Lattice Gauge Theory at CERN

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Networks

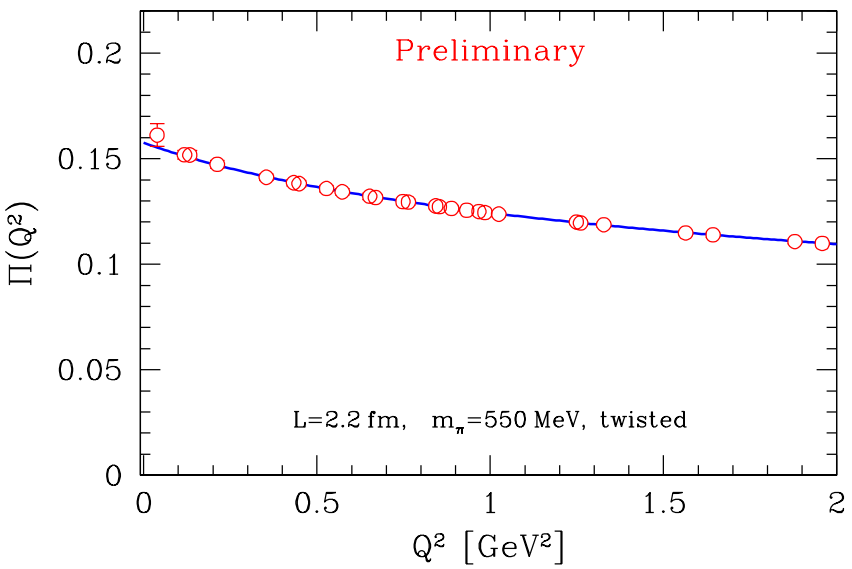
- ⋆ Coordinated Lattice Simulations (CLS)
  Berlin, Madrid, Mainz, Rome, Valencia
- ⋆ RBC-UKQCD collaboration
  Columbia, Edinburgh, Southampton, ...
- ⋆ UKQCD-BSM collaboration
  Edinburgh, Odense, Swansea, ...

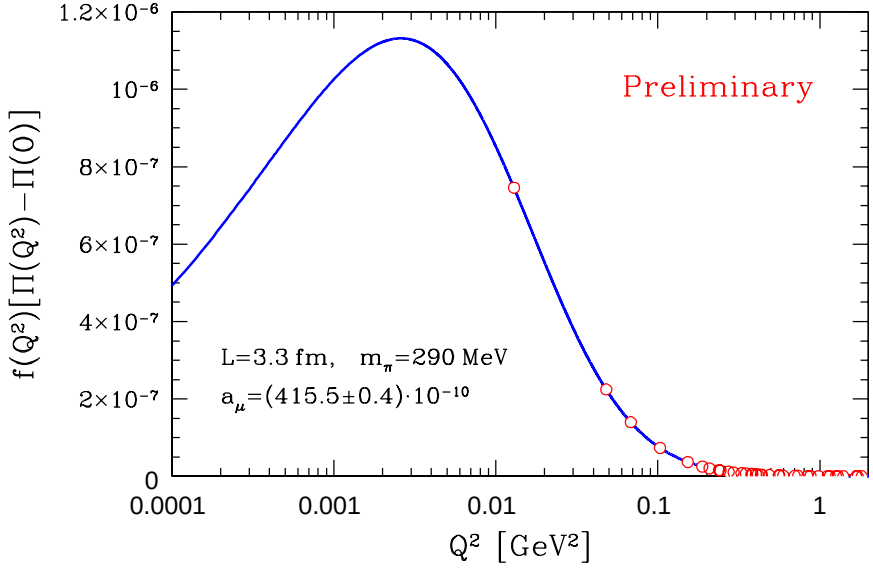
84 nodes (672 cores)

Infiniband 20+20 Gb/s per link

Hadronic contribution to $(g-2)_\mu$ Andreas Jüttner

$$a_\mu^{\rm had} = 4\pi^2 \left(\frac{\alpha}{\pi}\right)^2 \int_0^\infty {\rm d}Q^2\, f(Q^2)\{\Pi(Q^2) - \Pi(0)\}$$





Brandt et al. (Mainz–CERN), arXiv:1010.2390

$K \to \pi\pi$ decays

Silvia Necco

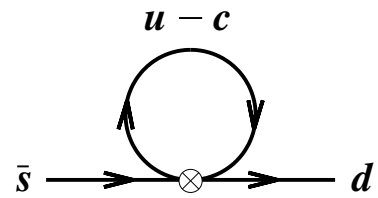
LO effective weak interaction

$$\mathcal{H}_{\rm w}(x) = \sqrt{2} G_{\rm F} (V_{us})^* V_{ud} \{ k_+ \mathcal{Q}^+(x) + k_- \mathcal{Q}^-(x) \}$$

$$\mathcal{Q}^\pm = (\bar{s}\gamma_\mu P_- u)(\bar{u}\gamma_\mu P_- d) \pm \ldots, \qquad P_- = \tfrac{1}{2}(1-\gamma_5)$$

Issues

- ⋆ Non-perturbative renormalization
- ⋆ Final-state interactions
- ⋆ Virtual charm-quark effects

