Implications of $\mathcal{CP}$-violating transitions in hot quark matter for heavy ion collisions

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Quantum chromodynamics (QCD) contains field configurations which can be characterized by a topological invariant, the winding number Q_w. Configurations with nonzero Q_w break the charge-parity ($\mathcal{CP}$) symmetry of QCD. We will show that these configurations can separate charge in the presence of a background magnetic field. This we will call the chiral-magnetic effect. We argue that sufficiently large magnetic fields are created in heavy ion collisions so that the chiral-magnetic effect causes preferential emission of charged particles along the direction of angular momentum. Since separation of charge is $\mathcal{CP}$-odd, any observation of the chiral magnetic effect could provide a clear demonstration of the topological nature of the QCD vacuum. We give an estimate of the effect and conclude that it might be observed experimentally.

References

[1] D.E. Kharzeev, L.D. McLerran, and H.J. Warringa, *in preparation*, (2007)