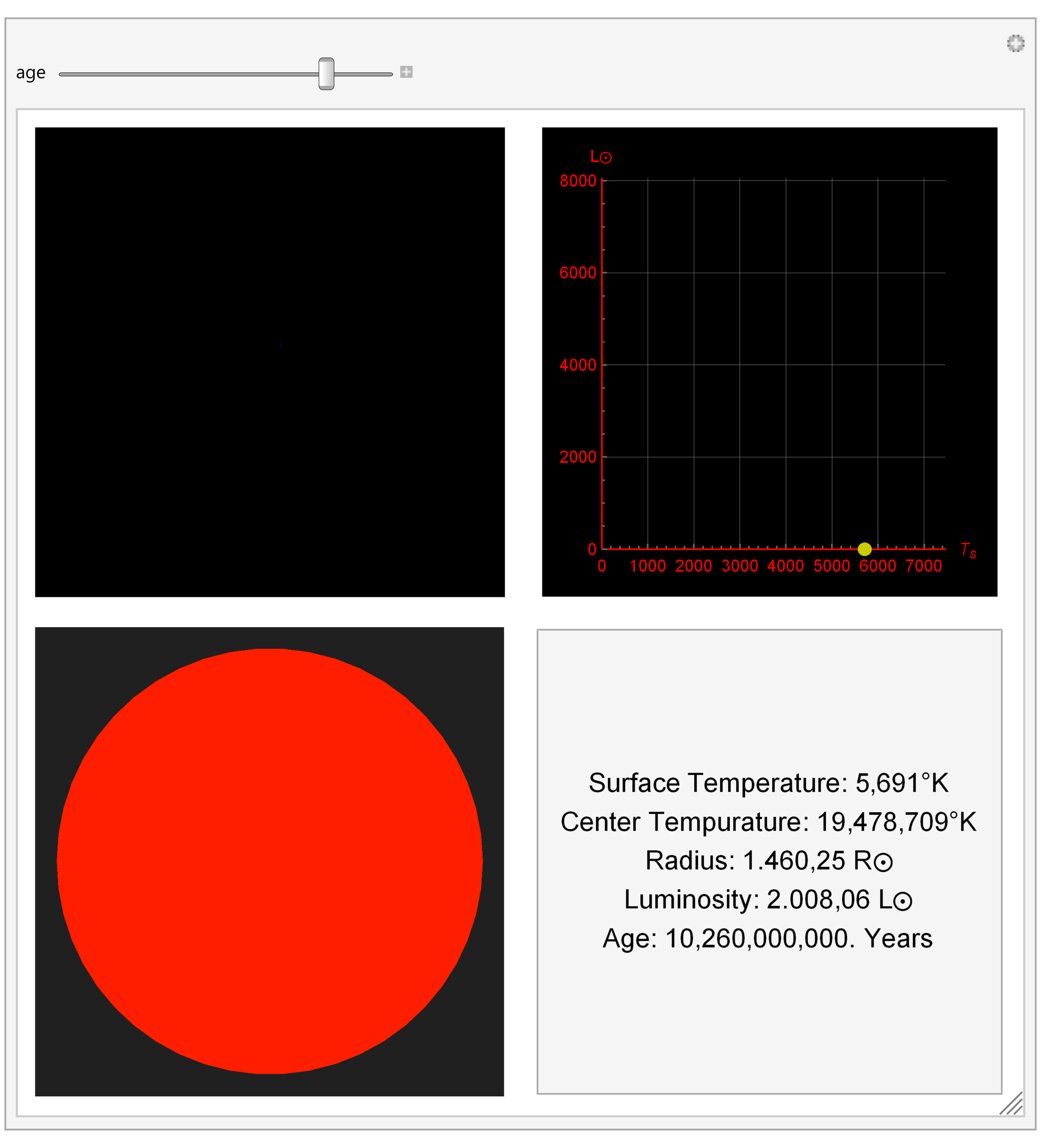
Stellar Evolution Simulator

Reese Danzer & Karthik Boyareddygari

Output:

```
interface[]
```



Main Code:

```
In[12]:= interface[] :=
  DynamicModule[{
    maxStep = Length[oneMSunData],
    maxAge = oneMSun[Max, "Age"],
    maxRadius = oneMSun[Max, "Radius"],
    maxLuminosity = oneMSun[Max, "Luminosity"],
    maxTSurface = oneMSun[Max, "Ts"],
    color, radius, surfaceTemp, centerTemp, luminosity, stepFunction
   },
   Manipulate[
    stepFunction = InverseFunction[Interpolation[Normal[oneMSun[All, "Age"]]]];
    color = fancyInterpolate[age, "Radius", stepFunction]^-1;
    radius = fancyInterpolate[age, "Radius", stepFunction];
    luminosity = fancyInterpolate[age, "Luminosity", stepFunction];
    surfaceTemp = fancyInterpolate[age, "Ts", stepFunction];
    centerTemp = fancyInterpolate[age, "Tc", stepFunction];
    (*This will be the list of changing variables to be used below, because if we just slap the commands in themselves it will get really cluttered really fast.*)
    GraphicsGrid[{
      {Graphics3D[{Hue[color], Tooltip[Sphere[{0, 0, 0} , radius]]}, Background → Black, Boxed → False, PlotRange → maxRadius],
       (*The Sphere Graphic*)
       Panel[Graphics[PlotRange → {{maxTSurface, 0}, {0, maxLuminosity}}, Axes → True, GridLines → Automatic, Background → Black, AxesStyle → Directive[Red],
         AxesLabel → {"Ts", "L⊙"}, Epilog → {Darker[Yellow, 0.2], PointSize → 0.04, Point[{surfaceTemp, luminosity}]}], Background → Black]},
      (*The HR Diagram*)
      {Graphics[{Hue[0.02], Tooltip[Disk[{0, 0}, 1]], Hue[0.15], Tooltip[Disk[{0, 0}, 1/age]]}], PlotRange → 1.1, Background → Darker[Gray, 0.75]],
       (*The Internal Diagram*)
       Panel[Graphics[{FontSize → 16, Text[
           "Surface Temperature: " <> ToString[NumberForm[Round[surfaceTemp], DigitBlock → 3]] <> "°K" <>
