A No-Go Theorem for the Consistent Quantization of Spin 3/2 Fields on General Curved Spacetimes

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It is well-known that coupling a spin $\frac32$-field to a gravitational or electromagnetic background leads to potential problems both in the classical and in the quantum theory. Various solutions to these problems have been proposed so far, which are all restricted to a limited class of backgrounds. On the other hand, negative results for general gravitational backgrounds have been reported only for a limited set of couplings to the background to date. Hence, to our knowledge, a comprehensive analysis of all possible couplings to the gravitational field and general gravitational backgrounds including off-shell ones has not been performed so far. In this work we analyse whether it is possible to couple a spin $\frac32$-field to a gravitational field in such a way that the resulting quantum theory is consistent on arbitrary gravitational backgrounds. We find that this is impossible as all couplings require the background to be an Einstein spacetime for consistency. This enforces the widespread belief that supergravity theories are the only meaningful models which contain spin $\frac32$ fields as in these models such restrictions of the gravitational background appear naturally as on-shell conditions.

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