Thermodynamics of density dependence of B parameter

From Thermodynamic point of view one can obtain the following relations:

\[ a = \frac{d\ln p}{d\ln \rho} \]

where \( a \) is a constant and \( \rho \) is the density. The last term in middle equation leads to a density dependent B parameter. For a constant B, this additional term which arises from the above three equations vanishes leading to MIT-B bag model EOS.

The values of the set \( \rho_0 \) and \( a \) are then used to determine the EOS of matter content. Here \( a \) is a constant which picks up different values for different combination of alpha and lambda.

**Physical Parameters**

The physical parameters of a general relativistic star are given by

\[ E = \frac{GM^2}{2R} + \frac{\omega^2 M^2}{2R^3} + \frac{\omega^4 M^2}{2R^5} \]

Eqs. (11) and (12) with equations (13) and (15) comprise a set of equations relevant for determining the physical parameters exactly.

The total mass of a star is given by

\[ M = \frac{4\pi}{3} \int_0^R \rho(r) r^2 dr \]

The Compensate factor 'a' (the ratio of mass to radius) is given by

\[ a = \frac{M}{R} \]

The parameter 'B' may be evaluated employing equations (11), (13), and (16), which is given by

\[ B = \frac{\rho^2}{\rho_0^2} \]

where \( \rho_0 \) is the mean density of the star.

The pressure inside the star should vanish, which yields

\[ \rho_0 \frac{d\rho}{dr} = 0 \]

Using equations (20), (21), and (22) we determine the constants C and D.

1. The pressure \( p \) inside the star, which leads to an inequality, is given by

\[ p \leq \frac{\rho^2}{\rho_0^2} \]

2. The pressure \( p \) inside the star, which leads to an inequality, is given by

\[ p \leq \frac{\rho^2}{\rho_0^2} \]

**Physical Application**

To study the effect of anisotropy of a compact star parameter 'B', we venture the eq. 19 becomes 0 where 1. Thus 'B' can be studied as a function of 'r' for different values of 'a' and 'B' is also determined numerically.

Once the constants C and D and the parameter 'B' is known, the value of 'B' can be evaluated using eq. (12) for different values of anisotropy parameter 'a'.

Thus 'B' can be studied as a function of 'r' for different values of 'a'. 'B' is also determined numerically.

**Numerical and Graphical result**

We study the interior of a compact star in two distinguished regions (i) near the center of the star and (ii) away from the center up to the surface.

Three different cases we have studied:

1. X Ray Pulsar HS 1113 [21] Mass M = 0.88 Ms, where Ms is the Solar mass Radius R = 7.7 Km., and the parameter 'a' = 0.1, which leads to Compton a = 0.2994.

2. SAX J 1808.4-3658 millisecond pulsar [16] Mass M = 1.435 Ms, where Ms is the Solar mass Radius R = 7.07 Km. and the parameter 'a' = 0.1, which leads to Compton a = 0.2994.

3. X-ray pulsar HER X-1 [21] Mass M = 0.68 Ms, where Ms is the Solar mass Radius R = 7.7 Km. which leads to Compton a = 0.2994.

**Conclusion**

- Physically viable relativistic models of a compact star having anisotropic matter content with strange EOS EOS, \( \rho, \omega \), etc., can be obtained by following the procedure suggested by Mahatheeji et al. [12].
- In this model parameter 'B' acquired a density dependence.
- For this the star parameter 'B' increased linearly with anisotropy parameter for given compactness and hadron parameter.
- Anisotropy of the star there is practically no effect of anisotropy on the value of parameter 'B'.
- For specific configuration of the compact object, parameter 'a' picks up negative value, indicating the repulsive nature of core region for such configuration or existence of exotic kind of matter.
- Equation of state of matter content inside the star this model is similar to that obtained from the consideration of micro-physics.
- Equation of state of matter content may be described by expansion of the pressure.

**General Solution**

The general solution of eq. (11) [20] is given below in two cases

1. Case I: In this case the value of \( a \) and \( \omega \) are such that \( \epsilon = \frac{\omega^4}{\omega^2} = \frac{\omega^2}{\omega^4} \)

\[ a = \frac{d\ln p}{d\ln \rho} \]

\[ \omega = \frac{d\ln p}{d\ln \rho} \]

2. Case II: In this case the value of \( a \) and \( \omega \) are such that \( \epsilon = \frac{\omega^4}{\omega^2} = \frac{\omega^2}{\omega^4} \)

\[ a = \frac{d\ln p}{d\ln \rho} \]

\[ \omega = \frac{d\ln p}{d\ln \rho} \]

Where C and D are two constants to be determined from boundary condition and...