rigel

February 7, 2026

[1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

[2]:
```
import pandas as pd

filename1 = "history.data"

# Find the line with the header (starts with #)
with open(filename1, "r") as f:
    for i, line in enumerate(f):
        if line.startswith("#"):
            header_line = i
            break
h1= pd.read_csv("history.data", delim_whitespace=True, comment="!", header=0)
```

```
/tmp/ipykernel_5409/609677372.py:11: FutureWarning: The 'delim_whitespace'
keyword in pd.read_csv is deprecated and will be removed in a future version.
Use ``sep='\s+'`` instead
  h1= pd.read_csv("history.data", delim_whitespace=True, comment="!", header=0)
```

[3]:
```
h1.head()
```

[3]:

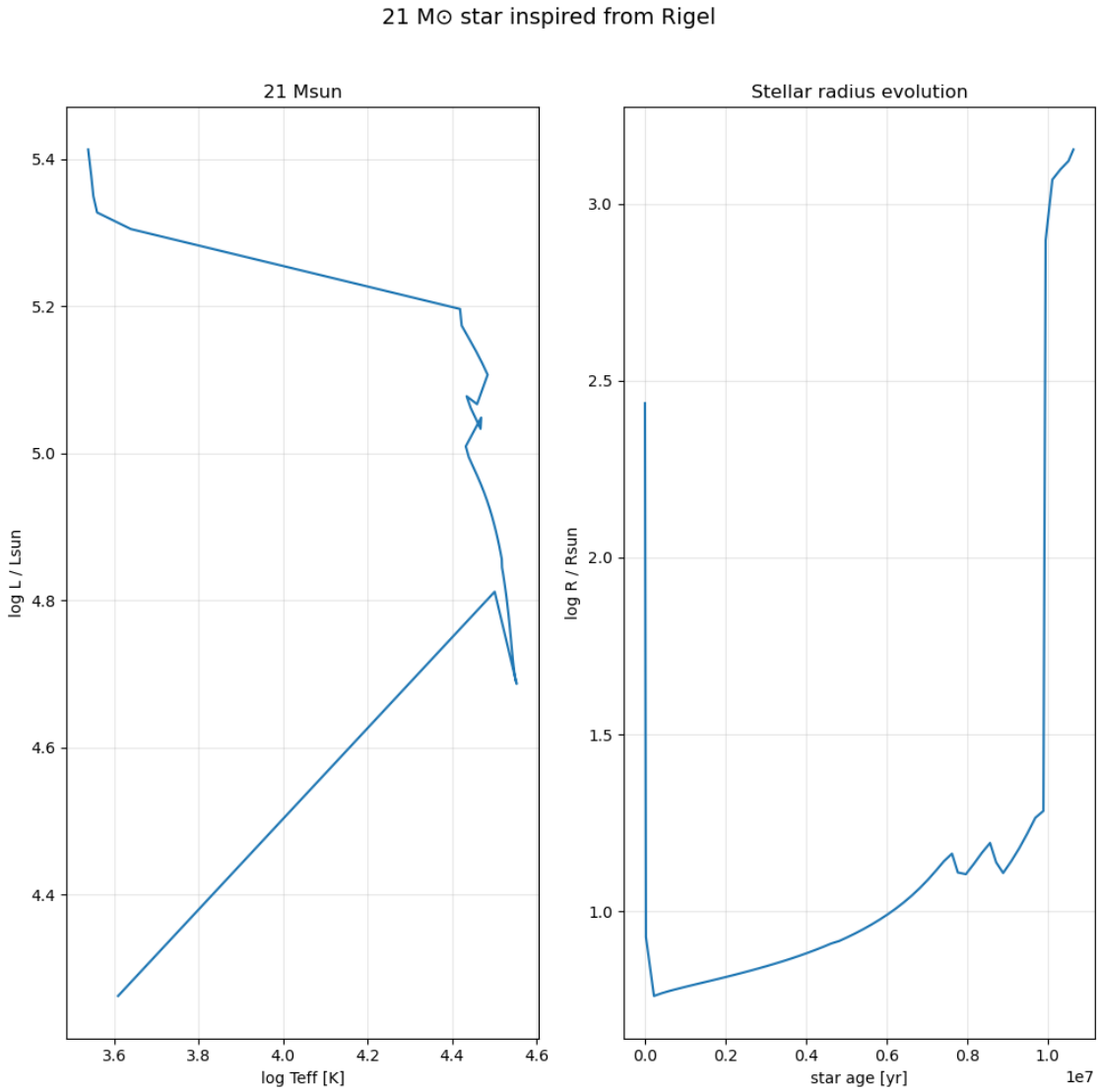
	model_number	num_zones	star_age	log_dt	star_mass	log_xmstar	\
0	1	601	0.000010	-5.000000	21.0	34.620725	
1	200	1108	24442.293442	2.890637	21.0	34.620725	
2	400	1138	224357.792806	3.000000	21.0	34.620725	
3	600	1130	424357.792806	3.000000	21.0	34.620725	
4	800	1130	624357.792806	3.000000	21.0	34.620725	

	log_abs_mdot	mass_conv_core	conv_mx1_top	conv_mx1_bot	…	center_h1	\
0	-99.0	0.000000	0.999977	5.915693e-02	…	0.718000	
1	-99.0	1.359833	0.063853	7.812883e-08	…	0.717874	
2	-99.0	9.580760	0.454908	7.812883e-08	…	0.707976	
3	-99.0	9.530569	0.452040	7.812883e-08	…	0.697648	
4	-99.0	9.414668	0.447733	7.812883e-08	…	0.687134	

