A non Abelian effective model for ensembles of magnetic defects in 3D Yang–Mills theory

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A non Abelian effective model for ensembles of magnetic defects in 3D Yang–Mills theory

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Abstract

We construct a non Abelian model for SU(2) Yang–Mills theory in an Euclidean three-dimensional spacetime and study its different phases. The model contains a center vortex sector coupled to a dual effective field encoding information about how the vortices are paired in the ensemble. The possible phases in the parameter space are interpreted in terms of the proliferation of either closed center vortices or closed chains, where the endpoints of open vortices are attached in pairs to monopole-like defects.

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1. Introduction

One of the most promising physical explanations for quark confinement is based on the role played by magnetic objects when analyzing the vacuum structure of SU(N) Yang–Mills theories. These scenarios have been analyzed in the lattice, relying only on monopoles [1–4], only on Z(N) center vortices [5–9], or on chains. In the latter case, the ensemble includes configurations where N center vortices are attached to a monopole [10–12]. In the continuum, the difficulties encountered when trying to explore these ideas from first principles, by following controlled steps on the partition function of pure Yang–Mills theories, are daunting. Indeed, three related questions come to mind, the first being how quantum effects can generate a dimensionful scale to characterize these ensembles. Then, one should know how to define a path integral measure including those magnetic configurations. Finally, one should compute the corresponding ensemble integration. These stumbling blocks are precisely what make semiheuristic effective models interesting. Using as a phenomenological input the possibility that magnetic defects could play a relevant role, and based on general principles of symmetry, different models can be proposed to be contrasted with experiments or the lattice. In this direction, effective field models based on the monopole component, to
Applying the Cho–Duam–Ge decomposition to supersymmetric QCD

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Applying the Cho–Duam–Ge decomposition to supersymmetric QCD

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Abstract
We study the chromomonopole component of the gluon, as identified by the Cho–Duam–Ge decomposition, in supersymmetric quantum chromodynamics. It is found to be incapable of representing the supersymmetry algebra, leading to supersymmetry breaking. Furthermore, its field strength squared is invariant under the supersymmetry generators. This makes it immune to the positive-definite energy theorem. The energetic favourability of such a condensate is expected in the case of asymptotic freedom. We identify one component of the gluino as the Goldstone fermion.

1. Introduction
While supersymmetry (SUSY) is widely believed to be a symmetry of nature at Planck or even unification energies, it is indisputably broken at those of the standard model. The actual energy scale of SUSY breaking is of enormous importance to physics beyond the standard model.

Dynamic SUSY breaking (DSB) in SUSY quantum chromodynamics (SQCD) has been controversial since the early eighties. While one early study was optimistic about it naturally yielding SUSY breaking and realistic experimental parameters [1], application of the Witten index [2] found that SUSY could not be broken dynamically, at least in the absence of massless quarks [3]. (The index cannot be calculated in the presence of massless quark superfields [2, 4].) Indeed, for a long time this result caused many to restrict searches for DSB to chiral theories, until the Intriligator–Thomas–Izawa–Yanagida mechanism of DSB in a nonchiral model [5, 6], and its derivatives (see [7] for a summary), were published. Another study [8] found that SUSY was broken in SQCD when the number of flavours was less than the number of colours. A later study of the thermodynamic limits of SQCD [9] found that confinement implies SUSY breaking.
Study of fission dynamics of $^{215}$Fr and $^{213}$Fr produced in fusion reactions with three-dimensional Langevin equations

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Study of fission dynamics of $^{215}\text{Fr}$ and $^{213}\text{Fr}$ produced in fusion reactions with three-dimensional Langevin equations

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Abstract

A stochastic approach that treats fission dynamics on the basis of three-dimensional Langevin equations was used to calculate the average pre-scission neutron multiplicities, fission probabilities, mass and energy distribution of fission fragments, and the dependences of the multiplicities of pre-scission neutrons on the masses of fission fragments and their kinetic energies for compound nuclei $^{213}\text{Fr}$ and $^{215}\text{Fr}$. In these calculations, dissipation was generated through the chaos weighted wall and window friction formula. Comparison of the theoretical results with the experimental data showed that three-dimensional Langevin equations with dissipation generated through the chaos weighted wall and window friction formula make it possible to satisfactorily reproduce the experimental data.

