# Les Rencontres de Physique des Particules 2022

lundi 5 décembre 2022 - mercredi 7 décembre 2022

Tours

INSTITUT DENIS POISSON
ORLÉANS - TOURS Mathématiques & Physique Théorique

# Recueil des résumés

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# Searching for hidden matter at future e+e- collider experiments

**Auteurs:** Miguel Angel Sanchis-Lozano[1]; Edward Sarkisyan-Grinbaum[2]; Redamy Perez Ramos[3]

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The analysis of azimuthal correlations in multiparticle production can be useful to uncover the existence of new physics beyond the Standard Model, e.g., Hidden Valley, in e+e- annihilation at high energies. In this work, based on previous theoretical studies and using the pythia8 event generator, it is found that both azimuthal and rapidity long-range correlations are enhanced due to the presence of a new stage of matter on top of the QCD partonic cascade. Ridge structures, similar to those observed in hadronic collisions at the LHC, show up providing a possible signature of new physics at future e+e- colliders.

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# Signatures of the Yang-Mills deconfinement transition from the gluon two-point correlator

**Auteurs:** Duifje van Egmond[1]; Urko Reinosa[2]

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We evaluate the longitudinal or (chromo-)electric Yang-Mills gluon propagator in the recently proposed center-symmetric Landau gauge at finite temperature [1]. To model the effect of the Gribov copies in the infrared, we use the Curci-Ferrari model which, in turn, allows us to rely on perturbative calculations. At one-loop order in the SU(2) case, the so-obtained longitudinal gluon propagator provides a clear signature for Z2 center-symmetry breaking with a singular behavior, characteristic of a continuous phase transition. This is in sharp contrast with what is found within the standard Landau gauge. We also identify various signatures for Z3 center-symmetry breaking in the SU(3) case in the form of genuine order parameters. Among those, we find that the gluon propagator, although degenerate along the diagonal color directions in the confining phase, becomes non-degenerate in the deconfined phase. Our results open new ways of identifying the transition from correlation functions both within continuum approaches and on the lattice.

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# Quasi Transverse Momentum Dependent correlator @ next-to-leading power

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The theory and phenomenology of transverse-momentum dependent parton distributions (TMDs) have seen increasing activity in the past years. Factorization theorems for both leading-power (LP) and next-to-leading power (NLP) scenario has been discussed in the context of experimental processes such as Drell-Yan (DY) or SIDIS.
However, experimental determination of all TMD distributions is an extremely challenging problem. Therefore, lattice simulations of QCD can help bringing complementary information and guiding the phenomelogical parametrizations. On the lattice, since one cannot access directly the TMD correlator, one resorts to study an equal-time 'quasi'-TMD correlator. However, the relation between the quasi-TMDs and the TMDs in non-trivial. In fact, the quasi-TMD correlator can be interpreted as the counterpart of the hadronic tensor in DY or SIDIS.
In this talk, I will present our results for the quasi-TMD correlator both at LP and NLP at one-loop accuracy. I will show how the quasi-TMD correlator can be factorized into the actual TMD distribution and an unknown function. I will discuss how ratios of quasi-TMD correlator determined from lattice calculations remove the unknown function and allow an extraction of the Collins-Sopper kernel.

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# Gravitational portals during reheating

**Auteur:** Simon Cléry[1]

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Inflation is now very well motivated because it can solve many issues of the Big Bang scenario. Specific models of inflation can be tested by observations, most notably by the CMB anisotropy power spectrum. I will present results on (dark) matter production in the late time evolution of this inflationary field usually called "reheating", and the challenges to probe these mechanisms. Especially I will present what we call gravitational portals as a minimal scenario to produce perturbatively particles during this phase of the early Universe.

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# Consistent propagation of spin 3/2 and 2 in an electromagnetic background

**Auteur:** Wenqi Ke[1]

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Consistent equations of motion and Lagrangian for higher spin states is an old problem which is still under investigation. One important challenge comes from the "Velo-Zwanziger problem", which states that charged massive particles of spin>1, minimally coupled to an external electromagnetic field, suffer from acausality and loss of hyperbolicity. In this talk, I will present explicit consistent Lagrangians describing charged massive spin-3/2 and spin-2. Though coupled in the Lagrangian to lower spins, they appear decoupled in the resulting equations of motion.

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## Exploring electromagnetism in the Standard-Model Extension: theory and satellite data analysis

**Auteur:** Alessandro D.A.M. Spallicci[1]

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The photon is the dominant astro-particle as astrophysical observations are largely based on electromagnetic signals still read with the Maxwellian massless and linear theory, possibly an approximation of a larger theory, as Newtonian gravity is for the Einsteinian gravity in weak fields. Apart from massive (de Broglie-Proca, Bopp, Podolski, Stueckelberg and others) and non-linear (Born-Infeld, Euler-Heisenberg and others) formalisms, the Standard-Model Extension (SME) dresses the photon of a mass dependent from the Lorentz-Poincaré symmetry violation. Extended Theories of Electromagnetism (ETE) lead to surprising options for reading the universe as challenges to the ΛCDM cosmology. The SME induces deviations from the Ampère-Maxwell law, by means of an extra-current. We have sought in six years data of the Magnetospheric Multi-Scale (MMS) mission, a four-satellite constellation, crossing mostly turbulent regions of magnetic reconnection and collecting about 95% of the data outside the less turbulent region of the solar wind. We examined 3.8 million points, at each of which we collected 82 parameters from the solar wind, magnetosheath and magnetosphere regions. In a minority of cases, (only 2.2% in modulus and 4.8% in Cartesian components for all regions, but 21% in modulus and 29.9% in Cartesian components in the solar wind), deviations have been found. New analysis or future satellite measurements may clarify the nature of these deviations, whether unaccounted errors or glimpses of new physics. Possibly, we are confronted with the limit of non-dedicated experiments. We mention more stringent but model-based limits. These is an informal collaboration on theory, observations and experiments with CERN-King's College London, Univ. Bremen, Univ. Napoli, UERJ and CBPF Rio de Janeiro, IAC Tenerife and other institutes.

