On Registration of a Massless Bose Particle - *Hion* With Spin 1, Whose Bose-Einstein Condensation Forms Dark Energy

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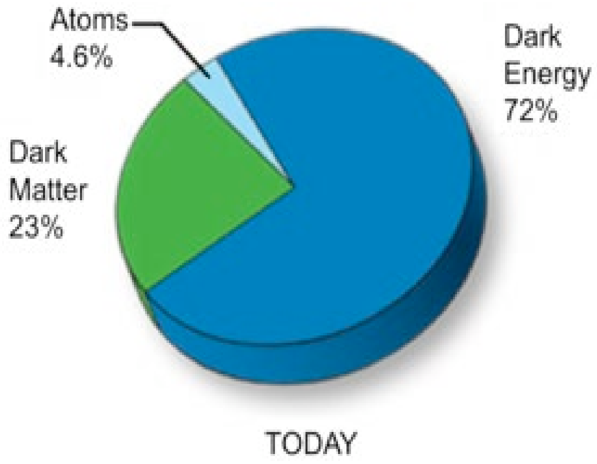
27 September 2021, Yerevan

Yerevan -2021, Armenia

The Main Types of Matter in the Universe

- Modern science claims that our universe is about 4.6% ordinary matter (nucleons, electrons, atoms etc.). Another 23% is mysterious *dark matter*, which we know very little about, since it is inaccessible for direct observation and, accordingly, 72.1% is *dark energy*, which we also know little about.
- The most popular hypothesis is the "cosmological constant", which states that *dark energy* is the "cost of the existence of space."
- The hypothesis of "quintessence" is also popular - a scalar field unknown for today, which leads to the existence of the same *dark energy* as the first hypothesis.



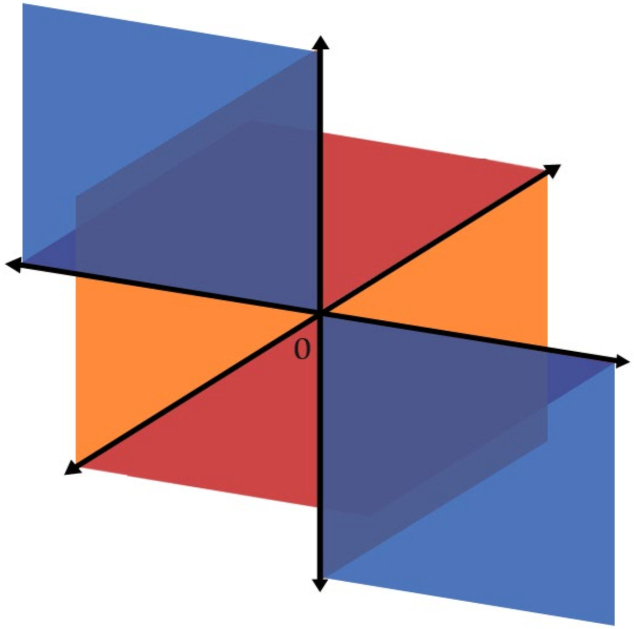
I adhere to the hypothesis that any volume of space has some fundamental, only its inherent energy.

Scalar Field

- Although a fundamental scalar field has not yet been observed experimentally, it is generally accepted that such fields play a key role in the construction of modern theory of elementary particles.
- There are several important hypothetical scalar fields, for example, the Higgs field for the *Standard Model*, dark energy-quintessence for the theory of quantum vacuum, etc. Recall that the presence of each of them is necessary for a complete classification of the theory of fundamental fields, including for the string theory.
- As shown in [Savvidy, G.K., Phys. Lett. B 1977, 71, 133–134.], as well as in work [Scharf, G., Il Nuovo Cim. A 1996, 109, 1605–1607.], the radiative corrections of the massless Yang–Mills theory, in the framework of the SU(3) gauge symmetry group, leads to instability of the vacuum state, which corresponds to the asymptotic freedom of gauge theories and is due to infrared features.
- Thus, within the framework of the Yang-Mills theory, including taking into account non-Abelian terms, it is impossible to obtain solutions for massless particles, and this is a very serious problem for the theory.

Stochastic Extension of Yang-Mills Theory

- To solve this problem, we recently proposed using complex stochastic differential equations (SDEs) of Langevin type as the basic equation of motion, for which the Yang-Mills equations are the principle of local correspondence [Gevorkyan, A.S., Particles **2019**, 2, 281–308].
- In particular, for the gauge symmetry group SU(2)xU(1), which describes electroweak fields, we have proved the possibility of the formation of a stable massless Bose particle (*hion*) with spin 1 in the limit of statistical equilibrium.



