15. (a) Consider a spherical, optically thin dust thermal cloud with constant dust temperature $T_d$, constant dust opacity $\kappa_\nu$, and a radius $R$. Using the results from a previous homework, derive an equation relating the observed flux density of this cloud at a distance $d >> R$ to the mass of the cloud $M$. Write your answer in terms of the mass opacity $\kappa_\nu$ of the cloud.

(b) Consider a millimeter mapping survey of the Rho Ophiuchus molecular cloud at $\lambda = 1.3$ mm (below). If the cloud is located at a distance of 135 pc (the nearest molecular cloud to the Earth) and the mapping has a 3-sigma flux density sensitivity of 0.1 Jy (N.B. 1 Jy = $10^{-23}$ erg s$^{-1}$ cm$^{-2}$ Hz$^{-1}$), what gas mass is the survey sensitive to (quote your answer in solar masses) for dense cores at $T_d =$ 10K and 20 K. If dense cores are up to 50% efficient (meaning <= 50% of their mass goes into a forming star), could this survey detect dense cores capable of forming stars down to the hydrogen burning limit ($M \sim 0.08 \ M_{\odot}$)? $\kappa_\nu \sim 0.9$ cm$^2$/g of dust at 1.3mm (OH5).