

# QCD Vacuum Structure and Confinement



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## Duality, noncommutative space and quantum gravity

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Abstract: Recently, we proposed a new duality in flat space under Poincare symmetry, which exchanges between spin and orbital degrees of freedom. The ‘spin-orbit duality’ maps 4D bulk spacetime onto a 3D world-tube, a cylinder  $S^2 \times R$ , which is noncommutative and for low energies reduces to the fuzzy sphere. Progress shows that, firstly, the duality is really the first Hopf map. As an illustration, we take the Landau levels of a uniform magnetic field in bulk space and show that the dual theory on the sphere has the same spectrum under a Dirac monopole, whose ground state (lowest Landau level) indeed implies a fuzzy sphere. In fact, this particular example yields that an oscillator in the bulk is dual to an Ising model on the sphere. Secondly, the duality transforms the bulk Poincare group  $ISO(1,3)$  into the conformal  $SO(2,3)$ . Hence, the dual theory is really defined on the conformal class of the cylinder  $S^2 \times R$ , which is the conformal boundary of  $AdS_4$ . Therefore, set next to the AdS/CFT duality, spin-orbit duality could provide a bridge between (non-conformal) QFT and supergravity.

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