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# RADIATION PROCESSES – AST1440F

## Review Questions for Section 10

1. Compare the initial (cloud) conditions for protostar formation as adopted by Hayashi, Larson, and Shu. For each case, consider the accretion rate, its constancy, and the amount of gravitational binding energy that gets radiated away during the collapse phase.
2. Why do Hayashi's protostars first come into virial (hydrostatic) equilibrium at very large radii ($\sim 50\,\mathrm{R}_\odot$) and correspondingly large luminosities?
3. Describe the Shu-Bondi steady-state accretion model in an isothermal cloud. What is the approximate accretion rate for gas at (i) $10\,^\circ$K, and (ii) $100\,^\circ$K?
4. In what way is accretion onto protostars (or black holes) analogous to fluid flow through a funnel?
5. What basic role does the accretion shock play in the formation of a protostar?
6. What approximation did Larson use for the boundary temperature of an accreting protostar? What assumption(s) did he make? How does it differ from the Shu approach?
7. Why do we say that the shock temperature $T_2$ is a *non-equilibrium* quantity whereas the post-relaxation temperature $T_3$ is an *equilibrium* one? What are typical values for the two temperatures?
8. In words, how do we estimate the radiative equilibrium temperature $T_3$? Why does $T_3$ play a role at all in view of the fact that the flux appears to depend only on the *gradient* of the source function (which is proportional to $T^4$)?
9. Larson's boundary temperature appears to be a little too large at least compared to Shu's value. What affect does this have on the final radius and luminosity of a protostar when it finally arrives on the Hayashi track?
10. Why might we expect the radiative shock position to oscillate wildly about some mean position? [I have seen this phenomenon in videos that portray hydrodynamical simulations of shocks – the underlying instability is probably not driven by the same mechanism in all cases.]