GDR QCD
working group “QCD at low energy"

Assemblée Générale, 8 – 10 March 2021

– use analytical tools to describe phenomena in a regime where usual perturbation theory is not reliable
– compute hadronic quantities by ab-initio approaches
– study suitable low energy processes to detect effects of New Physics
– investigate color confinement and chiral symmetry breaking in background magnetic fields and high vorticity
– examine transport effects in QCD generated by the conformal anomaly
– open question: solve QCD with machine learning?

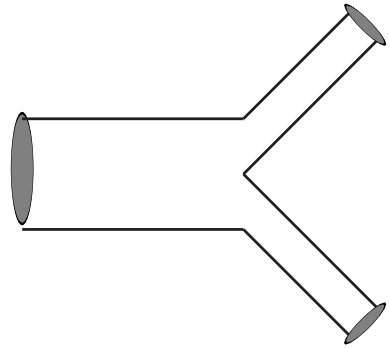
WG coordinators

Benoît Blossier
CNRS/IJCLsb Orsay
Lattice QCD, flavour physics (B and D)

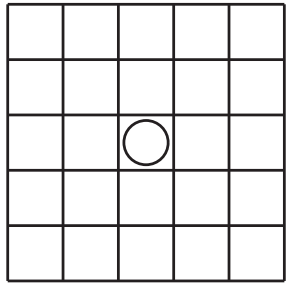
Research projects in next years:

distribution amplitudes of charmonia associated to $h \to J/\psi\gamma$

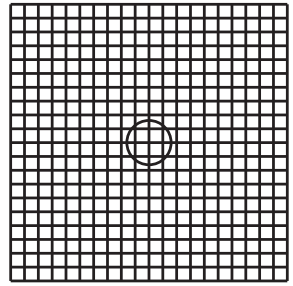
multihadronic systems



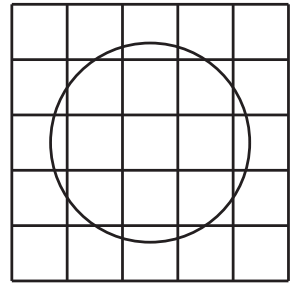
B physics from simulations at the physical poin



Cut-off Effects



cut-off effects



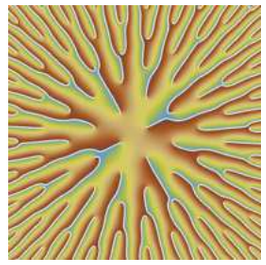
cut-off effects

Maxim Chernodub, CNRS/Institut Denis Poisson (Tours-Orléans)

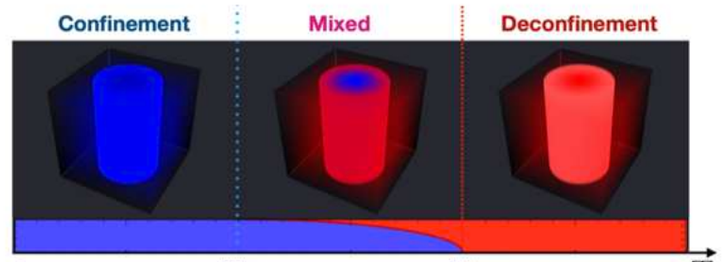
Lattice QFT and QCD; non-perturbative analytical approaches

Coming projects:

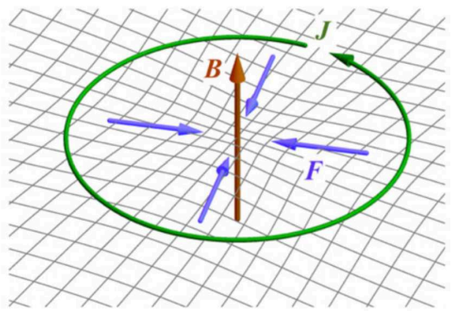
— **Lattice Electroweak Model** in magnetic fields (numerical): phase structure, electroweak symmetry restoration,
→ implications for the early Universe;



