently high masses (up to $\approx 2.2\mathcal{M}_\odot$) so that isochrones may be computed for ages as low as 1 Gyr. The remaining grids contain tracks for masses from 0.4 to $4.0\mathcal{M}_\odot$ and 12 [Fe/H] values between -0.60 and $+0.49$ (assuming solar metal-to-hydrogen number abundance ratios). In these grids, isochrones may be calculated for ages down to ≈ 0.2 Gyr.

These models do not treat gravitational settling or radiative acceleration processes. However, the extent of convective core overshooting has been modelled using a parameterized version of the Roxburgh (1989, A&A, 211, 361) criterion, in which the value of the free parameter at a given mass and its dependence on mass have been determined from analyses of binary star data and the observed color-magnitude diagrams for several open clusters.

Normalization: The models have been normalized to the Sun, for which $L = 3.845 \times 10^{33}$erg/s, $T_{\mathrm{eff}} = 5780$ K, $M_{bol} = 4.75$, $B - V = 0.64$, and $M_V = 4.82$ (i.e., $BC_V = -0.07$) are assumed.

B. OVERVIEW OF THE SOFTWARE

The Victoria–Regina grids of evolutionary tracks are presented in the form of "equivalent evolutionary phase" files identified by the file extension `.eep`. They can be processed into isochrones on the $\log L$– $\log T_{\mathrm{eff}}$ by means of the FORTRAN program **vriso.f**. These "theorists" isochrones can then be processed further onto the observers' magnitude–colour index plane with the program **vrcmd.f**, or into isochrone probability functions, luminosity functions, or colour functions via **vripf.f**. The zero-age horizontal branch models included with the grids are in files prefixed with `zahb` and the file extension `.data`. They can be transformed to the observers' magnitude–colour index plane by means of the program **vrzahb.f**.

The archive of software includes the main programs vriso.f, vrcmd.f, vripf.f, and vrzahb.f, as well as three subroutine libraries vrakm.f, vrcolor.f, and vrutil.f. The Akima spline routines used in the isochrone interpolations are contained in vrakm.f, the colour–T_{eff} transformations are in vrcolor.f, and a few I/O routines used by all the main programs are contained in vrutil.f. Executable versions of the main programs are made by compiling them and linking them to the appropriate subroutine libraries.

To make an executable version of vriso.f, it must be compiled and linked with vrakm.f and vrutil.f. On my SUN Ultra 10 this is accomplished by typing

```
>f77 -o $HBIN/vriso vriso.f vrakm.f vrutil.f
```

with the result that an executable named vriso is placed in my personal binary directory `$HBIN`. Similarly, the other programs are compiled with the following dependencies:

```
>f77 -o $HBIN/vrcmd vrcmd.f vrakm.f vrcolor.f vrutil.f
>f77 -o $HBIN/vripf vripf.f vrakm.f vrcolor.f vrutil.f
>f77 -o $HBIN/vrzahb vrzahb.f vrcolor.f vrutil.f
```

Unpacking the Model Grids: The model grids are archived as (unix) compressed tar files. Each one contains the `.eep` files that tabulate the evolutionary tracks, the `zahb*.data` files that tabulate the raw zero-age horizontal branch models, the colour–$T_{\rm eff}$ transformation files `bvrihi.data`, `bvrilo.data`, `uvbyhi.data`, `uvbylo.data`, and a template `VRISO.OPT` file required by the program vriso.f. You will probably want to unpack each compressed tarfile (e.g., `vr0a.tar.Z`) into its own directory — if you do, each directory will have all the files necessary for the accompanying software to work. Before unpacking a grid, create a new directory for it, move the respective tar file into the new directory and untar it.

Compressed Tar File	α/[Fe]	Number of Grids	[Fe/H]
vr0a.tar.Z	0.0	20	$-2.31 \leq 0.00$
vr2a.tar.Z	0.3	20	$-2.31 \leq 0.00$
vr4a.tar.Z	0.6	20	$-2.31 \leq 0.00$
vrss.tar.Z	Scaled Solar	12	$-0.60 \leq +0.49$

C. DESCRIPTIONS OF THE MAIN PROGRAMS

VRISO This program generates fundamental isochrones directly from a grid of evolutionary tracks. In addition to the `.eep` files containing the tracks, the user is prompted for a `.opt` file (the default is `VRISO.OPT`) that instructs the program

1. whether to use linear or Akima spline interpolation (or some combination of the two methods) for each of the age–mass, $\log L$–mass, and $\log T_{\rm eff}$–mass relations.
2. whether to use the default age values built into the software, the ages specified within the options file itself, or whether to prompt the user for ages interactively.

The user may configure the option file(s) to suit their preferred method of operation, and such files can have arbitrary names. The default output file has the same filename as the input `.eep` file but with the file extension `.iso`.