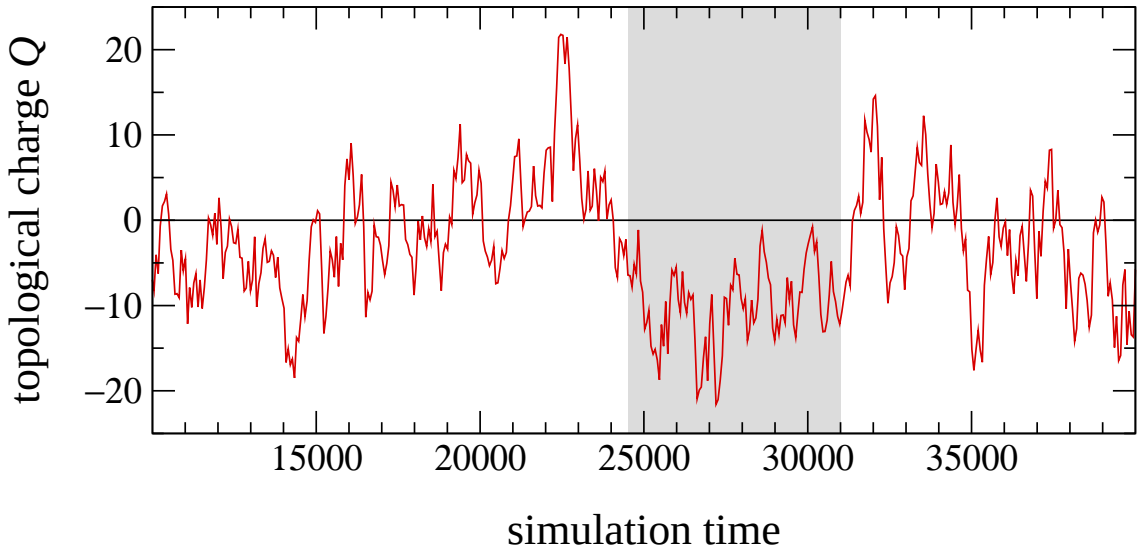


⇒ *Need to disentangle these to be able to understand the* $\Delta I = 1/2$ *rule*

Technicolor theories Agostino Patella → next talk

Acceleration of QCD simulations Stefan Schaefer, ML

It seems we are running against another brick wall



Autocorrelations increase very rapidly towards the continuum limit

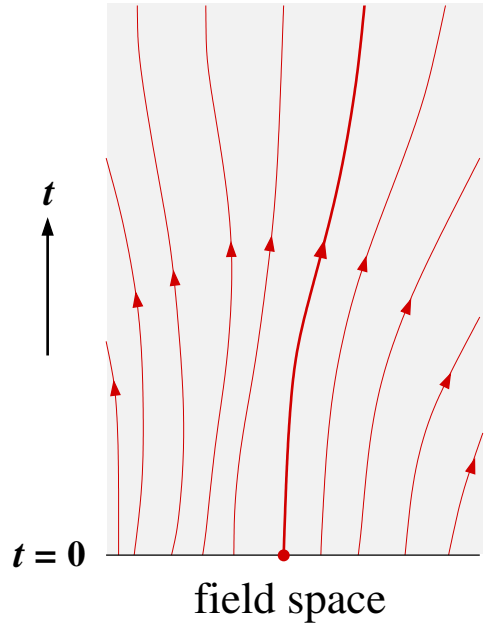
Probably several causes, still not fully understood

Theoretical developments ML

Gradient flow in non-abelian gauge theories

$$\dot{B}_\mu = D_\nu G_{\nu\mu}, \qquad B_\mu|_{t=0} = A_\mu$$

$$B_\mu(t,x) = \int_y K_t(x-y) A_\mu(y) + \text{g.t.} + \mathrm{O}(A^2)$$



$B_\mu(t,x)$ *is a smooth renormalized gauge field*

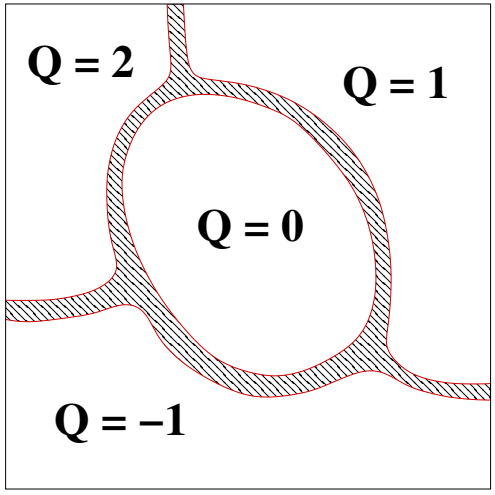
$$E = \tfrac{1}{4} G^a_{\mu\nu} G^a_{\mu\nu}$$

$$\langle E \rangle = \frac{3}{4\pi t^2} \alpha_s(q) \{1 + k_1 \alpha_s(q) + \ldots\}, \qquad q = 1/\sqrt{8t}$$

$\Rightarrow$ probes the theory at scale q

Applications of the flow in lattice QCD

- ⋆ Non-perturbative RG
- ⋆ Topological sectors
- ⋆ Simulation algorithms



field space