Addendum

Graphene and high energy physics

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In a recent paper,¹ we had argued that two-dimensional crystals like graphene can be a possible test bed for High Energy Physics experiments as behavior like zitterbewegung, Compton scale, noncommutative space-time etc. are exhibited though at a different scale much like wind tunnels work with Reynolds scaled down numbers.

For example, the Fermi velocity replaces the velocity of light, which is some 300 times higher.

It was also pointed out that such effects as minimum conductivity and the Fractional Quantum Hall Effect get a remarkable derivation due to the noncommutative nature of the space of these structures.

We would like to point out two new and important points in this context. The first is that the magnetic field in this case is stronger than the usual Maxwellian field² and in fact is now given by its expression in noncommutative space:

$$Bl^2 = \frac{hc}{e}. \quad (1)$$

In Eq. (1), symbols have their usual meaning except that l stands for the minimum length, the lattice length in this case. This was deduced independently by the author and Saito several years ago.³⁻⁵ The experimentally observed and mysterious

minimum conductivity is given by

$$\sigma = 4 \frac{e^2}{h}. \quad (2)$$

Again symbols have their usual meanings in Eq. (2). Remarkably (2) can be deduced from the above considerations.¹ What is equally remarkable is that the magnetic field (1) and the electric current following from (2) arise solely as a result of the noncommutative space geometry of these two-dimensional crystalline structures.

References

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