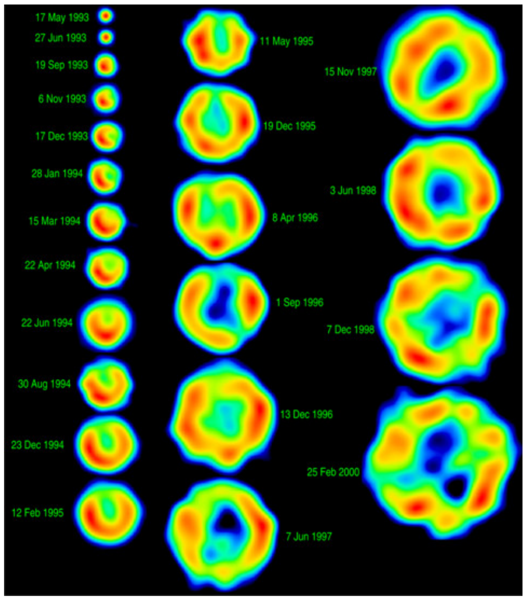
AST 300B – Spring 2019

<u>In-class/Take-home Problems Due: Mon. Feb. 25</u>

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



(a) If the source has a solid angle of Ω, how does the observed flux density of synchrotron emission vary with ν when the emission is in the limits of optically thick and optically thin (assume $F_\nu \sim I_\nu \Omega$, no background, and constant source function along the line of sight)? On the plot on the back, 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 (give numbers when possible). Also indicate where $\tau_\nu \sim 1$ on the plot. (**Hint:** Since the emission is ***non-thermal***, can you assume $S_\nu = B_\nu(T)$?).

(b) Supernova SN1993J was observed toward M81 (D = 3.6 Mpc) with the VLBA (see Figure above) 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. Calculate the strength of the magnetic field flux density B (give answer in Gauss – cgs unit where 1 Gauss = 10^{-4} Tesla).

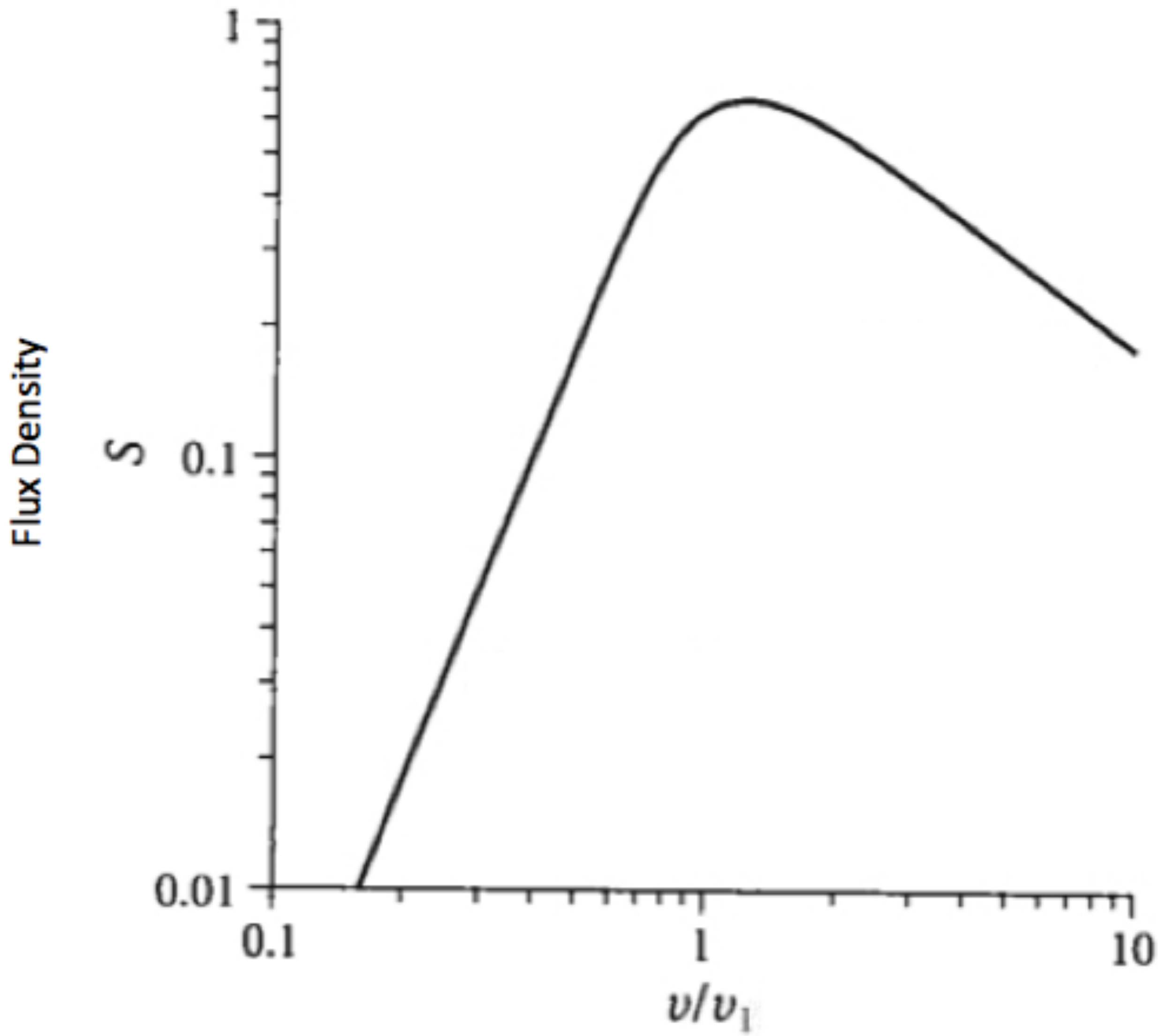


Figure: A synchrotron spectrum.