Astronomy 401

Stars

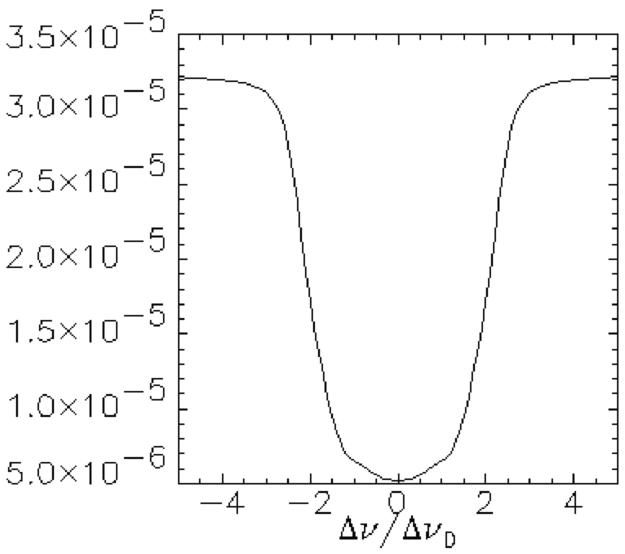
Homework # 3, Due Thursday, October 4, 2001

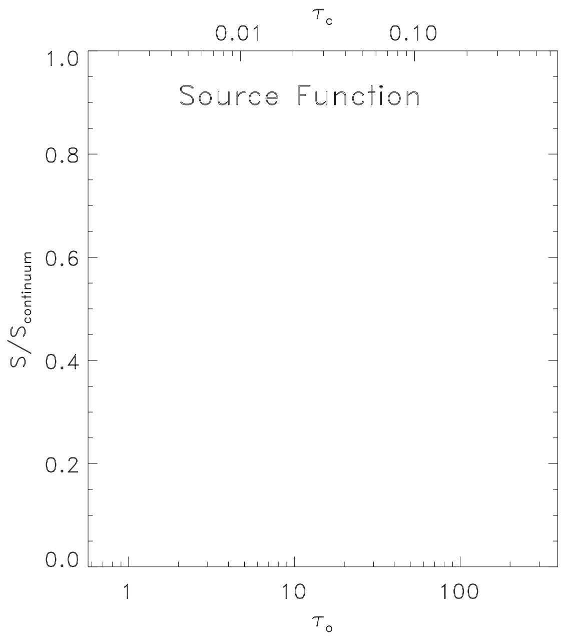
Name: ______________________________

Student number: ______________________

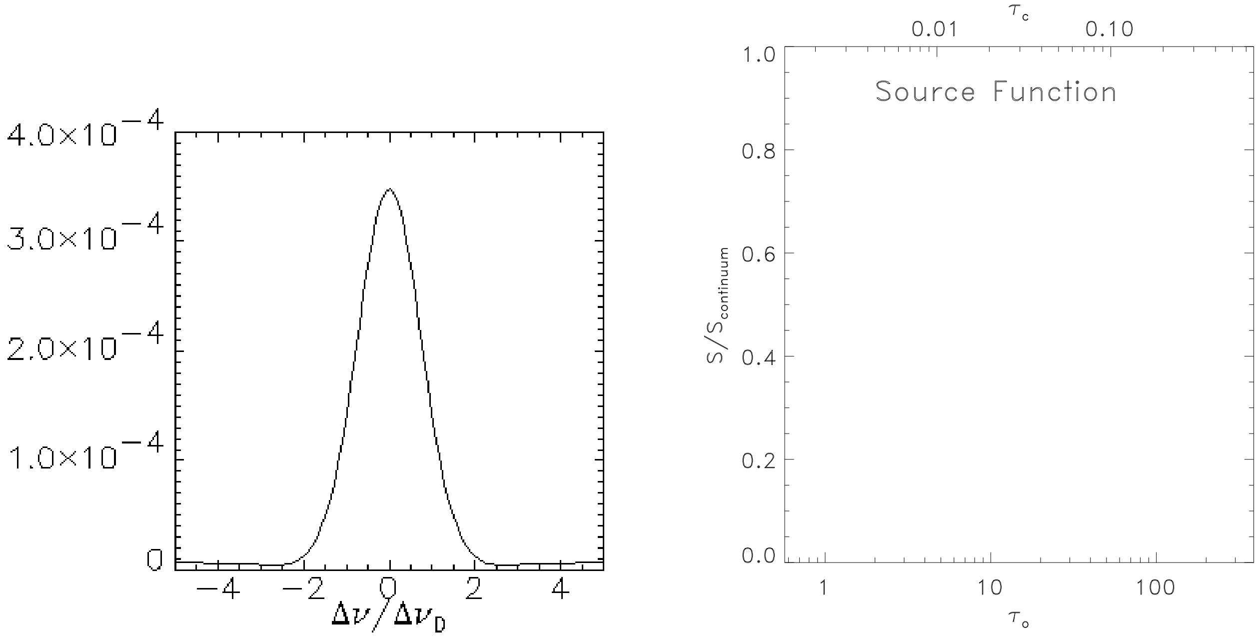
1. Use the Eddington-Barbier relations to sketch the optical depth dependence of the source function (in the blank graph on the right) that produces the line profile shown in the graph on the left, for the three cases (a), (b), (c). Here $\Delta\nu$ is the frequency offset from the center of the line, $\Delta\nu_D$ is the Doppler width of the line, τ_o is the line center optical depth and τ_c is the continuum optical depth. Note: the absorption coefficient in a line decreases approximately as a Gaussian with increasing offset from the line center frequency.

