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Commutative/Non-Commutative Dualities

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We show that it is in principle possible to construct dualities between commutative and noncommutative theories in a systematic way. This construction exploits a generalization of the exact renormalization group equation (ERG). This link can also be understood as a blocking (coarse graining) transformation of the degrees of freedom. We apply this to the simple case of the Landau problem and then generalize it to the free and interacting non-canonical scalar field theory. In non-canonical quantum field theories, the canonical equal time commutation relations between fields are modified in a similar way to non-commutative quantum mechanics. This differs from usual non-commutative field theories where the space-time labels are non-commutative. This constructive approach offers the advantage of tracking the implementation of the Lorentz symmetry in the non-commutative dual theory. We briefly demonstrate this for the free scalar theory. In principle, we can construct completely consistent non-commutative and non-local theories where the Lorentz symmetry and unitarity are still respected but may be implemented in a highly non-trivial and non-local manner.

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