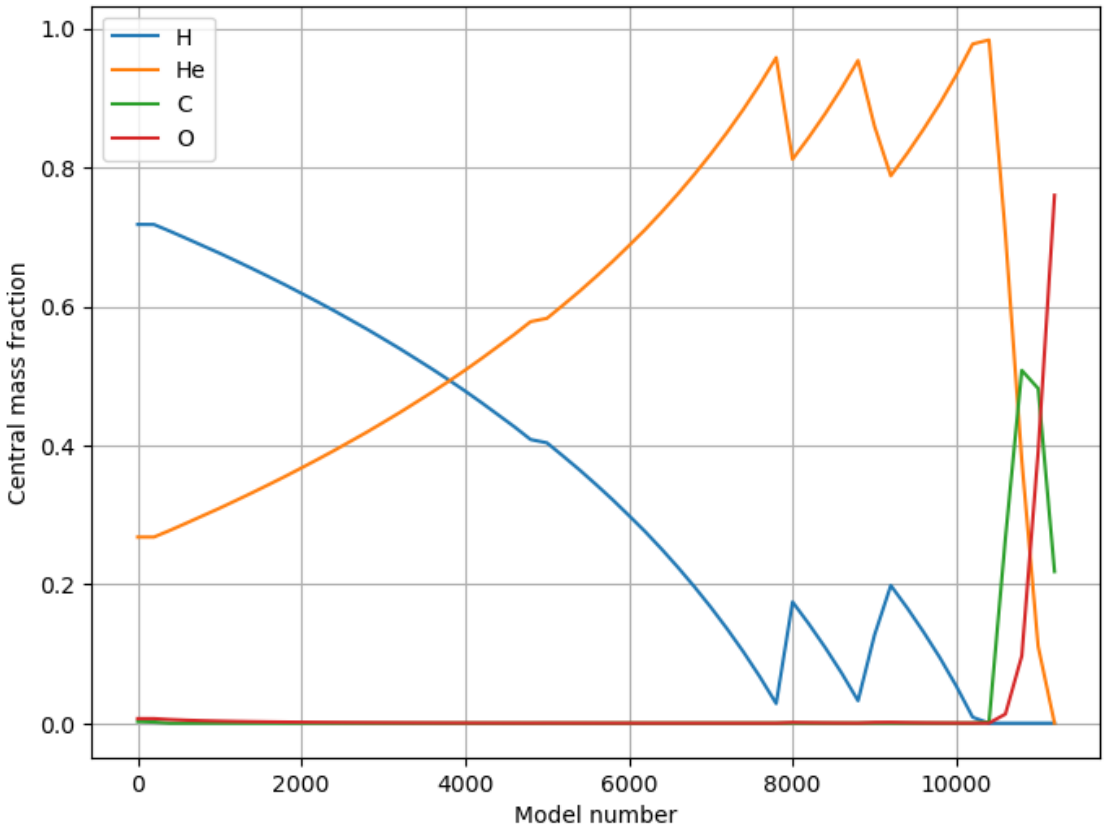
	center_he4	center_c12	center_o16	surface_c12	surface_o16	\

```
0    0.267971    0.002413    0.006566     0.002413     0.006566
1    0.267986    0.001649    0.006566     0.002413     0.006566
2    0.277805    0.000060    0.005181     0.002413     0.006566
3    0.288253    0.000070    0.004234     0.002413     0.006566
4    0.298855    0.000078    0.003541     0.002413     0.006566

   total_mass_h1  total_mass_he4  num_retries  num_iters
0      15.078000        5.627401            0          2
1      15.077756        5.627435            4          4
2      14.980785        5.722427            4          3
3      14.881264        5.822923            4          3
4      14.780707        5.924212            4          3

[5 rows x 60 columns]
```

[15]:
```python
import matplotlib.pyplot as plt

fig, ax = plt.subplots(nrows=1, ncols=2, figsize=(10, 10))

# HR diagram (top-left)
ax[0].plot(h1['log_Teff'], h1['log_L'], linestyle='-')
ax[0].set_xlabel('log Teff [K]')
ax[0].set_ylabel('log L / Lsun')
ax[0].invert_xaxis()
ax[0].set_title('21 Msun')

# Radius evolution (top-right)
ax[1].plot(h1['star_age'], h1['log_R'], linestyle='-')
ax[1].set_xlabel('star age [yr]')          # or /1e9 for Gyr
ax[1].set_ylabel('log R / Rsun')
ax[1].set_title('Stellar radius evolution')



# Optional: overall title
fig.suptitle('21 M  star inspired from Rigel ', fontsize=14)

for a in ax.flat:
    a.grid(True, alpha=0.3)
    try:
        if 'Teff' in a.get_xlabel():
            a.invert_xaxis()
    except:
        pass

plt.tight_layout(rect=[0, 0, 1, 0.96])
plt.show()
```



[16]:
```
fig2, ax2 = plt.subplots(figsize=(8,6))

ax2.plot(h1['model_number'], h1['center_h1'], label='H')
ax2.plot(h1['model_number'], h1['center_he4'], label='He')
ax2.plot(h1['model_number'], h1['center_c12'], label='C')
ax2.plot(h1['model_number'], h1['center_o16'], label='O')

ax2.set_xlabel('Model number')
ax2.set_ylabel('Central mass fraction')
ax2.legend()
ax2.grid(True)
plt.show()
```


H
He
C
O
Central mass fraction
Model number
0.0
0.2
0.4
0.6
0.8
1.0
0
2000
4000
6000
8000
10000

[ ]: