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Probing spatial orientability of Friedmann–Robertson–Walker spacetime from electromagnetic quantum fluctuations

Orientability is an important topological property of spacetime manifolds. It is widely believed that spatial orientability can only be tested by global journeys around the Universe to check for orientation-reversing closed paths. Since such global journeys are not feasible, theoretical arguments that combine universality of physical experiments with local arrow of time, CP violation and CPT invariance are usually offered to support the choosing of time- and space-orientable spacetime manifolds. The nonexistence of globally defined spinor fields on a non-orientable spacetime is another theoretical argument for orientability. We show that it is possible to access spatial orientability of Friedmann–Robertson–Walker spacetime through local physical effects involving quantum electromagnetic fluctuations. We argue that a putative non-orientability of the spatial sections of spatially flat FRW spacetime can be ascertained by the study of the stochastic motions of a charged particle or a point electric dipole under quantum vacuum electromagnetic fluctuations. In particular, the stochastic motions of a dipole permit the recognition of a presumed non-orientability of 3−space in itself. Our findings open the way to a conceivable experiment involving quantum electromagnetic fluctuations to locally probe the spatial orientability oF FRW spacetime.

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