            "\nCenter Tempurature: " <> ToString[NumberForm[Round[centerTemp], DigitBlock → 3]] <> "°K" <> "\nRadius: " <>
            ToString[NumberForm[radius, DigitBlock → 3, NumberSeparator → ","]] <> " R⊙" <>
            "\nLuminosity: " <> ToString[NumberForm[luminosity, DigitBlock → 3, NumberSeparator → ","]] <> " L⊙" <>
            "\nAge: " <> ToString[AccountingForm[age, DigitBlock → 3, NumberSeparator → ","]] <> " Years"]}]]}
      (*The Text Readouts*)
     },
     ContentSelectable → False,
     (*So they don't get their grubby hands on our nice animation.*)
     ImageSize → Full
     ],
    {age, 1, maxAge}, ContentSize → {600, 600}]
   ]
```

Dataset Initialization

```
In[9]:= SetDirectory[NotebookDirectory[]];
oneMSunData = Import["One Solar Mass.txt", "Table"];
oneMSun = Dataset[Table[
    <|"Age" → oneMSunData[[i, 2]], "Mass" → oneMSunData[[i, 3]], "Luminosity" → 10^oneMSunData[[i,4]], "Radius" → 10^oneMSunData[[i,5]], "Ts" → 10^oneMSunData[[i,6]],
     "Tc" → 10^oneMSunData[[i,7]], "ρc" → 10^oneMSunData[[i,8]], "Pc" → 10^oneMSunData[[i,9]], "RHe" → oneMSunData[[i, 27]], "RC" → oneMSunData[[i, 28]], "RO" → oneMSunData[[i, 29]]|>,
    {i, Length[oneMSunData]}]
   ];
```

```
In[5]:= alter[data_] :=
  Module[{association},
   association = <|"Step" → data[[1]], "Age" → data[[2]], "Mass" → data[[3]], "Luminosity" → 10^data[[4]], "Radius" → 10^data[[5]], "Ts" → 10^data[[6]], "Tc" → 10^data[[7]],
     "ρc" → 10^data[[8]], "Pc" → 10^data[[9]], "RHe" → data[[27]], "RC" → data[[28]], "RO" → data[[29]]|>;
   Return[association];
   ]
```

Complex Interpolation

```
In[6]:= fancyInterpolate[age_, qty_, f_] :=
  Module[{step},
   step = f[age];
   Return[
    Interpolation[
     connect[{Normal[oneMSun[Round[step] - 3 ;; Round[step] + 3, "Age"]],
       Normal[oneMSun[Round[step] - 3 ;; Round[step] + 3, qty]]}], age]
    ]
   ];
```

