AST 300B – Spring 2018

In-class/Take-home Problems Due: Wednesday Feb 28

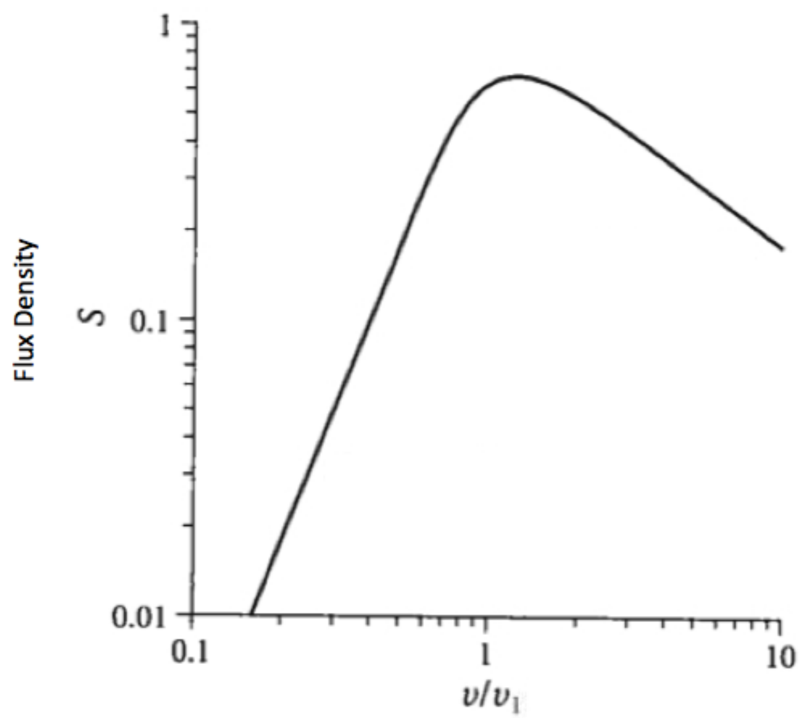
(SEE BACK for problem 26 – 2 pages)

25. Let's analyze the SED of non-thermal synchrotron emission. Assume the electrons obey a power-law in energy given by $N(E) = N_0\, E^{-\Gamma}$ cm^{-3} erg^{-1} (N_0 is a constant).

(a) Given the expressions for the emissivity and absorption coefficients for synchrotron radiation, derive the equation for the Source function. (Hint: Since the emission is non-thermal, can you assume $S_\nu = B_\nu(T)$?).

(b) Now write down the 1D solution to the radiative transfer equation assuming that the Source function is constant along the line of sight. Ignore the background. If the source has a solid angle of Ω, how does the observed flux density vary with ν (assume $F_\nu \sim I_\nu \Omega$) when the emission is the limits of optically thick and optically thin?

(c) On the plot below, indicate the frequency regions where the emission is optically thin and optically thick and the spectral indicies α ($F_\nu \sim \nu^\alpha$) in those limits (quote numbers). Also indicate approximately where $\tau_\nu \sim 1$.



26. Supernova SN1993J was observed toward M81 (D = 3.6 Mpc) in the radio 273 days after the observed explosion to have a rising spectrum ($\sim\nu^{2.5}$) at low frequencies with a flux density of ~ 72 mJy at 1.43 GHz and a falling spectrum ($\sim\nu^{-1}$) with a flux density of ~ 25 mJy at 23 GHz. The radius of the supernova was measured to be 0.0123 pc.

(a) Calculate the electron energy spectral index Γ for SN1993J

(b) What is the brightness temperature at 1.43 GHz?

(c) Calculate the strength of the B field (in Gauss)

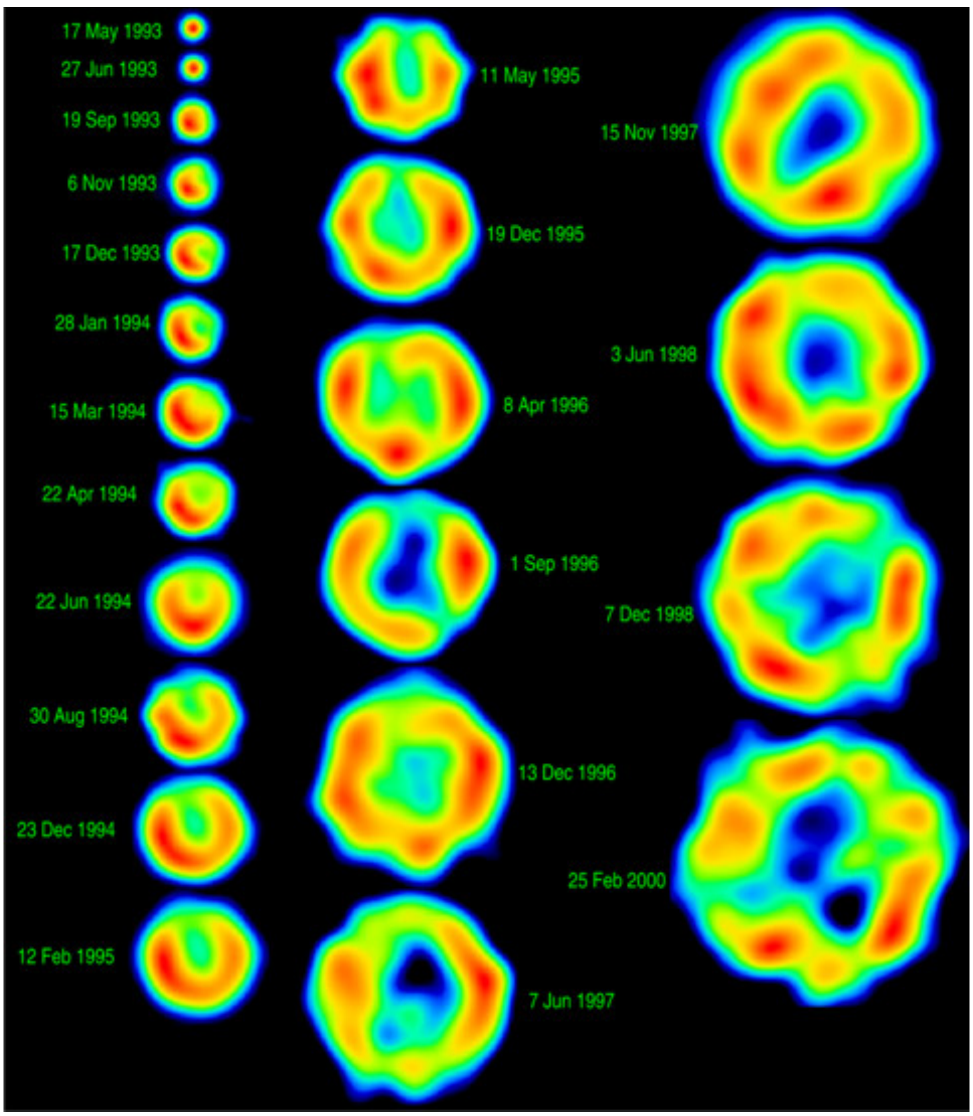


Figure 1: Time evolution of SN1993J observed by the VLBA