Dynamics of the Core of Baryons

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Abstract: In 2017, scientists from Osaka University measured unexpected gamma-ray energy spectrum of the lithium reaction with the 246-MeV protons. Here, using the dynamics of the core of baryons described within the Scale-Symmetric Theory (SST), we showed that the two absorption lines follow from such dynamics.

1. Introduction

In 2017, researchers from Osaka University measured unexpected flux as function of gamma-ray energy for collisions of the 246-MeV protons with ^{7}Li [1]. There are two absorption lines with central values ~3.5 MeV and ~21 MeV (see Fig.3 in [1]).

On the other hand, the energies ~0.3 MeV and ~400 MeV appear as the peaks in best-fit model for the time-integrated photon spectrum (3.3 s – 21.6 s) for Gamma-Ray Bursts (GRBs) [2].

Here we show that the four gamma-ray energies (we show that their more precise values are 3.42 MeV, 21.48 MeV, 0.27 MeV and ~424.4 MeV) follow from the dynamics of the core of baryons which partially is described in the Scale-Symmetric Theory (SST) [3].

The core of baryons [3] consists of the spin-1/2 torus/electric-charge with a mass of $X^{+,-}$ = 318.2955 MeV and the spin-zero scalar condensate with a mass of Y = 424.1245 MeV. Inside the torus are created the large loops with a mass of m_{LL} = 67.54441 MeV which are responsible for the nuclear strong interactions (the neutral pion, π^{o} = 134.97674 MeV is the spin-zero binary system of such large loops with components interacting electromagnetically). We can calculate mass of such loop from $X^{+,-}$

$$m_{LL} = 2\, X^{+,-} / (3\pi)\,. \qquad (1)$$

2. The spectral lines from dynamics of the core of baryons

Range of the large loop, so of the neutral pion as well (it is responsible for the strong interactions), is $2\pi R$, where R is the radius of the loop. It follows from the rolling-unrolling mechanism characteristic for the virtual (or real) large loops. On the other hand, range is inversely proportional to mass so mass of the loop with a radius of $2\pi R$ is

$$M_1 = \pi^{o} / (2\pi) = 21.48 \text{ MeV}\,. \qquad (2)$$

Next such unrolling leads to mass

$$M_2 = M_1 / (2\pi) = 3.42 \text{ MeV} . \quad (3)$$

The creations of loops with masses of M_1 and M_2, which can next transform into the neutral pions, cause that there appear the observed gamma-ray absorption lines.

But there can be a transition from the spin motion of the large loop to the vibrations along its radius. It leads to conclusion that mass of the loop increases 2π times and next such energy is emitted

$$E_3 = Y^* = 2 \pi m_{LL} = 424.4 \text{ MeV} . \quad (4)$$

From the Stefan-Boltzmann law we have

$$j^* \sim T^4 , \quad (5)$$

where j^* is the total energy radiated per unit surface area of a black body across all wavelengths per unit time (the radiant emittance), and T is the black body's thermodynamic absolute temperature. The radiant emittance is the radiant flux emitted by a surface per unit area. In our theory, the area of the condensate Y^* (it behaves as a star) is constant so the assumption that radiant flux is constant leads to

$$j^* \sim E_{Emitted} , \quad (6)$$

where $E_{Emitted}$ is the emitted energy during a time t.

We know that emitted energy is directly proportional to four powers of temperature while from the Wien's displacement law we have that absolute temperature is inversely proportional to wavelength (which, here, decreases from $2\pi r$ to r) i.e. emitted energy is directly proportional to $1/(2\pi)^4$

$$E_4 = E_3 / (2\pi)^4 = 0.27 \text{ MeV} . \quad (7)$$

3. Summary

Here, using the SST dynamics of the core of baryons, we showed that many elements of the curve describing dependence of the gamma-ray flux on energy of photons can be explained via such dynamics.

References

[1] Yosuke Iwamoto, et al. (2017). "Experimental analysis of neutron and background gamma-ray energy spectra of 80-400 MeV ^{7}Li(p,n) reactions under the quasi-monoenergetic neutron field at RCNP, Osaka University"
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