The following example shows a typical run of `vriso`. At the prompt `>`, the user types the command `vriso` and is asked for an input EEP–file (here it's `vr0a-061.eep`). The program prints a table on the screen showing the number of tracks, their masses, the age of the youngest model on each track, and the model numbers that correspond to the seven primary EEP points. In this example, a 0.27 Gyr isochrone will reach all the way down to $0.5\mathcal{M}_\odot$.

```
>vriso
                      EEP Tracks file:vr0a-061.eep

                          ZAMS              Primary EEP Models
        Track     Mass     Ages  ZAMS MSTO BLHK HZGP BRGB GBPS RGBT
           1     2.400    0.006     1  221  328  618  806  955
           2     2.200    0.008     1  222  330  579  769  943
           3     2.000    0.010     1  210  318  533  706  931
           4     1.900    0.011     1  207  314  551  699  944
           5     1.800    0.013     1  199  306  530  666  938
           6     1.700    0.013     1  195  302  508  594  701  872
           7     1.600    0.015     1  182  286  467  563  659  810
           8     1.500    0.018     1  159  258  440  554  634  802
           9     1.400    0.020     1  127  214  364  447  539  723
          10     1.300    0.023     1   89  150  295  366  463  654
          11     1.200    0.028     1   55   76  197  263  358  564
          12     1.165    0.028     1   44   50  163  227  324  534
          13     1.100    0.034     1   42   46  158  214  314  520
          14     1.000    0.043     1   45       145  211  292  440
          15     0.900    0.058     1   57       137  195  277  431
          16     0.800    0.084     1   79       144  193  276  436
          17     0.700    0.123     1  106       158  211
          18     0.600    0.192     1  150       158
          19     0.500    0.270     1
```

The program then prompts for an output file name. If you respond by hitting `<return>`, it will have the default file name shown; otherwise type in a name that you want. Similarly, if you have created your own `.opt` file, you can enter it at the next prompt. The program then prints the interpolation options set in the `.opt` file and a list of the ages chosen.

```
                   Default Isochrone file [vr0a-061.iso]:

                   Default Options File [VRISO.OPT]:

                   INTERPOLATION OPTIONS

         AM = 1.00         Age-Mass interpolant; 1=spline, 0=linear
         LM = 1.00  Luminosity-Mass interpolant; 1=spline, 0=linear
         TM = 1.00 Temperature-Mass interpolant; 1=spline, 0=linear

                   Interpolating  8.00 Gyr Isochrone.
                   Interpolating 10.00 Gyr Isochrone.
                   Interpolating 12.00 Gyr Isochrone.
                   Interpolating 14.00 Gyr Isochrone.
                   Interpolating 16.00 Gyr Isochrone.
                   Interpolating 18.00 Gyr Isochrone.
>
```

In this example, pure spline interpolation was chosen for the age–mass, the $\log L$–mass, and the $\log T_{\rm eff}$–mass interpolation relations.

If you opt for entering the ages interactively by setting line 3 in the `.opt` file to a value other than 0 or 1, then `vriso` will write prompts like those shown below to the screen.

```
                   Isochrone Age(Gyr) Type E<ret> to exit: 8
                   Isochrone Age(Gyr) Type E<ret> to exit: 10
                   Isochrone Age(Gyr) Type E<ret> to exit: 12
                   Isochrone Age(Gyr) Type E<ret> to exit: 14
                   Isochrone Age(Gyr) Type E<ret> to exit: 16
                   Isochrone Age(Gyr) Type E<ret> to exit: 18
                   Isochrone Age(Gyr) Type E<ret> to exit: e


                   Interpolating  8.00 Gyr Isochrone.
                   Interpolating 10.00 Gyr Isochrone.
                   Interpolating 12.00 Gyr Isochrone.
                   Interpolating 14.00 Gyr Isochrone.
                   Interpolating 16.00 Gyr Isochrone.
                   Interpolating 18.00 Gyr Isochrone.
>
```

VRCMD This program transforms the fundamental isochrones to the observers' plane so that they can be compared dirctly to colour-magnitude diagrams. The input files are the `.iso` file generated by vriso, as well as the colour–$T_{\rm eff}$ transformation files **`bvrihi.data`**, **`bvrilo.data`**, **`uvbyhi.data`**, **`uvbylo.data`**.

The default output file has the same filename as the input **`.iso`** file but with the file extension **`.cmd`**. In addition to the abundance parameters and the fundamental quantities mass, $M_{\rm bol}$, $\log T_{\rm eff}$, and $\log g$, the output files (see p. 16) tabulate the V/y magnitude ($V = y$ is assumed) and the colour indices $B - V$, $V - R$, $V - I$, $b - y$, m_1, and c_1 at 250 evenly spaced points along each isochrone.

```
>vrcmd
                    Input ISOCHRONE File: vr0a-061.iso
                    Output Fiducial File: vr0a-061.cmd

          6 ISOCHRONES   [Fe/H] = -0.61
          Color grid interpolated to [FE/H] = -0.61
          Color grid interpolated to [FE/H] = -0.61

                    Age, NPTS:   8.00   329
                    Age, NPTS:  10.00   322
                    Age, NPTS:  12.00   317
                    Age, NPTS:  14.00   313
                    Age, NPTS:  16.00   310
                    Age, NPTS:  18.00   307
>
```

VRIPF This program transforms the fundamental isochrones (in `.iso` files) into isochrone probablility functions (IPFs) and/or luminosity functions (LFs) and/or colour functions (CFs). The input files are the `.iso` file generated by vriso and the colour–$T_{\rm eff}$ transformation files `bvrihi.data`, `bvrilo.data`.

