ALGEBRAIC VERSION OF THE CRITICAL PHENOMENA THEORY IN THE VICINITY OF CRITICAL POINTS

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1. It is proposed the application to critical phenomena of the previously proposed [1] hypothesis of the phase transition-decomposition of the maternal universe, described by the semisimple Clifford algebra (CA) $Cl_{1,9}$ [2], to direct sum of CA $Cl_{1,3}$ (which corresponds to our Universe) and "universes-algebras" $Cl_{0,4}$, $Cl_{0,6}$, which have degenerate time degree of freedom into space one. It is considered a paradigm energy portals reversible tunneling between Minkowski space $Cl_{1,3}$ and $Cl_{0,4}$- spaces, which are isomorphic in terms of the sum equality of the corresponding signatures. This fact may explain phase transitions and the appearance of fluctuations when the system achieves the vicinity of critical points not statistically, as in standard theories, but in a systematic natural way, using (i) invertible transformations of the metric in critical area and (ii) the law of conservation of energy as basic invariant under decomposition of the maternal space $Cl_{1,9}$. Examples of model using in comparison with standard theories of critical phenomena are given.

2. The motivation for constructing such model and various related studies is caused by recent discoveries in astrophysics, especially when using the James Webb Space Telescope (JWST). These discoveries are questioned the Standard Model with the Big Bang theory (BB). In contrast to the BB theory in this dynamical algebraic model (DAM), it is proposed that the BB did not exist at all, but a phase transition from infinite and continuous universe took place.

Such transition according to the Frobenius theorem [2] is mathematically corresponding to complete decomposition of a semisimple CA into a direct sum of CA and its complement *C* to a complete CA:

$$Cl_{1,9} \cong Cl_{1,3} \oplus C \cong Cl_{1,3} \oplus \bigoplus\nolimits_{i=1}^{n_1} (Cl_{0,6})_i \oplus \bigoplus\nolimits_{j=1}^{n_2} (Cl_{0,4})_j, \qquad (1)$$

where $n_1 = 15$ and $n_2 = 3$ chosen in such a way as to satisfy the condition of preserving the number of basic elements (algebra's dimension) $\mathbb{N} = 2^{p+q} = 2^{1+9} = 2^{10} = 1024$ of the maternal CA $Cl_{1,9}$. Expansion (1) contains CAs $Cl_{0,4}$, which are isomorphic to $Cl_{1,3}$, then it is natural to assume energy exchange between them. In $Cl_{0,4}$ the time degree of freedom is degenerated into a spatial one. This fact is used to construct an algebraic theory of reversible energy tunneling between isomorphic spaces through a transition portal:

$$Cl_{1,3} \Leftrightarrow Cl_{0,4}. \qquad (2)$$

So, there are main ideas: (i) portal is a new introduced concept, broader than the vicinity of a critical point, because it also performs the additional function of interconversion between time and spatial degrees of freedom and (ii) integral energy of all subspaces must be conserved. Namely the absence of an explicit dependence on time into $Cl_{0,4}$ explains any critical phenomena accompanied by strong fluctuations of macro-quantities into the vicinity of critical points, because namely there appears reversible energy tunneling through the portal with the preservation of the integral energy. This means that when energy passes between spaces through the portal, the global energy remains constant, but metric has reversible changes:

$$ds_{1,3}^2 = -f(t)dt^2 + a^2(dx^2 + dy^2 + dz^2) \Leftrightarrow ds_{0,4}^2 = g(w)dw^2 + b^2(dx^2 + dy^2 + dz^2 + du^2), \qquad (3)$$

where $f(t)$, $g(w)$, a, b, du^2 - portal parameters.

Here we till ignore tunneling into $Cl_{0,6}$ spaces which are non-isomorphic to our Universe as unlikely.

3. As an example, this algebraic model is used to construct a phase diagram that may differ from the usual QCD phase diagram, the causes and consequences of this difference are given.

1. S.O. Omelchenko. The hypothesis of phase transition from supersymmetric matter to ordinary one. In: Proc. of XXXI-th Annual Scientific Conference of the Institute for Nuclear Research, May 27-31, 2024 (Kyiv, 2024) p. 42.
2. P. Lounesto. *Clifford algebra and spinors*. 2nd ed. (Cambridge: Cambridge University Press, 2001) 346 p.