AST5210 Spring semester 2010.

## 1. Basic concepts

What units are common for opacity? intensity? emissivity? Explain in words the meaning of opacity, absorption, scattering, emissivity, mean intensity, source function, optical depth. Why is it practical to define the source function? Interprete the different terms in the equation of radiative transfer.

Give the solution of the transfer equation for a homogeneous slab, small optical depth. Give the formal solution for the outgoing intensity for a semi-infinite 1D atmosophere. Describe in words the origin of the two factors inside the integral.

What is the Eddington-Barbier relation?

## 2. Numerical integration

Explain numerical integration (quadrature). Trapezoidal and Simpson methods, Gaussian quadrature, Gauss-Legendre, Gauss-Laguerre

## 3. Source function with scattering

Explain why there are two terms in the source function when scattering is considered. Describe some methods of direct integration of the formal solution. When can direct integration be employed? What is lambda iteration? Why does lambda iteration fail when scattering dominates? Give some cases when scattering dominates the opacity. What is shooting?

## 4. Feautrier

Why is it possible to use Feautrier's method to solve the transfer equation with scattering present? What is the basic difference between Feautrier's method and a direct integration? Outline the basic steps in the Feautrier method.

## 5. ALI

Explain the principles behind Accelerated Lambda iteration (ALI). What is Sharmer's method? Olson-Auer-Buchler operator?

## 6. Convergence acceleration

Explain the basic principle behind Ng acceleration (full derivation not necessary).

7. Linearization

Explain linearization, Newton-Raphson, convergence radius. Specify the two operator perturbation steps (1. error(n)=? 2. delta(x)(n)=?) resulting from linearization of the following equations:

a) x^3 = 2
b) 4*x^2 + x*y + y^2 = 16
   2*x + x*y^2 = 9

8. non-LTE

How is the number density of the different energy levels in an atom determined in LTE? in non-LTE? Why is non-LTE so much more complicated? Relate locality/non-locality to LTE/ non-LTE. How is the coupling between variables in the two cases? When can we expect LTE to be a good approximation? Where in a stellar atmosphere do we expect such conditions?

What processes are involved in the statistical equilibrium? Describe how the radiative transfer and the statistical equilibrium couple. Describe the principles of linearizing the statistical equilibrium equations. Why don't we get any linearization terms from collisional rates? What is the complication caused by the radiation? How do we eliminate the perturbation in intensity from the statistical equilbrium equations?

9. 2D-3D

Describe the principles behind long characteristics and short characteristics.

10. Energy equation

Describe techniques to get fewer frequency points in the frequency integral: Opacity sampling, Opacity distribution function and multi group opacities. How is the linearization extended to solving for the temperature structure?