The user is prompted for a magnitude bandpass (B, V, R, or I), a colour index ($B-V$, $B-R$, $B-I$, $V-R$, or $V-I$, as well as three values of the mass spectrum exponent x. For each of the three output file options (`.ipf`, `.lfn`, or `.cfn`), the user is then prompted to specify bin widths. For IPFs, bin widths are specified in terms of "distance" along the isochrone — 0.2 mag widths are typical. For LFs, 0.2 mag bins are typical; for Cfs, 0.02 mag bins are useful.

```
>vripf
                    Input ISOCHRONE File: vr0a-061.iso

                    Available Magnitudes & Colour Indices

                            1) B           1) B-V
                            2) V           2) B-R
                            3) R           3) B-I
                            4) I           4) V-R
                                           5) V-I

       Select a Magnitude(1-4) & Colour Index (1-5): 4 3

       Power law mass spectrum exponent (1+x)
                     Enter three values of x: -0.5 0.0 0.5

                    Do you want an IPF? [Y/N] y
                    Input IPF bin width: 0.2
                    Do you want a LF? [Y/N] y
                    Input LF bin width: 0.2
                    Do you want a CF? [Y/N] y
                    Input CF bin width: 0.02

          6 ISOCHRONES   [Fe/H] = -0.61
          Color grid interpolated to [FE/H] = -0.61

                    Age, NPTS:   8.00   329
                    Age, NPTS:  10.00   322
                    Age, NPTS:  12.00   317
                    Age, NPTS:  14.00   313
                    Age, NPTS:  16.00   310
                    Age, NPTS:  18.00   307
>
```

The output file(s) (see p. 17) contain tabulations of magnitudes and colour indices in the specified passband and colour index as well as the differential and cumulative distribution functions at the bin centres.

VRZAHB This program performs the transformation of the fundamental ZAHBs onto the observers' plane. The tabulations are identical to those in a `.cmd` file.

```
>vrzahb
                Input zahb*.data File: zahb0a-061.data

                Color grid interpolated to [FE/H] = -0.61
                Color grid interpolated to [FE/H] = -0.61
>
```

D. INPUT FILES

TO VRISO, the `.eep` files The format of a typical `.eep` file is shown below. For each track, the line entries are 1) the model number, 2) $\log L/L_\odot$, 3) $\log T_{\rm eff}$, 4) age increment in Gyr (except for model 1, which gives the contraction age at the ZAMS), 5) central hydrogen content, 6) $d(\log L)/d(\log t)$, and 7) $d(\log T_{\rm eff})/d(\log t)$.

```
TRACKS      18
[Fe/H]      -1.009
[alpha/Fe]  +0.3
Z           3.380D-03   Z = 2.000D-03 + alpha-element enhancement
X           0.757620
Y           0.239000
ALPHA(mlt)  1.89

 Mass  Npts  Match    D(age)    D(log Teff)   Zage      Primary EEPs
2.200   925                                  0.0071  1199299649777 925
  1  1.532293 4.089855 7.1000D-03 0.7554  4.2065162D-03 -5.9255999D-03
  2  1.532429 4.089269 1.6295D-03 0.7545  2.9246640D-03 -6.8292727D-03
  3  1.532691 4.088533 2.2748D-03 0.7533  1.4879255D-03 -7.8421365D-03
  4  1.533059 4.087783 2.6329D-03 0.7518  4.2368634D-03 -8.2013753D-03
  5  1.532699 4.086956 3.0213D-03 0.7503  5.4559847D-03 -8.8729513D-03
  .       .        .         .         .          .              .
  .       .        .         .         .          .              .
  .       .        .         .         .          .              .
922  2.585755 3.669352 4.3474D-06 0.4515  1.3609228D+01 -5.2487380D-01
923  2.585760 3.669352 4.3474D-06 0.4515 -1.5933669D+01  1.3871665D+00
924  2.585676 3.669359 4.3474D-06 0.4515 -4.7051187D+01  3.4759499D+00
925  2.585506 3.669371 4.3474D-06 0.4515 -7.8168705D+01  5.5647334D+00

 Mass  Npts  Match    D(age)    D(log Teff)   Zage      Primary EEPs
2.000   916                                  0.0090  1191293602749 916
  1  1.376188 4.059259 9.0000D-03 0.7554  9.7216255D-04 -3.6463100D-03
  2  1.376219 4.058990 1.4285D-03 0.7548  2.3108369D-03 -4.0028861D-03
  3  1.376630 4.058552 2.8571D-03 0.7535  4.5111398D-03 -4.5889701D-03
  .       .        .         .         .          .              .
  .       .        .         .         .          .              .
  .       .        .         .         .          .              .

 Mass  Npts  Match    D(age)    D(log Teff)   Zage      Primary EEPs
0.600   173                                  0.1787  1140   173
  1 -0.948990 3.656905 1.7870D-01 0.7554  6.2870184D-03 -2.4095576D-03
  2 -0.948873 3.656860 6.0220D-03 0.7553  6.3810406D-03 -2.3941318D-03
  3 -0.947972 3.656652 5.4198D-02 0.7545  7.1108853D-03 -2.2743900D-03
```

VRISO OPTIONS, the `.opt` files A `.opt` file begins with a dummy header line that identifies it as such (in the example below `vriso.opt`).

The second line, read in `3F5.2` format, defines the nature of the three interpolation relations, age-mass, $\log L$-mass, and $\log T_{\rm eff}$-mass. A value of `1.00` indicates pure spline interpolation while `0.00` means purely linear interpolation. Intermediate values result in weighted averaging of the two interpolation results (e.g. 0.50 means a straight average of the two interpolation methods).

