BREAKDOWN OF LORENTZ INVARIANCE FOR SPIN-1/2 PARTICLE MOTION IN CURVED SPACE-TIME WITH APPLICATIONS TO MUON DECAY*

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This paper explores the properties of the Pauli-Lubanski spin vector for the general motion of spin-1/2 particles in curved space-time. Building upon previously determined results in flat space-time, it is shown that the associated Casimir scalar for spin possesses both gravitational contributions and frame-dependent contributions due to non-inertial motion, where the latter represents a possible quantum violation of Lorentz invariance that becomes significant at the Compton wavelength scale. When applied to muon decay near the event horizon of a microscopic Kerr black hole, it is shown that its differential cross section is strongly affected by curvature, with particular sensitivity to changes in the black hole's spin angular momentum. In the absence of curvature, the non-inertial contributions to the decay spectrum are also identified and explored in detail, where its potential for observation is highest for large electron opening angles. It is further shown how possible contributions to noncommutative geometry can emerge from within this formalism at some undetermined length scale. Surprisingly, while the potential exists to identify noncommutative effects in muon decay, the relevant terms make no contribution to the decay spectrum, for reasons which remain unknown.

* *References:* D. Singh and N. Mobed, to appear in *Phys. Rev. D* (2009) – arXiv:0807.0937 [gr-qc]; *Class. Quantum Grav.* **24** (2007) 2453-2463 – hep-th/0506156.

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