QCD Vacuum Structure and Confinement

Monday, 26 August 2024 - Friday, 30 August 2024

Book of Abstracts

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Were there any anomalies in the gluon jets in ALEPH?

Author: Inkyu Park[1]

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According to the Abelian decomposition of QCD, there is a theoretical prediction that gluons can be classified into two types, each exhibiting distinct experimental signatures. The optimal setting for experimental verification of this theory is a clean environment such as the LEP, rather than the LHC. We have investigated whether there were any anomalies observed already in the gluon jets recorded in the ALEPH experiment and revisited the analyses with the archived ALEPH data. In this presentation, we will show our latest updates on our study on the gluon jet properties in ALEPH.

2

Dual Theory of Decaying Turbulence

Author: Alexander Migdal[1]

[1] *New York University, Abu Dhabi*

We have found an infinite dimensional manifold of exact solutions of the Navier-Stokes loop equation for the Wilson loop in decaying Turbulence in arbitrary dimension d > 2. This solution family is equivalent to a fractal curve in complex space Cd with random steps parametrized by N Ising variables σi = ±1, in addition to a rational number p q and an integer winding number r, related by Σ σi = qr. This equivalence provides a dual theory describing a strong turbulent phase of the Navier Stokes flow in Rd space as a random geometry in a different space, like ADS/CFT correspondence in gauge theory. From a mathematical point of view, this theory implements a stochastic solution of the unforced Navier-Stokes equations. For a theoretical physicist, this is a quantum statistical system with integer-valued parameters, satisfying some number theory constraints. Its long-range interaction leads to critical phenomena when its size N ⟶ ∞ or its chemical potential μ ⟶ 0. The system with fixed N has different asymptotics at odd and even N ⟶ ∞, but the limit μ ⟶ 0 is well defined. The energy dissipation rate is analytically calculated as a function of μ using methods of number theory. It grows as ν/μ 2 in the continuum limit μ ⟶ 0, leading to anomalous dissipation at μ ∝ √ ν ⟶ 0. The same method is used to compute all the local vorticity distribution, which has no continuum limit but is renormalizable in the sense that infinities can be absorbed into the redefinition of the parameters. The small perturbation of the fixed manifold satisfies the linear equation we solved in a general form. This perturbation decays as t −λ , with a continuous spectrum of indexes λ in the local limit μ ⟶ 0. The spectrum is determined by a resolvent, which is represented as an infinite product of 3 ⊗ 3 matrices depending of the element of the Euler ensemble.

3

How Large is the Space of Covariantly Constant Gauge Fields

Author: Georgios Savvidis[1]

[1] *Nat. Cent. for Sci. Res. Demokritos (GR)*

The covariantly constant gauge fields are solutions of the sourceless Yang-Mills equation and represent classical vacuum fields. We found that the moduli space of the covariantly constant gauge

fields is infinite-dimensional and is therefore much larger than the space of constant chromomagnetic fields. These solutions represent a space lattice of non-perturbative magnetic flux tubes/vertices oriented in the opposite directions, each of which has a Dirac quantum flux. The geometrical structure of the solutions is self-sustaining without presence of any Higgs field support. They are similar to a condensate of the Nielsen-Olesen magnetic flux tubes of opposite orientations. The solutions have a non-vanishing Hopf invariant density.

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Conformal symmetry of the Nambu-Goto string

Author: Yuri Makeenko[1]

[1] *Niels Bohr Institute*

I consider a generalization of the Liouville action which corresponds to the Nambu-Goto string like the usual Liouville action corresponds to the Polyakov string. The two differ by higher-derivative terms which are negligible classically but revive quantumly. I exactly solve the four-derivative case and argue that conformal symmetry of the Nambu-Goto string in 4 dimensions is described by the (4,3) minimal model.

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