Akima spline interpolation is recommended for all three interpolation relations. However, *in a few of the grids*, isochrones in the age range of ≈ 2.6–3.4 Gyr derived via spline interpolation exhibit gaps in the point distribution over the transition from the blue hook (the blueward excursion that occurs following core hydrogen exhaustion in stars with convective cores) to the base of the red giant branch. As illustrated in Fig. 7 of Vandenberg, Bergbusch, & Dowler (2006 ApJS, in press), just switching to linear interpolation for the age-mass relation solves the problem with very little impact on the quality of the isochrones.

The third line, read in `I2` format, is the switch that controls the way ages are supplied to the program. A value of `0` means that the ages indicated subsequently in the `.opt` file are to be used, while a value of `1` means that the default list of ages 0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 0.75, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2, 2.4, 2.6, 2.7, 2.8, 2.9, 3.0, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.8, 4.2, 4.6, 5, 6, 7, 8, 10, 12, 14, 16, and 18 Gyr are to be used. Any other value causes `vriso` to prompt the user for ages directly from the keyboard.

When the entry on the third line of the `.opt` file is zero, vriso expects to read ten more lines from the file. These lines, read in under `F5.2, F6.2, F5.2` format, specify the desired set of ages. The first entry in each line tells the program the initial age in a range, the second entry gives the final age in that range, and the third entry gives the age increment.

If the first entry in a row is `0.00` input from the list of ages is terminated. In the example, the last age processed would be 18 Gyr, but if the first entry on line 7 had been `0.00` instead of `6.00`, the last age processed would have been 6 Gyr.

```
vriso.opt file
 1.00 1.00 1.00
 0
 0.10  1.00 0.10
 1.00  3.20 0.20
 3.20  6.00 0.40
 6.00  8.00 1.00
 8.00 18.00 2.00
 0.00  0.00 0.00
 0.00  0.00 0.00
 0.00  0.00 0.00
 0.00  0.00 0.00
 0.00  0.00 0.00
```

Colour–$T_{\rm eff}$ Relations There are currently four files containing the fiducial data for these relations, `bvrihi.data`, `bvrilo.data`, `uvbyhi.data`, and `uvbylo.data`. The example shown is from `bvrihi.data`.

```
 34 TEFF'S        7 LOG G'S       6 FE/H'S        4 INDICES  (1 Sept 2005)
 4000. 4250. 4500. 4750. 5000. 5250. 5500. 6000. 6500. 7000. 7500. 8000. 8500.
 9000. 9500.10000.11000.12000.13000.14000.15000.16000.17000.19000.21000.23000.
25000.27000.29000.31000.33000.35000.37500.40000.
 2.0 2.5 3.0 3.5 4.0 4.5 5.0
 [Fe/H] = -3.00: Color Index = B-V
 1.258 1.112 0.959 0.810 0.677 0.572 0.506 0.380 0.270 0.172 0.093 0.021-0.011
-0.026-0.035-0.044-0.076-0.094-0.111-0.106-0.139-0.151-0.161-0.180-0.209-0.226
-0.241-0.243-0.269-0.272-0.286-0.288-0.296-0.299
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
 1.349 1.175 1.013 0.867 0.742 0.641 0.570 0.453 0.366 0.302 0.262 0.230 0.172
 0.119 0.082 0.049-0.005-0.043-0.069-0.090-0.107-0.123-0.138-0.164-0.186-0.206
-0.224-0.240-0.256-0.270-0.282-0.291-0.297-0.301
 [Fe/H] = -2.00: Color Index = B-V
 1.238 1.094 0.957 0.830 0.715 0.615 0.533 0.397 0.284 0.185 0.103 0.021-0.012
-0.027-0.036-0.045-0.077-0.095-0.111-0.106-0.140-0.152-0.162-0.180-0.209-0.226
-0.240-0.258-0.269-0.280-0.287-0.294-0.297-0.300
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
 1.329 1.150 1.009 0.895 0.798 0.707 0.613 0.476 0.380 0.311 0.268 0.217 0.172
 0.119 0.082 0.048-0.007-0.044-0.070-0.090-0.108-0.124-0.138-0.164-0.187-0.207
-0.224-0.241-0.256-0.270-0.282-0.291-0.298-0.302
 [Fe/H] = -1.00: Color Index = B-V
 1.223 1.117 1.004 0.890 0.781 0.681 0.595 0.430 0.309 0.210 0.124 0.027-0.011
-0.029-0.038-0.047-0.080-0.097-0.113-0.107-0.142-0.154-0.164-0.180-0.210-0.224
-0.237-0.257-0.268-0.272-0.287-0.290-0.298-0.302
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
 1.314 1.157 1.022 0.906 0.807 0.723 0.651 0.520 0.415 0.332 0.276 0.223 0.176
 0.121 0.081 0.046-0.010-0.048-0.073-0.093-0.110-0.126-0.140-0.166-0.188-0.208
-0.225-0.241-0.255-0.269-0.282-0.291-0.299-0.303
 [Fe/H] = -0.50: Color Index = B-V
 1.320 1.206 1.087 0.967 0.851 0.743 0.648 0.464 0.329 0.229 0.143 0.035-0.009
-0.030-0.041-0.050-0.083-0.100-0.117-0.110-0.145-0.156-0.167-0.181-0.211-0.223
-0.236-0.256-0.267-0.271-0.286-0.290-0.299-0.304
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
 1.398 1.228 1.082 0.956 0.847 0.753 0.670 0.548 0.434 0.346 0.287 0.231 0.181
 0.122 0.081 0.045-0.013-0.051-0.077-0.096-0.114-0.129-0.143-0.168-0.191-0.210
-0.226-0.241-0.255-0.269-0.281-0.291-0.299-0.304
 [Fe/H] =  0.00: Color Index = B-V
 1.473 1.352 1.228 1.103 0.981 0.865 0.757 0.512 0.360 0.256 0.167 0.047-0.006
-0.031-0.045-0.055-0.090-0.107-0.123-0.114-0.150-0.161-0.170-0.181-0.211-0.222
-0.233-0.254-0.264-0.267-0.283-0.287-0.295-0.301
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
```

```
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
 1.413 1.283 1.154 1.030 0.916 0.815 0.730 0.578 0.459 0.367 0.303 0.245 0.189
 0.126 0.081 0.042-0.018-0.057-0.083-0.103-0.119-0.135-0.148-0.173-0.194-0.212
-0.228-0.241-0.254-0.267-0.279-0.287-0.294-0.300
 [Fe/H] =  0.30: Color Index = B-V
 1.528 1.418 1.304 1.186 1.067 0.947 0.829 0.558 0.388 0.270 0.174 0.058-0.002
-0.032-0.048-0.060-0.096-0.114-0.129-0.143-0.155-0.165-0.173-0.201-0.211-0.221
-0.231-0.253-0.262-0.275-0.282-0.290-0.298-0.305
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
 1.438 1.299 1.175 1.064 0.963 0.871 0.787 0.611 0.481 0.384 0.318 0.265 0.196
 0.129 0.082 0.041-0.022-0.062-0.088-0.108-0.125-0.140-0.153-0.177-0.197-0.215
-0.229-0.241-0.253-0.266-0.277-0.286-0.296-0.304
 [Fe/H] = -3.00: Color Index = V-R
 0.754 0.652 0.567 0.497 0.438 0.389 0.346 0.272 0.201 0.137 0.084 0.037 0.020
 0.013 0.009 0.004-0.016-0.026-0.035-0.030-0.051-0.057-0.062-0.072-0.090-0.098
-0.106-0.106-0.122-0.121-0.132-0.130-0.135-0.134
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
 [Fe/H] = -3.00: Color Index = V-I
 1.492 1.305 1.149 1.020 0.912 0.820 0.737 0.589 0.450 0.323 0.217 0.127 0.080
 0.059 0.044 0.030-0.020-0.046-0.069-0.066-0.109-0.125-0.139-0.163-0.201-0.222
-0.242-0.244-0.276-0.277-0.297-0.294-0.304-0.301
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
 [Fe/H] = -3.00: Color Index = BCv
-0.897-0.676-0.511-0.392-0.305-0.240-0.183-0.100-0.035 0.018 0.033 0.013-0.051
-0.146-0.254-0.363-0.561-0.764-0.956-1.147-1.305-1.463-1.612-1.887-2.142-2.358
-2.534-2.652-2.864-2.980-3.156-3.290-3.485-3.680
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
 [Fe/H] =  0.30: Color Index = BCv
-0.997-0.725-0.517-0.361-0.245-0.157-0.086 0.010 0.086 0.118 0.120 0.090 0.028
-0.058-0.152-0.250-0.431-0.624-0.812-0.990-1.156-1.310-1.453-1.731-1.960-2.169
-2.356-2.570-2.722-2.911-3.058-3.229-3.420-3.618
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
   .     .     .     .     .     .     .     .     .     .     .     .     .
-1.020-0.791-0.592-0.424-0.287-0.183-0.113-0.026 0.013 0.026 0.026 0.017 0.003
-0.053-0.132-0.229-0.433-0.631-0.819-1.000-1.174-1.341-1.500-1.794-2.054-2.284
-2.486-2.666-2.830-2.977-3.113-3.249-3.427-3.617
```

