Level 2 Stars

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Problem Set S.6

a) Initially, stars are formed through the condensation of dense molecular clouds that have a density of about 100 Hydrogen molecules cm^{-3} (i.e., H_2) and a temperature of about 10 K. Estimate the minimum mass such a cloud must have in order to become unstable. [2 marks]

b) Given that typical stars have masses similar to that of the Sun, what does your answer from (a) suggest about the formation of stars? [2 marks]

c) After some collapse, the cloud fragments to form protostars of average mass double that of the Sun. Assuming that the temperature of the cloud remains constant at 10 K, what is the ratio of densities between the initial cloud (in part a) and the fragmented cloud? [3 marks]

d) The radiation from a protostar of radius 4×10^6 km is absorbed by a surrounding spherical dust cloud of radius 10^{10} km. If all of the radiation (as measured by the luminosity) from the protostar is re-emitted by the dust cloud and the cloud is observed to have a temperature of 100 K, what is the effective temperature of the protostar? [3 marks]

[$k = 1.38 \times 10^{-23}$ J K^{-1}; $M_H = 1.67 \times 10^{-27}$ kg; $G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}]