Cherenkov radiation from the quantum vacuum

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A charged particle moving through a medium emits Cherenkov radiation when its velocity exceeds the phase velocity of light in that medium. Since light in vacuum is usually assumed to move at the universal speed c, causality appears to preclude vacuum Cherenkov radiation (VCR). Under the influence of a strong electromagnetic field, however, quantum fluctuations can become polarised, imbuing the vacuum with an effective permittivity tensor and reducing the speed of light. It follows that sufficiently energetic particles can emit Cherenkov radiation even when travelling in vacuum [1]. The required field strengths and particle energies suggest it is unlikely that VCR will be observable in near–future laboratory experiments. However, for high energy cosmic rays traversing the magnetic fields around a pulsar, VCR can be comparable to, and even substantially exceed, other known forms of radiation.

References

[1] A.J. Macleod, A. Noble and D.A. Jaroszynski, arXiv:1810.05027 (2018).