Answer on Question #54985, Physics / Astronomy | Astrophysics

Star formation begins in Giant Molecular Clouds (GMCs). The Milky Way has several thousand of these objects, each with masses of $10^4 M_\odot < M < 10^7 M_\odot$, and sizes between 10 and 100 pc.

A cloud will collapse if the gravitational potential is stronger than its thermal (and magnetic) support. In other words $|E_{grav}| > 2E_i$. As we just saw, the internal energy is:

$$E_i = \int_0^{M_T} \frac{1}{\gamma - 1} \times \frac{P}{\rho} dM = \int_0^{M_T} \frac{1}{\gamma - 1} \times \frac{1}{\mu m_H} kT dM$$

For simplicity, let's take a uniform density, isothermal cloud. For such a cloud:

$$\left|E_{grav}\right| = \int_0^R \frac{GM(r)}{r} dM = \frac{3}{5}\frac{GM^2}{R} = 2E_i = \frac{2}{\gamma - 1} \times \frac{1}{\mu m_H} kTM$$

or:

$$M_J = \frac{5}{3} \times \frac{2}{\gamma - 1} \times \frac{1}{G\mu m_H} kTR$$

All scales larger than this are unstable to collapse.