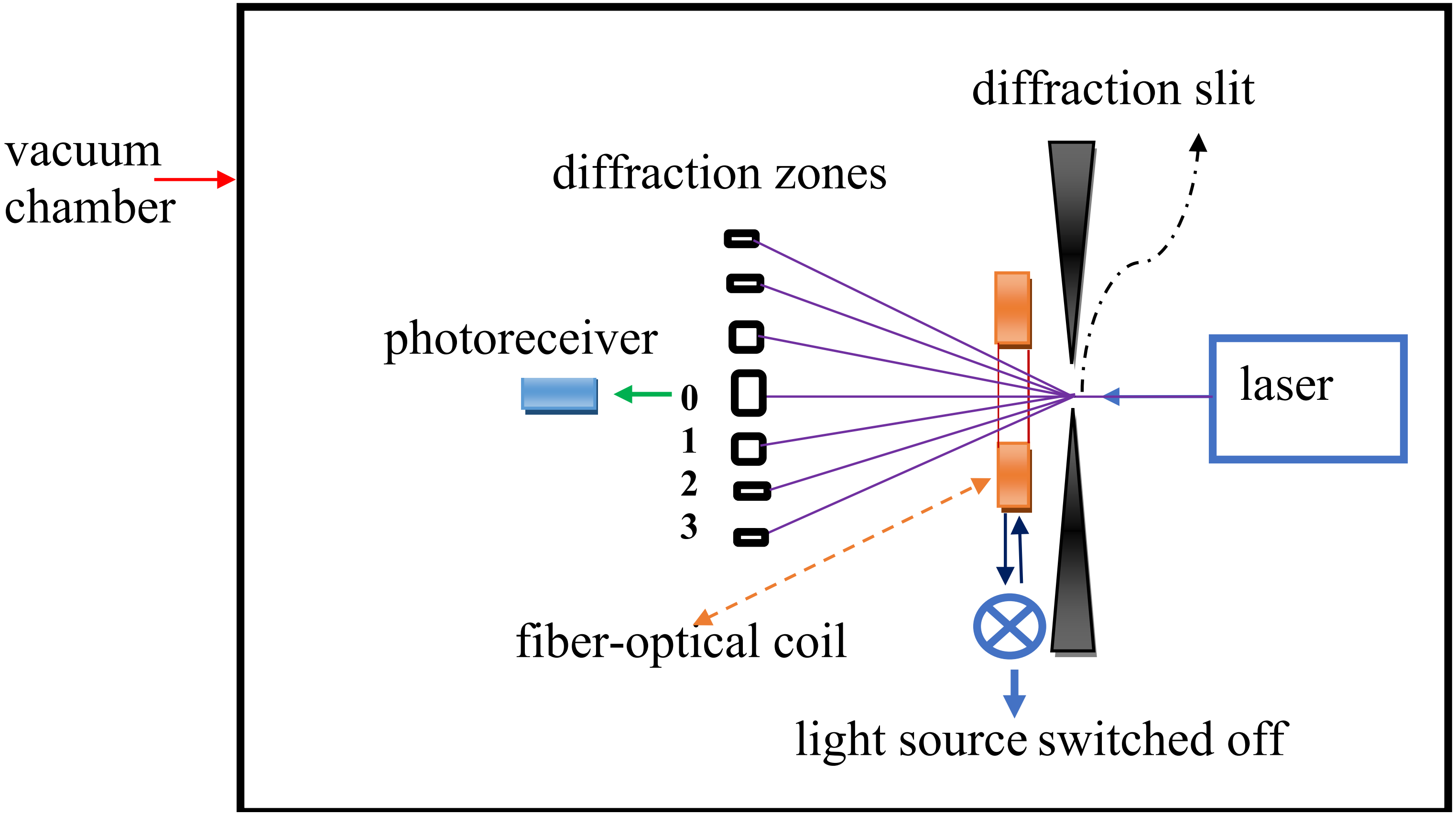
Vector bosons (hions) with opposite +1 and -1 spin projections entangled and create a spin-0 boson. The condensation of these bosons leads to the formation of a Bose-Einstein condensate, or a scalar field, which can play the role of dark energy.

Figure 1. *The coordinate system X,Y,Z divides the three-dimensional space into eight spatial regions using three planes. The boson of a vector field (hion) with projection of spin +1 is a structure consisting of six components, which localized on this manifold.*

Vector Field and the Idea of Its Experimental Registration

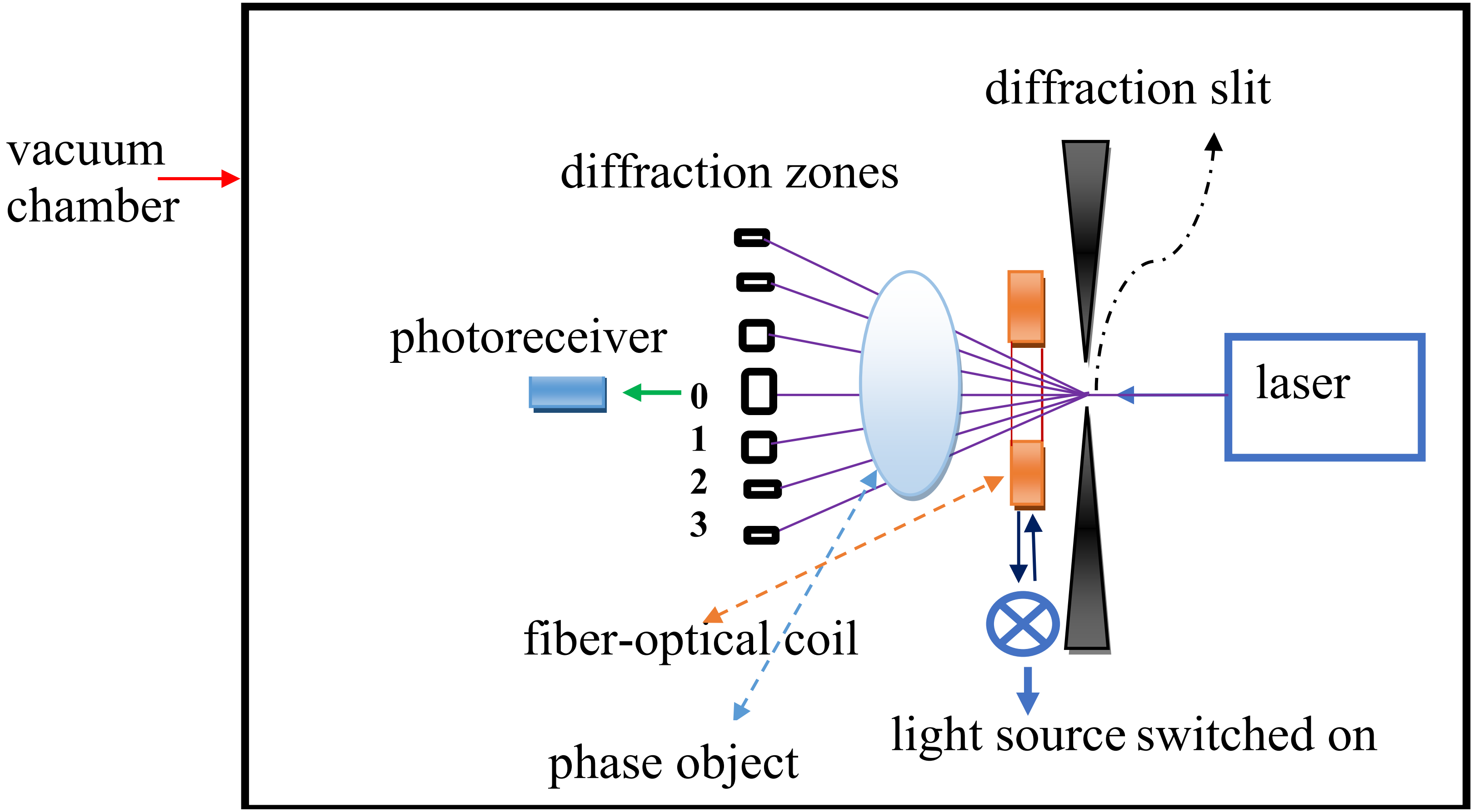
- As already mentioned, the scalar field practically fills the entire space evenly. Moreover, we have the right to speak about space when it is filled with a scalar field.
- However, we have shown theoretically that a scalar field has a finite probability of decay on a vector field, which consists of massless, chargeless particles, i.e. *hions* that have unit spins.
- We assume that they should also be uniformly and isotropically distributed in space, so that on atomic volume scales the total spin should be equal to zero.
- Unfortunately, it is impossible theoretically to estimate either the size or the concentration of *hions* in space, since the theory includes two unknown constants that can be determined only by experimental way.
- If everything said is correct, then a natural question arises, namely, how to influence the vector field so that the isotropy of the spin distribution is violated in space?
- Obviously, this would lead to the appearance of polarizability in space and, accordingly, would change the refractive indices of the vacuum.
- In other words, our goal is to transform the vector field, which is a component of dark energy, into a phase object by external influence and register it experimentally.

Experimental Setup



When the second light source is turned off, the usual Fresnel diffraction pattern appears on the screen behind the slit.

Experimental Setup with a Switched on Second Light Source



When the second light source is turned on, a diffraction pattern appears on the screen behind the slit that visually differs from the usual Fresnel diffraction pattern.

Experiment Description

- On the right, a laser beam with a wavelength of *l* = 440 nm falls on the slit and diffracts.
- In the case where the light beam from the second source does not pass through the optical fiber, i.e., the light source is simply turned off; behind the slit on the screen, we observe the usual Fresnel diffraction pattern.
- If the second light source is switched on and the light beam circulates through the optical waveguide, then after a while the illumination of the diffraction zones changes and, interestingly, the boundaries of the zones themselves definitely change.
- If a second light source is included, then there is only one explanation for this phenomenon. After switching on the second light source, a phase object is formed behind the slit of *haions* (vacuum is a deep and in this region there is nothing except massless *haions*), which is fixed by very sensitive beams of diffracted light.
- Thus, it can be argued that in a very simple experiment in the visible light region we indirectly prove the existence of massless particles (*hions*) of the vector field.
- Experiments continue and we hope to obtain new data on the nature of the interaction of vector bosons with light.

THANK YOU FOR ATTENTION!