Connect

```
In[7]:= connect[listoflist_] := (*assume that all lists in listoflist are of the same length because we are inputting them*)
  Module[{length = Length[listoflist[[1]]], lengthmain = Length[listoflist], final},
   final = Table[listoflist[[k, i]], {i, 1, length}, {k, 1, lengthmain}]; (*create a list of length lists each being lengthmain elements long*)
   Return[final]
   ]
```

Datasets:

```
Dynamic[oneMSun]
```

Age	Mass	Luminosity	Radius	T_s	T_c	ρ_c	P_c	R_{He}	R_C	R_O
0.	1.	0.7004	0.8857	5616.	1.337×10^7	78300.	1.414×10^{16}	0.	0.	0.
50000.	1.	0.7094	0.8958	5602.	1.34×10^7	78250.	1.416×10^{16}	0.	0.	0.
100000.	1.	0.7094	0.8958	5602.	1.34×10^7	78250.	1.416×10^{16}	0.	0.	0.
160000.	1.	0.7094	0.8958	5602.	1.34×10^7	78250.	1.416×10^{16}	0.	0.	0.
232000.	1.	0.7094	0.8958	5602.	1.34×10^7	78260.	1.416×10^{16}	0.	0.	0.
318400.	1.	0.7094	0.8958	5602.	1.34×10^7	78260.	1.416×10^{16}	0.	0.	0.
422100.	1.	0.7094	0.8958	5602.	1.34×10^7	78260.	1.416×10^{16}	0.	0.	0.
546500.	1.	0.7094	0.8958	5602.	1.34×10^7	78270.	1.416×10^{16}	0.	0.	0.
695800.	1.	0.7094	0.8958	5602.	1.34×10^7	78270.	1.416×10^{16}	0.	0.	0.
875000.	1.	0.7094	0.8958	5602.	1.34×10^7	78280.	1.416×10^{16}	0.	0.	0.
1.09×10^6	1.	0.7094	0.8958	5602.	1.34×10^7	78290.	1.416×10^{16}	0.	0.	0.
1.348×10^6	1.	0.7095	0.8958	5602.	1.34×10^7	78310.	1.417×10^{16}	0.	0.	0.
1.658×10^6	1.	0.7095	0.8958	5602.	1.34×10^7	78270.	1.416×10^{16}	0.	0.	0.
2.029×10^6	1.	0.7095	0.8958	5602.	1.34×10^7	78240.	1.416×10^{16}	0.	0.	0.
2.475×10^6	1.	0.7095	0.8958	5602.	1.341×10^7	78220.	1.416×10^{16}	0.	0.	0.
3.01×10^6	1.	0.7094	0.8958	5602.	1.341×10^7	78200.	1.415×10^{16}	0.	0.	0.

⋮ 892

2 levels | 908 rows

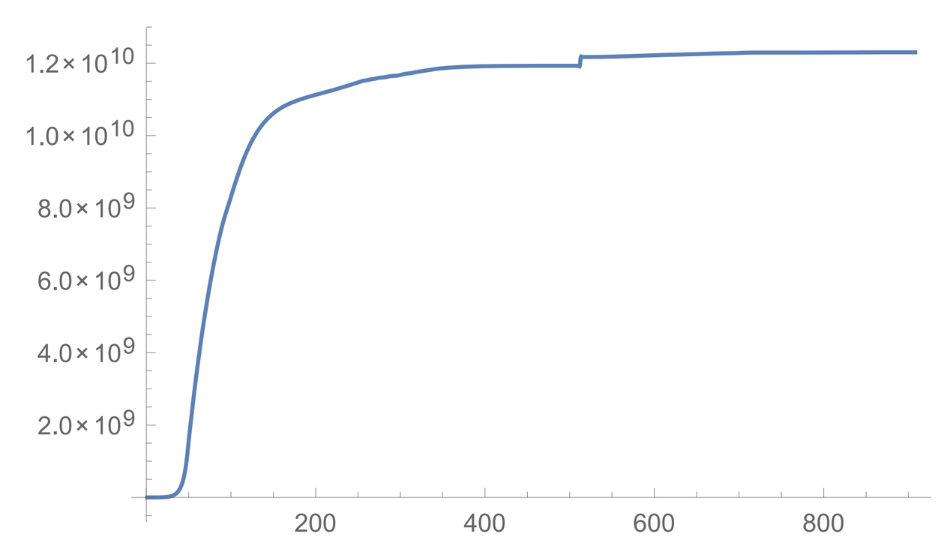
Variable Explanations:

Data Graphs:

One Msun:

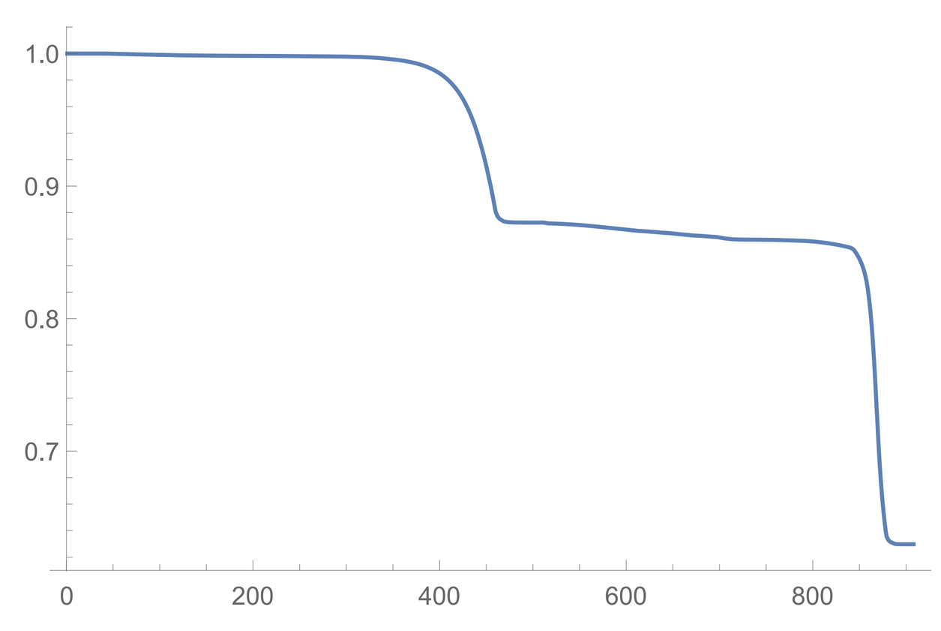
Age

```
Plot[Interpolation[Normal[oneMSun[All, "Age"]]][x], {x, 1, 908}, PlotRange → Full]
```



Mass

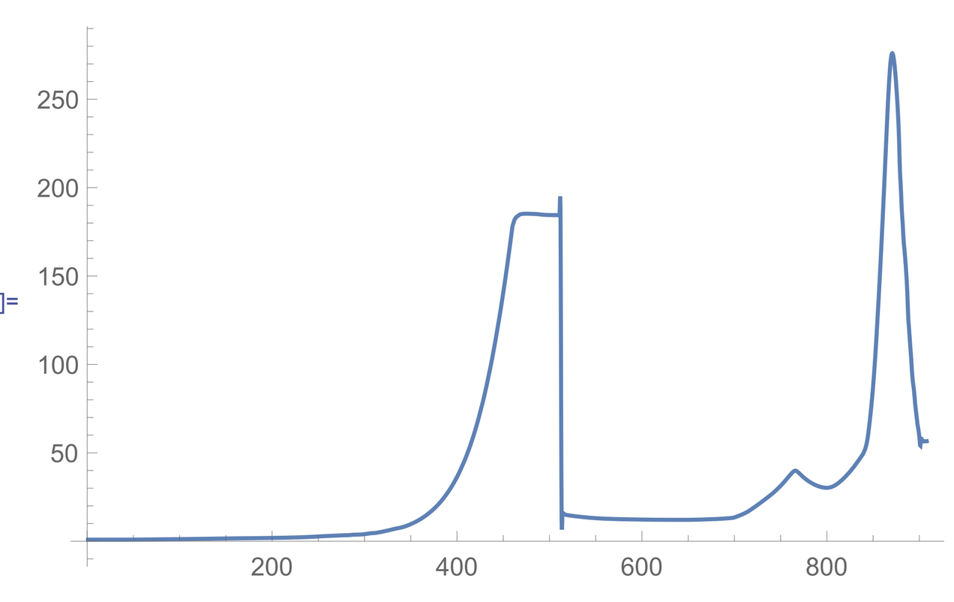
```
Plot[Interpolation[Normal[oneMSun[All, "Mass"]]][x], {x, 1, 908}, PlotRange → Full]
```



