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The Central Temperature of the Stars

Angel Fierros Palacios

Instituto de Investigaciones Eléctricas, División de Energías Alternas, Mexico City, Mexico
Email: afierros@iie.org.mx

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Abstract

From the theory about the internal structure and stars stability, a relationship for the central temperature of any gaseous star can be obtained.

Keywords

The Central Temperature of the Stars

1. Introduction

The value of the main parameters of the *Sun* and other stars, like the luminosity and the central temperature, can be obtained from the basic equations of the theory about the stability and equilibrium of the stars [1] [2]. However, given that some of its results are not totally satisfactory, it is necessary to modify that theory in order to get a new analytical scheme more wide and useful [1].

2. The Self-Generated Magnetic Field and the Central Temperature

Let us consider the following relations

$$L = \frac{4\pi GcM}{\alpha k_c}\left(\frac{1-\beta}{\beta}\right) \tag{1}$$

This is the *modified mass-luminosity relation* [1]. Here, L is the luminosity, M the mass, c the velocity of light in the empty space, G the universal gravitational constant, k_c the opacity coefficient at the center of the star, and $\alpha = 2.5$ a constant [1] [2]. Moreover, β is a parameter which represents the ratio between hot gases pressure and the whole pressure, while $1 - \beta$ is the ratio between radiation pressure and the whole pressure [1] [2]. Then,

$$\begin{gathered}(1-\beta)\, p = p_r \\ \beta p = p_g;\end{gathered} \tag{2}$$

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where p is the whole pressure, and

$$p_r = \frac{1}{3} a T^4$$
$$p_g = \frac{\mathcal{R} \rho T}{\mu} \tag{3}$$

are the radiation pressure and the hot gases pressure, respectively. In those relations, T is the temperature, ρ the mass density, $\mathcal{R}$ the gases universal constant, μ the average molecular weight, and $a = 7.64 \times 10^{-15}$ the *Stefan's constant* [1] [2].

Now, from the momentum balance equation of magneto hydrodynamics [3], and for any gaseous star, it follows that [2] [3]

$$H^2 = \frac{4\pi \mathcal{R} \rho T}{\mu} \tag{4}$$

where H^2 is the square of the intense magnetic field which all gaseous stars self-generate at an early stage of their evolution.

Substituting (2) and (3) in (4) we obtain that

$$H^2 = \frac{4\pi a \beta T^4}{3(1-\beta)} \tag{5}$$

and then

$$T_c = \left[\frac{3H^2}{4\pi a} \left(\frac{1-\beta}{\beta} \right) \right]^{1/4} \tag{6}$$

where the subscript c means the temperature at the center of stars. However, T_c and H^2 are directly related; so that another independent equation is necessary for the magnetic field. Hence, from the *polytropic gas sphere theory* [1]-[3], it can be obtained the relationship that follows

$$H^2 = 2\rho \pi \phi \left(\frac{1-\beta}{\beta} \right) \tag{7}$$

where

$$\phi = \frac{GM}{R} \tag{8}$$

is the *gravitational potential*, R the stellar radius, and M the mass [1].

Substituting (7) and (8) in the relation (1) we have that

$$H^2 = \frac{\alpha k_c \rho_c L}{2cR} \tag{9}$$

Finally, with this result substituting in (6), it is easy to see that

$$T_c = \left[\frac{3\alpha k_c \rho_c L}{8\pi c a R} \left(\frac{1-\beta}{\beta} \right) \right]^{1/4} \tag{10}$$

Thus, for any gaseous star, the central temperature behaves as a constant, in the meantime, the power generating source can be feed with new nuclear fuel [1].

3. Conclusions

In the specialized literature [1]-[3], the values of central temperature of the *Sun*, and also its luminosity estimated with the use of the non modified theory about the stability and equilibrium of the stars [2], are over valuated. In fact, the data reported are the following

$$L_{\odot} = 5.62 \times 10^{33} \text{ ergs} \cdot \text{sec}^{-1}$$

$$T_{c\odot} = 39.5 \times 10^{6} \text{ K};$$

where the symbol $\odot$ indicates the *Sun*.

This is so, because the self-generated magnetic field has never been included in that theory [1] [2]. In order to get the before mentioned modification, that magnetic field was introduced in the fundamental equation that governed the state of equilibrium, which is now magneto-mechanical [1], in order to get more realistic values for those sun's basically parameters.

Hence, for $L_{\odot}$ the calculated and the observational data has the same value, while the central temperature has the following magnitude

$$T_{c\odot} = 16.5 \times 10^{6} \text{ K};$$

which is a more acceptable value, given the stability and the state of equilibrium of the *Sun*. In consequence, the relationship (10) is useful to calculate the central temperature for any gaseous star.

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