

# 恆星天文物理 資格考 2015

(可用中文作答；題號須標示清楚)

1. About the Hertzsprung-Russell (H-R) diagram, answer the following. (30%)
  - (a) What are the horizontal and vertical axes of the H-R diagram?
  - (b) Draw an H-R diagram to show the regions of stars of different types, including the main-sequence stars, super-giants, giants, and white dwarfs.
  - (c) Historically we use the H-R diagram to discuss the stellar evolution. In your H-R diagram, draw the likely evolutionary path for a solar-mass star.
  - (d) Draw the likely evolutionary path for a star of 20 solar masses.
2. About the opacity of a star, answer the following questions: (30%)
  - (a) What are the sources for opacity?
  - (b) Which sources are more effective for the region deep in a stellar interior?
  - (c) Which sources are more effective for the outer layers of a star?
  - (d) Explain the Saha's equation.
3. For the formation and evolution of stars, convection is a very important process. Answer the following about the protostars. It is known that the Rossland opacity  $\alpha \propto P^{1.7} T^{4.3}$ , where  $P$  is the pressure and  $T$  is the absolute temperature. The luminosity, mass, and radius of a star are denoted as  $L$ ,  $M$ , and  $R$  respectively. (20%)
  - (a) For population I stars of low surface density, how does  $L$  scale with  $M$  and  $R$ ?
  - (b) For population I stars, how does  $L$  scale with  $M$  and the effective temperature  $T_{\text{eff}}$ ?
  - (c) How does the lifetime of protostars scale with  $M$  and  $R$ ?
  - (d) Derive the first-order equation for the evolution of  $R$ .
4. Consider a dust grain at a distance  $r$  from a star and assume thermal equilibrium with a temperature  $T$ . Answer the following questions. (20%)
  - (a) By considering the energy balancing, explain why smaller grains are warmer than the larger ones?
  - (b) Assume that the absorption efficiency  $Q_{\text{abs}} \propto \nu^\beta$  for small  $\nu$ , where  $\nu$  is the frequency. How does  $T$  scale with  $r$ ?