Radius

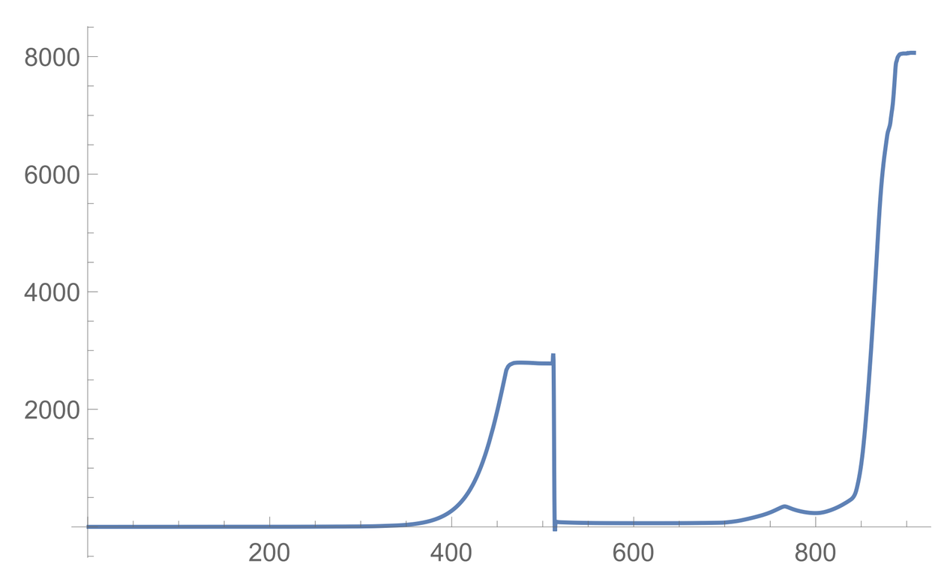
```
In[8]:= Plot[Interpolation[Normal[oneMSun[All, "Radius"]]][x], {x, 1, 908}, PlotRange → Full]
```

Out[8]=



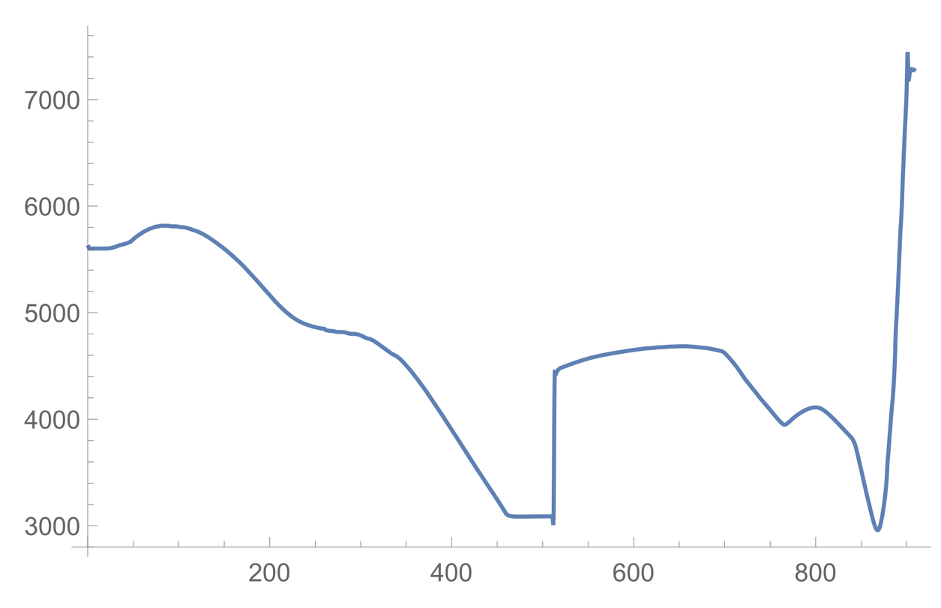
Luminosity

```
Plot[Interpolation[Normal[oneMSun[All, "Luminosity"]]][x], {x, 1, 908}, PlotRange → Full]
```



Surface Tempurature

```
Plot[Interpolation[Normal[oneMSun[All, "Ts"]]][x], {x, 1, 908}, PlotRange → Full]
```



Center Tempurature

```
Plot[Interpolation[Normal[oneMSun[All, "Tc"]]][x], {x, 1, 908}, PlotRange → Full]
```