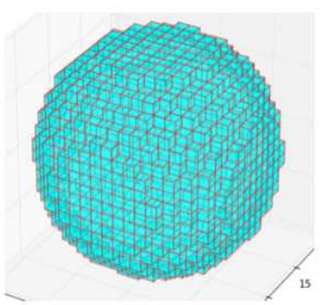
— **Quark-gluon plasma** in rotation (analytical): inhomogeneities, deconfinement and chiral symmetry, spin polarization and transport effects in vortical plasmas,
→ implications for non-central heavy-ion collisions;



— **Scale symmetry breaking** in QCD and QED (analytical): anomaly-induced transport effects and instabilities in thermal and gravitational backgrounds;
→ evolution of Quark-Gluon plasma
→ astrophysical applications in Lorentz-violating extensions of the Standard Model



— **Casimir effects in lattice QCD** (numerical): properties of QCD in a-few-femtometer-sized spherical bags, quark-gluon droplets;
→ implications for bag models of hadrons



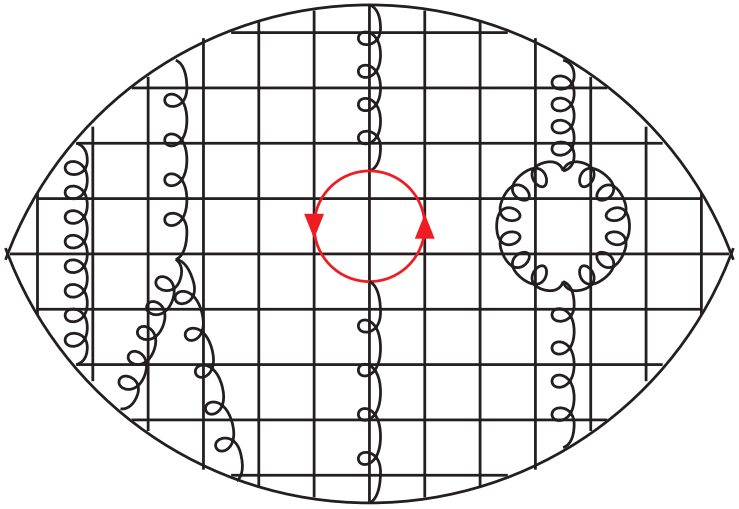
Cédric Mezrag,
Irfu-CEA, Université Paris-Saclay

Main reasearch topics:
Hadron structure through non-perturbative continuum techniques

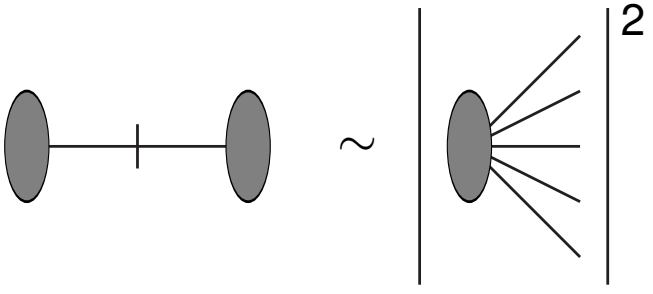
- Dyson-Schwinger and Bethe-Salpeter Equations
  - Minkowski space developments
  - Symmetry-preserving truncations
- Hadron Structure:
  - models based on continuum techniques for mesons and baryons (PDFs, GPDs, DAs, and TDAs in the future)
  - numerical implementations of evolution equations
- Phenomenology for current and future facilities (JLab, EIC, EICC,...)
  - member of the PARTONS project

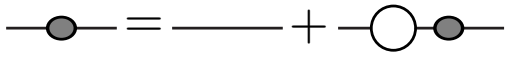
WG activities in France

Lattice QCD
Teams at LPC Clermont, LPSC Grenoble,
CPT Marseille, IJCLsb Orsay, IDP Tours-Orléans
flavour physics, QCD at finite chemical
potential, muon $g-2$, parton distribution
functions, infrared regime of QCD



