

## Qualifying Exam of Stellar Astrophysics (2023)

1. By invoking the virial theorem (see below), make a crude estimate of an “average” temperature for the Sun. Is your result consistent with other estimates obtained in “The Interiors of Stars”? Why or why not? (15%)

$$-2 \langle K \rangle = \langle U \rangle$$

2. Please draw an evolutionary track of a star with 1 solar mass on Hertzsprung–Russell diagram (starting from the Hayashi-track). Meanwhile, you should give some description briefly (but clearly) at every important process including pre-main sequence star, main sequence star, sub-giant branch, red giant branch, horizontal branch, asymptotic giant branch, planetary nebula and white dwarf. (40%)
3. Electron degeneracy pressure will halt the gravitational collapse of a star if its mass is below the Chandrasekhar limit ( $1.4 M_{\odot}$ ). This is the pressure that prevent a white dwarf star from collapsing. Please use the dimension analysis to derive the equation of states under the cases of relativistic and non-relativistic. (Hint:  $dE = E_k V d^3k / \pi^2$  in Fourier space) (25%)
4. What are “Population III” stars? Please make your description as detail as you can do. (20%)