Nonlinearity of the non-Abelian gauge field theory on lattice considering the spectrum of Kolmogorov-Sinai entropy and complexity

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The Yang-Mills fields have an important role in the non-Abelian gauge field theory which describes the properties of the quark-gluon plasma. The real time evolution of the classical fields is given by the equations of motion which are derived from the Hamiltonians to contain the term of the SU(2) gauge field tensor[1]. This system shows chaotic behaviour[2, 5, 6]. The homogeneous Yang-Mills contains the quadratic part of the gauge field strength tensor $F^a_{\mu\nu}$ in the Minkowski space, it is expressed by gauge fields A^a_μ :

$$F^a_{\mu\nu} = \partial_\mu A^a_\nu - \partial_\nu A^a_\mu + g f^{abc} A^b_\mu A^c_\nu, \tag{1}$$

where $\mu, \nu = 0, 1, 2, 3$ are space-time coordinates, the symmetry generators are labeled by $a, b, c = 1, 2, 3$, g is the bare gauge coupling constant and f^{abc} are the structure constant of the continuous Lie group. The generators of the Lie group fulfills the following relationship $[T^b, T^c] = i f^{bcd} T^d$.

The equation of motion can be expressed by covariant derivative in the adjoin representation:

$$\partial^\mu F^a_{\mu\nu} + g f^{abc} A^{b\mu} F^c_{\mu\nu} = 0. \tag{2}$$

The real time evolution of the classical Yang-Mills fields equations is derived by the Hamiltonian for SU(2) gauge field tensor to constraint the total energy on constant values and it satisfies the Gauss law[3, 4]. The microcanonical equations of motion are solved on N^d lattice and chaotic dynamics is studied by the time dependent entropy-energy relation, which was presented by the spectrum of Kolmogorov-Sinai entropy and the complexity[7].

References

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