To VRZAHB, the `zahb*.zahb` files The format specification for each model line is `I3,F6.3,F9.6,F7.4,F8.6,F6.3,F5.3,F6.3,F7.4,D11.4,F6.4, F6.4`. The entries corresponding to each format specification are 1) the model number, 2) the mass, 3) $\log L/L_\odot$, 4) $M_{\rm bol}$, 5) $\log T_{\rm eff}$, 6) $\log g$, 7) $\log T_{\rm C}$, 8) $\log \rho_{\rm C}$, 9) age, 11) surface hydrogen abundance, & 12) He core mass.

```
MODELS     28
[Fe/H]     -1.009
[alpha/Fe] +0.0
Z          2.000D-03   Z = 2.000D-03 + alpha-element enhancement
X          0.759000    X (surface) 0.7440
Y          0.239000    CORE MASS   0.4852
ALPHA(mlt) 1.89

15 0.537 1.361022 1.34744.208195 4.5938.073 4.290 0.0020 2.2000D-040.74400.4852
15 0.541 1.377098 1.30734.193183 4.5208.073 4.289 0.0020 2.2000D-040.74400.4852
15 0.545 1.394557 1.26364.177350 4.4428.073 4.288 0.0020 2.2000D-040.74400.4852
15 0.549 1.414170 1.21464.160242 4.3578.074 4.287 0.0020 2.2000D-040.74400.4852
15 0.553 1.435292 1.16184.141789 4.2658.074 4.287 0.0020 2.2000D-040.74400.4852
15 0.557 1.456474 1.10884.122138 4.1698.074 4.287 0.0020 2.2000D-040.74400.4852
15 0.561 1.477590 1.05604.101169 4.0678.074 4.287 0.0020 2.2000D-040.74400.4852
15 0.565 1.497889 1.00534.079086 3.9618.074 4.287 0.0020 2.2000D-040.74400.4852
15 0.569 1.517005 0.95754.056049 3.8538.074 4.287 0.0020 2.2000D-040.74400.4852
15 0.573 1.534762 0.91314.032194 3.7438.074 4.287 0.0020 2.2000D-040.74400.4852
15 0.577 1.550903 0.87274.007774 3.6328.074 4.288 0.0020 2.2000D-040.74400.4852
15 0.581 1.566048 0.83493.982716 3.5208.073 4.288 0.0020 2.2000D-040.74400.4852
15 0.585 1.579663 0.80083.957382 3.4088.073 4.288 0.0020 2.2000D-040.74400.4852
15 0.589 1.591722 0.77073.931956 3.2978.073 4.288 0.0020 2.2000D-040.74400.4852
15 0.593 1.602841 0.74293.906086 3.1858.073 4.288 0.0020 2.2000D-040.74400.4852
15 0.597 1.613031 0.71743.879786 3.0738.073 4.288 0.0020 2.2000D-040.74400.4852
15 0.600 1.619953 0.70013.860053 2.9898.073 4.288 0.0020 2.2000D-040.74400.4852
15 0.603 1.627142 0.68213.839394 2.9028.073 4.289 0.0020 2.2000D-040.74400.4852
15 0.606 1.632460 0.66883.820431 2.8238.073 4.289 0.0020 2.2000D-040.74400.4852
15 0.610 1.640395 0.64903.794214 2.7138.073 4.289 0.0020 2.2000D-040.74400.4852
15 0.615 1.648097 0.62983.771104 2.6168.073 4.289 0.0020 2.2000D-040.74400.4852
15 0.630 1.667980 0.58003.746618 2.5098.073 4.289 0.0020 2.2000D-040.74400.4852
15 0.660 1.694564 0.51363.729773 2.4358.073 4.290 0.0020 2.2000D-040.74400.4852
15 0.700 1.718086 0.45483.719832 2.3978.073 4.290 0.0020 2.2000D-040.74400.4852
15 0.750 1.739359 0.40163.713670 2.3818.073 4.291 0.0020 2.2000D-040.74400.4852
15 0.800 1.756164 0.35963.710379 2.3798.073 4.291 0.0020 2.2000D-040.74400.4852
15 0.850 1.770551 0.32363.708505 2.3848.073 4.292 0.0020 2.2000D-040.74400.4852
15 0.900 1.783173 0.29213.707467 2.3928.073 4.292 0.0020 2.2000D-040.74400.4852
```