(Some figures may appear in colour only in the online journal)

1. Introduction

Fission of highly excited compound nuclei produced in heavy-ion induced fusion reactions and the nature of nuclear dissipation remains a topic of great interest. During the last three decades a stochastic approach based on the multidimensional Langevin equations and the multidimensional Fokker–Plank equation has been extensively and rather successfully used to solve many problems of nuclear reactions, such as induced fission, deep-inelastic heavy-ion collisions, quasi-fission and fusion–fission (see, for example [1–14] and references therein). It should be stressed that the Fokker–Plank equation is a partial differential equation, and it can be solved only by using cumbersome procedures and by invoking various assumptions, but Langevin equations can be solved on the basis of conventional numerical methods without recourse to additional assumptions. The Langevin dynamics was first used simultaneously by...
Neutron energy spectrum measurements with a compact liquid scintillation detector on EAST

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Neutron energy spectrum measurements with a compact liquid scintillation detector on EAST


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ABSTRACT: A neutron detector based on EJ301 liquid scintillator has been employed at EAST to measure the neutron energy spectrum for D-D fusion plasma. The detector was carefully characterized in different quasi-monoenergetic neutron fields generated by a 4.5 MV Van de Graaff accelerator. In recent experimental campaigns, due to the low neutron yield at EAST, a new shielding device was designed and located as close as possible to the tokamak to enhance the count rate of the spectrometer. The fluence of neutrons and γ-rays was measured with the liquid neutron spectrometer and was consistent with 3He proportional counter and NaI(Tl) γ-ray spectrometer measurements. Plasma ion temperature values were deduced from the neutron spectrum in discharges with lower hybrid wave injection and ion cyclotron resonance heating. Scattered neutron spectra were simulated by the Monte Carlo transport Code, and they were well verified by the pulse height measurements at low energies.

KEYWORDS: Nuclear instruments and methods for hot plasma diagnostics; Neutron detectors (cold, thermal, fast neutrons); Scintillators, scintillation and light emission processes (solid, gas and liquid scintillators)
Antihydrogen in a bottle

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Abstract
We describe recent experiments at CERN in which antihydrogen, an atom made entirely of antimatter, has been held in a magnetic minimum neutral atom trap and subjected to microwave radiation to induce a resonant quantum transition in the anti-atom. We discuss how this, the first experiment to observe an interaction between an antihydrogen atom and a photon, was achieved. We provide some background to antimatter physics and cover aspects of the current motivation for our experiments.

Introduction

2466 061 413 187 035 ± 10 Hz. This is the staggering precision, 4.1 parts in 10^{15}, with which the frequency of the transition between the ground state of hydrogen and its first excited electronic state is known [1]. Such accuracy is reached by laser spectroscopy, and the result provides a touchstone for fundamental physics and metrology. The technique deployed involves two-photon excitation from the ground 1S state, to the so-called metastable (intrinsic lifetime around an eighth of a second) 2S state. The two photons are arranged to excite the hydrogen atom from counter-propagating beams that serve to cancel the first order Doppler shift due to the motion of the atom, which would otherwise blur the transition.

Whilst studies of hydrogen are important in their own right, for our purposes it is comparisons with the same transition in antihydrogen that hold promise for the discovery of new phenomena in physics. In an earlier paper in this journal [2], we described how antihydrogen had been made in a controlled fashion. Here, we give an update for this field, made within the framework of the ALPHA antihydrogen collaboration at CERN [3], as we move towards the first comparisons of the properties of antimatter with those of matter. But, first, we answer an important question. Why should we bother to do this?

The trouble with antimatter

There are many fundamental mysteries concerning the make-up and evolution of the Universe, which cannot be explained by the laws of nature we already know. Examples include dark matter, which seems to account for 83% of the material in the Universe, or 23% of the full mass–energy content when dark energy, which is reputed to pervade space–time, is included. Another conundrum facing physics is the apparent