Quantum phase transitions in the non commutative Dirac Oscillator

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We study the $(2+1)$-dimensional Dirac oscillator in a homogeneous magnetic field in the non-commutative plane. It is shown that the effect of non-commutativity is twofold: i) momentum non commuting coordinates simply shift the critical value ($B_{\rm cr}$) of the magnetic field at which the well known left-right chiral quantum phase transition takes place (in the commuting phase); ii) non-commutativity in the space coordinates induces a new critical value of the magnetic field, $B^*_{\rm cr}$, where there is a second quantum phase transition (right–left), this critical point disappears in the commutative limit. The change in chirality associated with the magnitude of the magnetic field is examined in detail for both critical points. The phase transitions are described in terms of the magnetisation of the system. Possible applications to the physics of silicene and graphene are briefly discussed.