E. OUTPUT FILES

From VRISO, the `.iso` files For each isochrone, the line entries are 1) the model number, 2) $\log L/L_\odot$, 3) $\log T_{\rm eff}$, 4) mass in solar units, 5) "distance" along the isochrone (see Bergbusch & VandenBerg, 2001 ApJ, 556, 322), 6) & 7) are estimates of the derivative of the mass with respect to distance.

```
ISOCHRONES  6
[Fe/H]      -0.606
[alpha/Fe] +0.0
Z           5.000D-03   Z = 5.000D-03 + alpha-element enhancement
X           0.750000
Y           0.245000
ALPHA(mlt) 1.89

 Age   Npts
 8.00   329
  1 -1.274350 3.609303 0.5003129140  0.0000000 2.2933289D-01 1.8198195D-01
  2 -1.256175 3.611072 0.5055298034  0.0287919 2.2944252D-01 1.8035983D-01
  3 -1.238607 3.612824 0.5105742879  0.0568838 2.2949675D-01 1.7877716D-01
         .         .          .             .          .              .
         .         .          .             .          .              .
         .         .          .             .          .              .
327  3.354034 3.553364 1.0118045423  7.5656204 1.6293352D-04 1.6575159D-04
328  3.373577 3.551484 1.0118094655  7.5964493 1.7501134D-04 1.7660187D-04
329  3.389460 3.550042 1.0118143774  7.6209836 2.0266986D-04 1.8523674D-04

 Age   Npts
10.00   322
  1 -1.263469 3.610309 0.5013878018  0.0000000 2.2568230D-01 1.7782551D-01
  2 -1.248882 3.611757 0.5055124039  0.0232881 2.2562693D-01 1.7632758D-01
  3 -1.234673 3.613199 0.5095284347  0.0461634 2.2552875D-01 1.7485621D-01
         .         .          .             .          .              .
         .         .          .             .          .              .
         .         .          .             .          .              .

 Age   Npts
18.00   307
  1 -1.239816 3.612547 0.5000440982  0.0000000 2.0993610D-01 1.6140105D-01
  2 -1.226956 3.613911 0.5034318457  0.0210849 2.0940135D-01 1.5972868D-01
  3 -1.214333 3.615276 0.5067451962  0.0419447 2.0883341D-01 1.5807416D-01
         .         .          .             .          .              .
         .         .          .             .          .              .
         .         .          .             .          .              .
305  3.351027 3.541056 0.8102528070  7.1019067 5.5409075D-05 5.7541644D-05
306  3.376578 3.538456 0.8102550497  7.1430877 6.0628636D-05 5.9947569D-05
307  3.397808 3.536459 0.8102572872  7.1762993 6.8464642D-05 6.1887898D-05
```

