Entropy, neutrino physics, and the lithium problem: why are there stars with essentially no lithium due to serious lithium deficiency in certain spatial regions in the early universe?

A. Beckwith,[1,2]

[1]beckwith@aibep.org, abeckwith@uh.edu
[2]American Institute of Beam Energy Propulsion (life member)

October 18, 2009

Abstract

The consequences of abnormally low lithium abundance in a nearby population II star (which is almost as old as the supposed population III stars) as represented by HE0107-5240 are that standard BBN theory is out of sync with observations. Analysis of the big bang nucleosynthesis may help explain the anomalously low value of lithium abundance in the star HE0107-5240, which by orthodox BBN, should not exist, as explained by Shigeyama et al. [1].

Introduction

The dimensional identification of energy given by p^0, as well as variation in energy ΔE in a graviton, with $p^0 \sim \overline{L} \cdot \mu$ and $\Delta E \sim \overline{L} \cdot \mu$, define how gravitons evolve in space time due to conditions which are related to the degree gravitons evolving in space time relate to the gravitational Lorenz violation. Note that $\overline{L} \neq 0$ extends the standard model, as given by Jenkens [2], in which, if gravitons travel with a speed of v, $\overline{L} \sim (v-c)/c$. Bashinsky's [3] analysis with neutrino-graviton interaction occurs as $\overline{L} \neq 0$ becomes $\overline{L} \to 0$. We are seeking to understand the regime where neutrino-graviton mixing may be taking place, allowing for stars like HE0107-5240.

1 Dispersion of neutrinos in early cosmology

Marklund et al. [4] have estimated neutrino mass as $m_v^2 = -g_{\alpha\beta} p^\alpha p^\beta$, where m_v is neutrino mass, $g_{\alpha\beta}$ is for a metric, and p^α is four momentum. If space becomes abruptly flat at the onset of inflation, for a neutrino mass, as $\overline{L} \neq 0$ approaches zero, $g_{\alpha\beta}$ approaches $g_{\alpha\alpha}$ (i.e. leading to flat space), then by Marklund et al. [4], there exits, assuming k^α is a four space wave number, the inequality

$$\omega_F^2 > (g_{\alpha\alpha}/|g_{00}|) \cdot [k^\alpha]^2 + 2\omega_F (g_{00}/|g_{00}|) k^0. \tag{1}$$

It is suggested that neutrino-graviton interactions would allow a researcher to input values of k^α, k^0, $g_{\alpha\alpha}$, and g_{00} when Eqn. (1) is true. Based on this, the neutrino has approximately $10^{28} - 10^{29}$ times the effective mass of a graviton.

$$m_{\text{graviton}} \leq 4.4 \times 10^{-22} h^{-1} eV/c^2 \Leftrightarrow \lambda_{\text{graviton}} \equiv \frac{\hbar}{m_{\text{graviton}} \cdot c} \sim 2.8 \times 10^{15} \text{ meters} \tag{2}$$

versus

$$m_{\text{neutrino-relic-condt}} \leq .5 \times 10^{-1} h^{-1} eV/c^2 \Leftrightarrow \lambda_{\text{neutrino-relic-condt}} \equiv \frac{\hbar}{m_n \cdot c} \sim 2.8 \times 10^{-8} \text{ meters.} \tag{3}$$

I.e., for non-relativistic conditions, the contribution of the neutrino is $10^{22} - 10^{23}$ times larger than that from a graviton. So for a non-relativistic graviton, we have $\mu / M_{\text{Planck}} \sim \overline{L} \propto \frac{c-v}{c} \Leftrightarrow \frac{p^0}{\mu} \leq 1$. Once we specify that it is likely that graviton-neutrino wave mixing took place as $\overline{L} \to 0$, we can consider entropy contributions in the time neutrinos interacted with gravitons to perturbations on DM which may influence BBN.

2 Entropy generation via Ng's infinite quantum statistics

To understand the link between dark matter and gravitons, note that the "size" V of the nucleation space for dark matter is large, whereas graviton space V for nucleation is tiny and well inside inflation. Therefore, the log factor drops out of entropy S if V is chosen properly for both Eqn. (4) and Eqn. (5). According to Ng [5], removing the N from the denominator of $\lfloor V/N\lambda^3 \rfloor$ leads to entropy of the value $S = (\log[Z_N])$.

$$S \approx N \cdot (\log[V/N\lambda^3] + 5/2) \text{ which becomes } N \cdot (\log[V/\lambda^3] + 5/2) \approx N. \tag{4}$$