   (a)



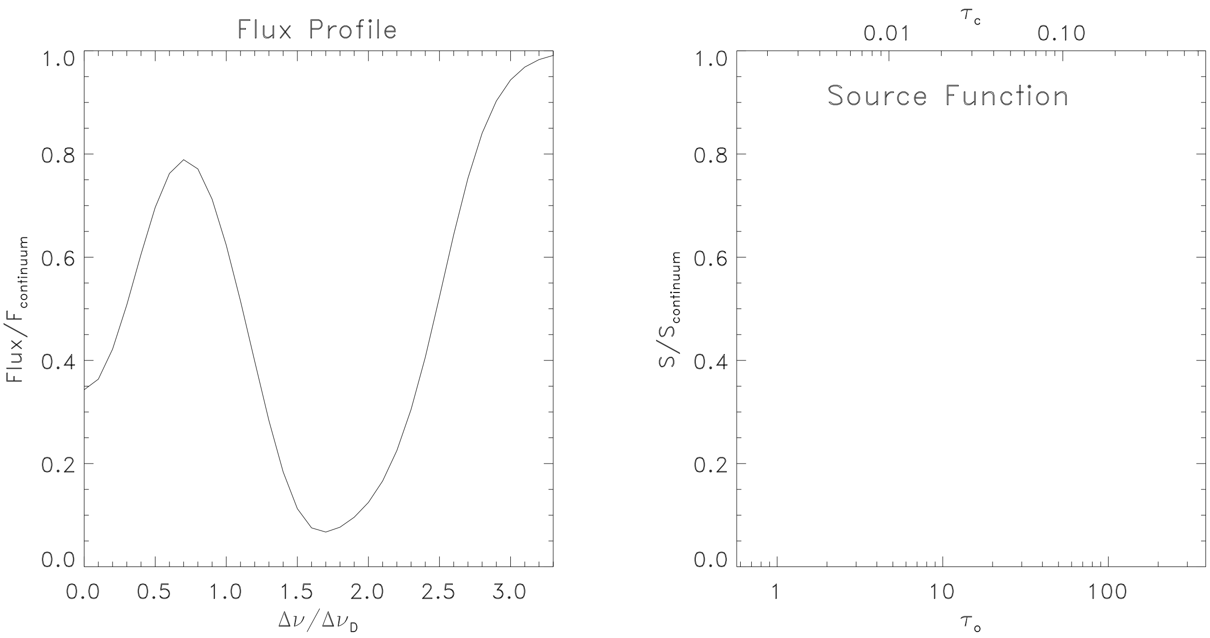


(b)



4.0×10^{-4}
3.0×10^{-4}
2.0×10^{-4}
1.0×10^{-4}
0
−4 −2 0 2 4
$\Delta\nu/\Delta\nu_D$
τ_c
0.01 0.10
Source Function
1.0 0.8 0.6 0.4 0.2 0.0
$S/S_{continuum}$
1 10 100
τ_o

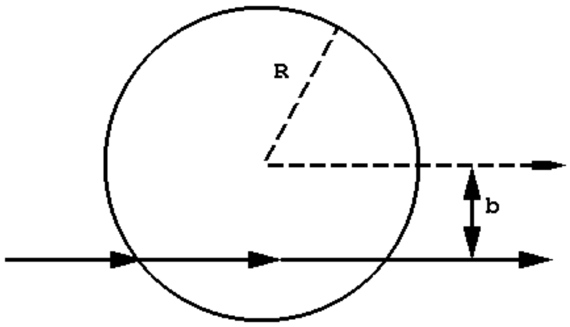
(c)



Flux Profile
1.0 0.8 0.6 0.4 0.2 0.0
$Flux/F_{continuum}$
0.0 0.5 1.0 1.5 2.0 2.5 3.0
$\Delta\nu/\Delta\nu_D$
τ_c
0.01 0.10
Source Function
1.0 0.8 0.6 0.4 0.2 0.0
$S/S_{continuum}$
1 10 100
τ_o

2. Carroll & Ostlie: problem 3.8 (a), (e), (f), (g)

3. A spherical cloud of gas, with radius R and temperture T is emitting radiation at the rate P_ν (power per unit volume per unit frequency).(a) What is the radiation intensity received at Earth, as a function of impact parameter b (distance from cloud center), if the cloud is optically thick and a distance D $\gg$ R (see figure). (b) Now what is



the radiation intensity received at Earth, as a function of impact parameter b if the cloud is optically thin? (c) What is the flux at Earth from the entire cloud for an optically thin cloud? (d) What is the flux received at Earth from the entire cloud for an optically thick cloud?

4. Carroll & Ostlie: problem 9.22

5. Below is an image of the Sun taken in the continuumn (a broad wavelength range corresponding roughly to visible light). Based on this image, what can you tell about the variation of the source function (in this case equal to the Planck function) with height above the level of optical depth = 1 looking vertically down on the center of the Sun?