From VRCMD, the `.cmd` files The table entries are obvious (I hope) — the assumption is that the V and y magnitudes are interchangeable.

```
Fiducials   6
[Fe/H]      -0.606
[alpha/Fe] +0.0
Z           5.000D-03   Z = 5.000D-03 + alpha-element enhancement
X           0.750000
Y           0.245000
ALPHA(mlt) 1.89

 Age   Npt
 8.00  250
          Mass        Mbol    log Te    log g     V/y     B-V     V-R     V-I     b-y     m1      c1
   1  0.5003129140  7.9359  3.609303  4.8016  8.7822  1.3189  0.8497  1.6403  0.8198  0.6622  0.0784
   2  0.5058570086  7.8876  3.611184  4.7946  8.7195  1.3069  0.8403  1.6210  0.8094  0.6668  0.0789
   3  0.5113473583  7.8398  3.613096  4.7878  8.6579  1.2946  0.8306  1.6017  0.7987  0.6711  0.0797
   .       .           .        .         .       .       .       .       .       .       .       .
   .       .           .        .         .       .       .       .       .       .       .       .
   .       .           .        .         .       .       .       .       .       .       .       .
 248  1.0118036343 -3.6259  3.553724  0.2605 -1.6621  1.6439  1.0867  2.3484  1.1945  0.9590  0.3237
 249  1.0118084765 -3.6743  3.551852  0.2336 -1.6431  1.6496  1.1036  2.3933  1.2088  0.9576  0.3242
 250  1.0118143774 -3.7237  3.550042  0.2066 -1.6258  1.6551  1.1209  2.4380  1.2230  0.9560  0.3248

 Age   Npt
10.00  250
          Mass        Mbol    log Te    log g     V/y     B-V     V-R     V-I     b-y     m1      c1
   1  0.5013878018  7.9087  3.610309  4.7957  8.7472  1.3123  0.8445  1.6298  0.8141  0.6646  0.0786
   2  0.5067059267  7.8616  3.612182  4.7890  8.6863  1.3003  0.8351  1.6107  0.8037  0.6690  0.0793
   3  0.5119643407  7.8151  3.614088  4.7825  8.6264  1.2880  0.8254  1.5915  0.7930  0.6730  0.0803
   .       .           .        .         .       .       .       .       .       .       .       .
   .       .           .        .         .       .       .       .       .       .       .       .
   .       .           .        .         .       .       .       .       .       .       .       .

 Age   Npt
18.00  250
          Mass        Mbol    log Te    log g     V/y     B-V     V-R     V-I     b-y     m1      c1
   1  0.5000440982  7.8495  3.612547  4.7798  8.6718  1.2973  0.8328  1.6063  0.8012  0.6695  0.0795
   2  0.5046649539  7.8057  3.614415  4.7738  8.6149  1.2852  0.8233  1.5876  0.7907  0.6734  0.0806
   3  0.5092149347  7.7622  3.616312  4.7679  8.5588  1.2728  0.8136  1.5689  0.7801  0.6769  0.0819
   .       .           .        .         .       .       .       .       .       .       .       .
   .       .           .        .         .       .       .       .       .       .       .       .
   .       .           .        .         .       .       .       .       .       .       .       .
 248  0.8102537203 -3.6536  3.539999  0.0980 -1.1652  1.6748  1.2377  2.7162  1.2974  0.9414  0.3242
 249  0.8102553020 -3.6983  3.538182  0.0729 -1.1297  1.6779  1.2651  2.7751  1.3124  0.9388  0.3247
 250  0.8102572872 -3.7445  3.536459  0.0475 -1.0969  1.6807  1.2920  2.8324  1.3270  0.9362  0.3253
```

From VRIPF, the `.ipf` files The `.lfn` and `.cfn` files have similar formats. For each value of the mass spectrum exponent, both differential and cumulative distributions are tabulated.

```
IPFs         6  I  B-I  x = -0.5 +0.0 +0.5
[Fe/H]      -0.606
[alpha/Fe] +0.0
Z           5.000D-03   Z = 5.000D-03 + alpha-element enhancement
X           0.750000
Y           0.245000
ALPHA(mlt) 1.89

 Age   Npt
 8.00  119
       I     B-I    Mass     Mbol  log Te  log g     d        x = -0.5          x = +0.0          x = +0.5
   1  7.064  2.902 0.5103126  7.849 3.6127  4.789   9.000   3.97187  5.00000   4.04247  5.00000   4.10920  5.00000
   2  7.003  2.855 0.5183802  7.779 3.6156  4.779   8.800   3.96313  4.99178   4.03032  4.99031   4.09364  4.98868
   3  6.944  2.807 0.5262452  7.710 3.6185  4.770   8.600   3.95535  4.98357   4.01928  4.98068   4.07932  4.97748
   .    .      .       .        .      .      .       .        .        .         .        .         .        .
   .    .      .       .        .      .      .       .        .        .         .        .         .        .
   .    .      .       .        .      .      .       .        .        .         .        .         .        .
 117 -4.008  3.988 1.0118032 -3.621 3.5539  0.263 -14.200   0.48880  0.23612   0.41076  0.15808   0.32884  0.07616
 118 -4.034  4.037 1.0118079 -3.669 3.5521  0.237 -14.400   0.51086  0.04375   0.43282 -0.03429   0.35090 -0.11622
 119 -4.055  4.078 1.0118123 -3.708 3.5506  0.215 -14.563   0.56227 -0.33960   0.48423 -0.41764   0.40231 -0.49957

 Age   Npt
10.00  119
       I     B-I    Mass     Mbol  log Te  log g     d        x = -0.5          x = +0.0          x = +0.5
   1  7.037  2.881 0.5117302  7.817 3.6140  4.783   8.600   4.00880  5.00000   4.07257  5.00000   4.13315  5.00000
   2  6.977  2.833 0.5195015  7.748 3.6169  4.773   8.400   4.00041  4.99104   4.06090  4.98961   4.11821  4.98803
   3  6.920  2.785 0.5270739  7.681 3.6198  4.765   8.200   3.99269  4.98208   4.05003  4.97925   4.10420  4.97615
   .    .      .       .        .      .      .       .        .        .         .        .         .        .
   .    .      .       .        .      .      .       .        .        .         .        .         .        .
   .    .      .       .        .      .      .       .        .        .         .        .         .        .
```