Analytical approaches: effective field theories,
Schwinger-Dyson equations, potential models,
dispersion relations
Teams at LPC Clermont, CEA/Irfu,
CPT Marseille, L2C Montpellier, IJCLab Orsay
CPhT Palaiseau, APC Paris, IDP Tours-Orléans
light-cone physics, muon $g-2$, hadron form factors
QCD in the infrared regime, QCD in external field

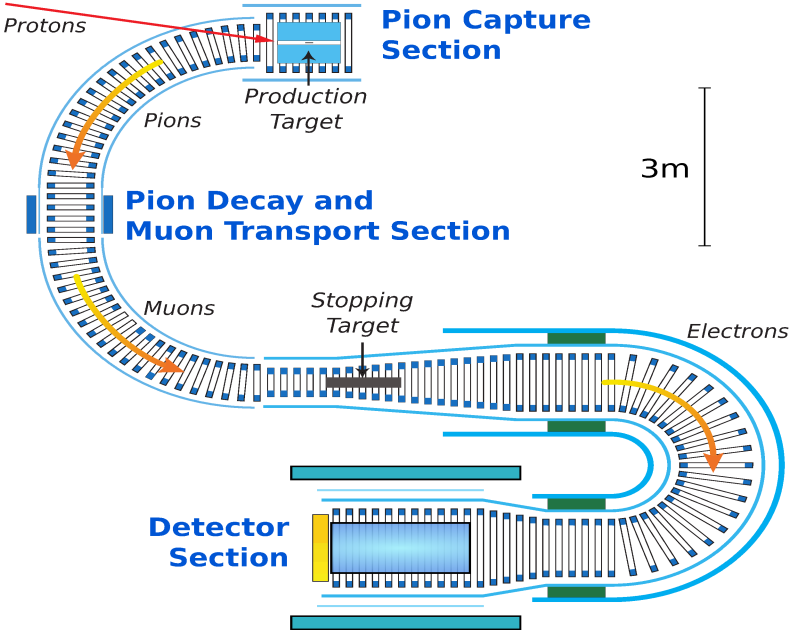


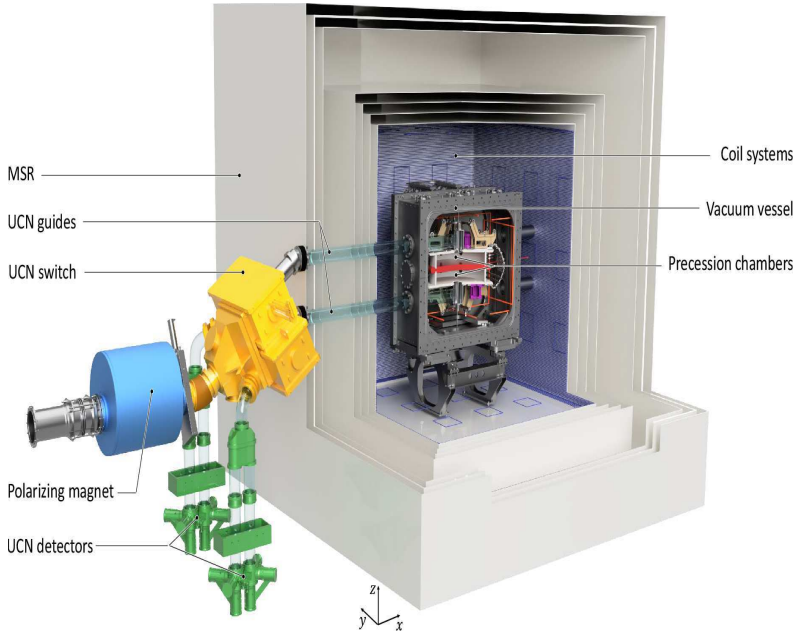


Experimental effort

Teams at LPSC Grenoble, IJCLab Orsay, LPNHE Paris

moments of inclusive decays, muon $g-2$, neutron electric dipole moment





WG events

We plan to organise an event per year, within our WG or with other WGs of the GDR.