However, $V \approx R_H^3 \approx \lambda^3$. So unless N in Eqn. (4) is about 1, S (entropy) would be < 0, which is a contradiction. Now this is where Ng [5] introduces removing the $N!$ term in Eqn. (4) where $g_{\text{today}} \approx 2-3$ in today's cosmos. We assert that Eqn. (4) occurs in a region of spacetime before $g_{\text{re-heat}} \approx 1000$. So after reheating, Eqn. (4) no longer holds, and we instead can look at

$$S_{\text{total}} \equiv S_{\text{Density}} \cdot V_4 = \frac{2\pi^2}{45} \cdot g_\bullet \cdot T^3 \cdot V_4 \tag{5}$$

where $T < 10^{32} K$. We can compare Eqn. (4) to Glinka's [6] quantum gas if we identify $\Omega = \frac{1}{2|u|^2 - 1}$ as a partition function (with u part of a Bogoliubov transformation) due to a graviton-quintessence gas, leading to an information theory based entropy value of $S \equiv \ln \Omega$. Eventually the contributing graviton wave functional becomes, instead, the same order of magnitude as the matter wave values of neutrinos:

$$m_{\text{graviton}}\Big|_{\text{RELATIVISTIC}} < 4.4 \times 10^{-22} h^{-1} eV/c^2 \Leftrightarrow \lambda_{\text{graviton}} \equiv \frac{\hbar}{m_{\text{graviton}} \cdot c} < 2.8 \times 10^{-8} \text{ meters.} \tag{6}$$

Also, the graviton wavelength could be within the initial sphere of space time at of the onset of inflation.

3 How DM would be influenced by gravitons

The interrelationship of structure with the DM density profile was given to the author by Matarre [7] as

$$\delta \equiv - \left[\frac{3}{2} \cdot \Omega_m \cdot H^2 \right]^{-1} \cdot \nabla^2 \Phi. \tag{7}$$

As presented by Matarre [7], the gravitational potential has, perturbatively speaking, an additional term f_{NL} added to variations in the gravitational potential term, which Matarre gave as

$$\Phi \equiv \Phi_L + f_{NL} \cdot \lfloor \Phi_L^2 - \langle \Phi_L^2 \rangle \rfloor + g_{NL} \cdot \Phi_L^3. \tag{8}$$

It is suggested that the function f_{NL} is largely due to entropy variations, some of which occurred during relic GW/graviton production. Here the expression f_{NL} equals variations from gaussianity. Furthermore, Φ_L is a linear Gaussian potential, and the overall gravitational potential is altered by inputs from f_{NL}. Note that f_{NL} is barely influenced by neutrino flavor oscillations, with no contributions to f_{NL} from standard neutrino flavor oscillation physics. Raffert [8] informed the author that extensions of the standard model may permit f_{NL} to have a weak dependence upon neutrino flavor oscillations. This non-importance of f_{NL} as far as being influenced by neutrino flavor oscillations leads the author to consider neutrino-graviton damping as a contributor to f_{NL}. This leads to emphasizing the role of entropy processes due to graviton-neutrino physics as $\overline{L} \rightarrow 0$.

4 Conclusion

The start to this investigation is to explain how and why the star HE0107-5240 could form with so little lithium in the first place. As stated by Fuller et al. [9], neutrinos could interact with DM potential wells in ways Beckwith [10] thinks could influence deviations from standard galaxy hierarchy formation models, which will also have a counter part in deviations in the BBN nucleosynthesis of light elements, by examining the role of temperature fluctuations modeled on Eqn. (9) below, leading to fluctuations affecting BBN element rarity.

$$(\delta T/T) \cong (1/3) \cdot \lfloor \Phi_L + \widetilde{f}_{NL} \cdot (\Phi_L^2 - \langle \Phi_L \rangle^2) \rfloor \tag{9}$$

While Eqn (8) above would have its maximum impact for regions as of about red shift $Z \sim 1.5 - 2.0$, the impact of Eqn (9) would be of red shifts $Z \sim 1000 - 1100$, with the corresponding $\widetilde{f}_{NL}$ influenced by Bashinsky's [3] neutrino-graviton damping, as stated by the coefficient of density fluctuation modified by $\lfloor 1 - 5 \cdot (\rho_{\text{neutrino}}/\rho) + \vartheta([\rho_{\text{neutrino}}/\rho]^2) \rfloor$. Note that $\widetilde{f}_{NL}$ would be larger than f_{NL} of Eqn. (8) and would be dominated by neutrino-graviton interactions, whereas f_{NL} would be dominated by graviton generated entropy, with neutrinos at $Z \sim 2.0$ hitting DM directly.

References

[1] T. Shigeyama, T. Tsujimoto, and Y. Yoshii, *Astrophys. J.* 586 (2003) L57-L60

[2] A. Jenkens, *Constraints on emergent gravity*, arXiv:0904.0453v1 [gr-qc] (2009)

[3] S. Bashinsky, *Coupled Evolution of Primordial Gravity Waves and Relic Neutrinos*, arXiv:astro-ph/0505502v1 (2005)

[4] M. Marklund, G. Brodin, and P.K. Shukla, *Phys. Scr.* T82 (1999) 130-132

[5] Y.J. Ng, *Entropy* 10 (2008) 4

[6] L. Glinka, *SIGMA* 3 (2007) 087

[7] S. Matarre, Lecture, International School of Astro Particle Physics, Como-Italy (10 July 2009)

[8] G. Raffert, Erice Nuclear Physics School, Private conversation (23 September 2009)

[9] G. Fuller and C. Kishimoto, *Phys. Rev. Lett.* 102 (2009) 201303

[10] A.W. Beckwith, *Entropy, Neutrino Physics, and the Lithium Problem: Why Stars with no Lithium in Early Universe Exist*, viXra:0910.0001 (2009)