From VRZAHB, the `zahb*.zahb` files The entries mimic those in the `.cmd` files.

```
MODELS      28
[Fe/H]      -1.009
[alpha/Fe] +0.0
Z           2.000D-03   Z = 2.000D-03 + alpha-element enhancement
X           0.759000    X (surface) 0.7440
Y           0.239000    CORE MASS   0.4852
ALPHA(mlt) 1.89
```

	Mass	Mbol	log Te	log g	V/y	B-V	V-R	V-I	b-y	m1	c1
1	0.5370000000	1.3474	4.208195	4.5926	2.8081	-0.1398	-0.0732	-0.1567	-0.0660	0.1217	0.3597
2	0.5410000000	1.3073	4.193183	4.5197	2.6778	-0.1340	-0.0694	-0.1483	-0.0623	0.1217	0.3963
3	0.5450000000	1.2636	4.177350	4.4421	2.5394	-0.1281	-0.0651	-0.1392	-0.0581	0.1215	0.4373
4	0.5490000000	1.2146	4.160242	4.3572	2.3895	-0.1209	-0.0607	-0.1294	-0.0534	0.1210	0.4848
5	0.5530000000	1.1618	4.141789	4.2654	2.2289	-0.1132	-0.0561	-0.1184	-0.0487	0.1204	0.5394
6	0.5570000000	1.1088	4.122138	4.1688	2.0625	-0.1052	-0.0515	-0.1065	-0.0437	0.1200	0.6021
7	0.5610000000	1.0560	4.101169	4.0669	1.8902	-0.0966	-0.0464	-0.0932	-0.0374	0.1190	0.6742
8	0.5650000000	1.0053	4.079086	3.9613	1.7161	-0.0869	-0.0408	-0.0785	-0.0318	0.1194	0.7562
9	0.5690000000	0.9575	4.056049	3.8531	1.5431	-0.0757	-0.0345	-0.0631	-0.0250	0.1197	0.8469
10	0.5730000000	0.9131	4.032194	3.7430	1.3729	-0.0627	-0.0277	-0.0465	-0.0177	0.1207	0.9460
11	0.5770000000	0.8727	4.007774	3.6322	1.2094	-0.0471	-0.0199	-0.0278	-0.0099	0.1240	1.0499
12	0.5810000000	0.8349	3.982716	3.5198	1.0557	-0.0261	-0.0103	-0.0036	0.0008	0.1298	1.1568
13	0.5850000000	0.8008	3.957382	3.4079	0.9196	0.0027	0.0038	0.0281	0.0147	0.1374	1.2455
14	0.5890000000	0.7707	3.931956	3.2970	0.8092	0.0402	0.0246	0.0751	0.0355	0.1438	1.2987
15	0.5930000000	0.7429	3.906086	3.1854	0.7323	0.0897	0.0577	0.1437	0.0669	0.1433	1.2892
16	0.5970000000	0.7174	3.879786	3.0729	0.6884	0.1650	0.1044	0.2404	0.1190	0.1346	1.1877
17	0.6000000000	0.7001	3.860053	2.9892	0.6761	0.2189	0.1393	0.3119	0.1612	0.1245	1.0811
18	0.6030000000	0.6821	3.839394	2.9016	0.6760	0.2722	0.1755	0.3850	0.2026	0.1139	0.9691
19	0.6060000000	0.6688	3.820431	2.8226	0.6863	0.3251	0.2104	0.4541	0.2457	0.1052	0.8614
20	0.6100000000	0.6490	3.794214	2.7126	0.7012	0.4018	0.2592	0.5496	0.2975	0.0982	0.7258
21	0.6150000000	0.6298	3.771104	2.6160	0.7151	0.4771	0.3025	0.6326	0.3423	0.1022	0.6169
22	0.6300000000	0.5800	3.746618	2.5087	0.7109	0.5692	0.3485	0.7208	0.3965	0.1208	0.5073
23	0.6600000000	0.5136	3.729773	2.4349	0.6853	0.6379	0.3833	0.7887	0.4350	0.1453	0.4437
24	0.7000000000	0.4548	3.719832	2.3972	0.6543	0.6801	0.4045	0.8300	0.4581	0.1659	0.4112
25	0.7500000000	0.4016	3.713670	2.3812	0.6192	0.7068	0.4171	0.8541	0.4729	0.1811	0.3951
26	0.8000000000	0.3596	3.710379	2.3793	0.5871	0.7212	0.4238	0.8668	0.4809	0.1899	0.3864
27	0.8500000000	0.3236	3.708505	2.3837	0.5569	0.7294	0.4276	0.8740	0.4853	0.1952	0.3808
28	0.9000000000	0.2921	3.707467	2.3918	0.5287	0.7339	0.4297	0.8780	0.4878	0.1983	0.3769