- Fall 2021 or Winter 2022: workshop dedicated to rotating quantum systems in background magnetic field. Emphasis on quark-gluon plasma with large angular momentum created in non-central heavy-ion collisions. WGs 2 and 5. Place: Tours
- Fall 2022: third edition of the workshop series “Progress in algorithms and numerical tools for QCD". All WGs. Place: Orsay
- 2023: workshop on “Analogous QCD"
- 2024: school on analytical methods

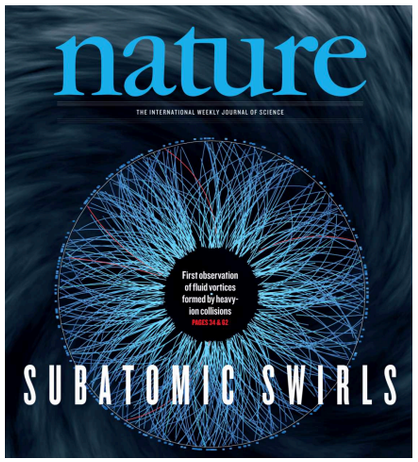
Workshop on highly vortical Quark-Gluon Plasma

(and on QFT in rotation and in strong magnetic fields, in general)

Who: WG2 and WG5; **When**: Fall 2021 or Winter 2022; **Where**: Tours

Motivation: Noncentral heavy-ion collisions create rapidly rotating quark-gluon plasma with (long-lasting) angular momentum subjected to (shorter-living) strong magnetic field

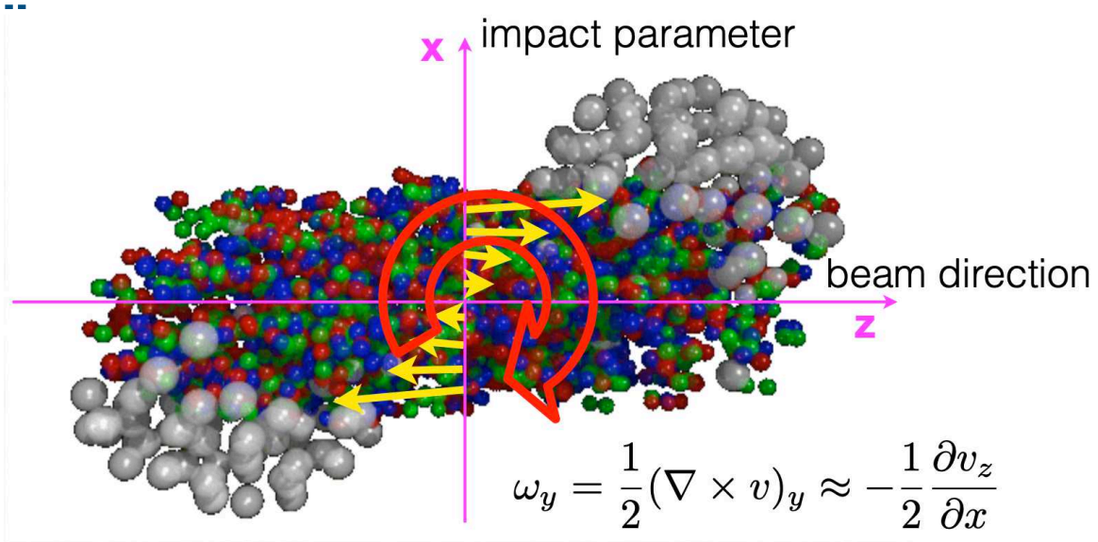
"The most vortical fluid ever observed"



$$\omega \approx (9 \pm 1) \times 10^{21}\,\mathrm{s}^{-1}$$

High vorticity / frequency of rotation

The STAR Collaboration, Nature 62, 548 (2017)



Topics:

— Spin and Hydrodynamics in Relativistic Nuclear Collisions
— Effects of rotation in QCD phase diagram
— Anomalous transport phenomena in vortical fluids
— Combined effects of rotation and magnetic field