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## Resolving the Scales of the Quark-Gluon Plasma with Energy Correlators

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Jets provide us with ideal probes of the quark-gluon plasma (QGP) produced in heavy-ion collisions, since its dynamics at its different scales is imprinted into the multi-scale substructure of the final state jets. This talk discusses a new approach to jet substructure in heavy-ion collisions based on the study of correlation functions of energy flow operators. By analysing the two-point correlator of an in-medium quark jet, the spectra of correlation functions robustly identify the scales defined by the properties of the QGP, particularly those associated with the onset of colour coherence. Preliminary results extending previous work to heavy flavour jets and more sophisticated models for medium interactions will be discussed.

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## Cosmological implications of photon-flux upper limits at ultra-high energies in scenarios of Planckian-interacting massive particles for dark matter

**Auteur:** Olivier Deligny[1]

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Instantons can give rise to decay of particles otherwise forbidden. Using data collected at the Pierre Auger Observatory, we present a search for signatures of such instanton-induced decay processes that could be at work for super-heavy particles produced sufficiently during the post-inflationary epoch to match the relic abundance of dark matter inferred today. The non-observation of these signatures allows us to derive a bound on the reduced coupling constant of gauge interactions in the dark sector: $\alpha_X \leq 0.09$, for $10^9 \leq M_X/\text{GeV} < 10^{19}$. Conversely, we obtain that, for instance, a reduced coupling constant $\alpha_X = 0.09$ excludes masses $M_X \geq 3 \times 10^{13}$ GeV. In the context of dark matter production from gravitational interactions alone, we illustrate how these bounds are

complementary to those obtained on the Hubble rate at the end of inflation from the non-observation of tensor modes in the cosmological microwave background.

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## The hadronic contribution to the electroweak couplings from Lattice QCD

**Auteurs:** Miguel Teseo San José Pérez[1]; Andreas Risch[2]; Antoine Gérardin[3]; Georg von Hippel[4]; Hartmut Wittig[4]; Harvey Meyer[4]; Jonas Wilhelm[None]; Kohtaroh Miura[5]; Konstantin Ottnad[4]; Marco Cè[6]

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We present an *ab initio* determination of the QCD contribution to the electromagnetic coupling at the Z-pole and the weak mixing angle at low momentum exchange.
To compute the low momentum, non-perturbative QCD contribution to the running of both quantities, we employ a broad set of $N_f = 2 + 1$ Lattice QCD simulations with $O(a)$-improved Wilson fermions.
To connect our lattice results to the Z-pole, we employ the so-called Euclidean split technique, which relies on perturbation theory at high momentum and allows the computation of the time-like electromagnetic coupling from our space-like simulations.
Finally, we compare our results with several phenomenological determinations, which use the $e^+e^- \to$ hadrons cross-section data, and comment on the effect our determination has on the Higgs mass determined by the electroweak global fits of the Standard Model.

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## Jet quenching in expanding media

**Auteur:** Carlota Andres[1]

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New measurements of jet quenching observables in heavy-ion collisions at RHIC and at the LHC demand an increased precision in the theory calculations describing medium-induced radiation of gluons. Closed expressions for the gluon spectrum including the full resummation of multiple scatterings have been known for the past 20 years. However, until very recently, they were only evaluated under restrictive approximations. I will present here a new method allowing the evaluation of this spectrum without any further approximations for static media. I will also revisit the conceptual and computational issues arising when embedding this (or any other approach including multiple scatterings) into dynamically evolving plasmas. I will show several paths to overcome these difficulties and present results on the fully-resumed spectrum for longitudinally evolving media.

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## Rencontre avec les tutelles

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## Inhomogeneity of rotating gluon plasma and Tolman-Ehrenfest law in imaginary time

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We present the results of first-principle numerical simulations of Euclidean SU(3) Yang-Mills plasma rotating with a high imaginary angular frequency. The rigid Euclidean rotation is introduced via "rotwisted" boundary conditions along imaginary time direction. The Polyakov loop in the co-rotating Euclidean reference frame shows the emergence of a spatially inhomogeneous confining-deconfining phase through a broad crossover transition. A continuation of our numerical results to Minkowski spacetime suggests that the gluon plasma, rotating at real angular frequencies, produces a new inhomogeneous phase possessing the confining phase near the rotation axis and the deconfinement phase in the outer regions. The inhomogeneous phase structure has a purely kinematic origin, rooted in the Tolman-Ehrenfest effect in a rotating medium. We also derive the Euclidean version of the Tolman-Ehrenfest law in imaginary time formalism and discuss two definitions of temperature at imaginary Euclidean rotation.

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## Reconstructing the mixing angles of a Pseudo-Goldstone sterile neutrino