Answer on Question #69702, Physics / Astronomy | Astrophysics

Ques. Derive the expression for the mean temperature in a star:< T > M^2/3 < P > ^1/3

Answer:

Internal energy $E_i = - E_g /2$

C E_g is Gravitational Energy.

$dP/dm = - G m /(4\pi r^4)$

Where P is the pressure, m is the mass enclosed in the spherical surface of radius r.

Gravitational Energy of the star

$E_g = - G M^2 / R$

Where, M = mass of the star and R = radius of the star

Let,

$\rho = M/[4\pi R^3 /3]$

R = [3 M / (4πρ)]^1/3

Internal Energy

E_i= 1/2 * G M^2 * [3 M / (4πρ)]^-1/3 = 1/2 * G M^(5/3) ρ^(1/3) * (3/4π)^1/3

Internal Energy (of a mono-atomic ideal gas or gas in the form of ions)

$E_i = 3/2\ k\ T\ N = 3/2\ k\ T\ [M /\mu\ m_H]$
Where, k = Boltzmann's constant, T = average temperature of the star, N = number of molecules/particles of gas, M = mass of the gas, m_H = mass of the particle of gas basically N is proportional to the mass M of star
We get:

E_i = M^(5/3) *ρ^(1/3) = T * M

T = M^(2/3) *ρ^(1/3)