On Running couplings from adiabatic regularization

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We extend the adiabatic regularization [1–4] method by introducing an arbitrary mass scale μ in the construction of the subtraction terms [5]. This allows us to obtain, in a very robust way, the running of the coupling constants by demanding μ-invariance of the effective semiclassical (Maxwell-Einstein) equations. In particular, we get the running of the electric charge of perturbative quantum electrodynamics. Furthermore, the method brings about a renormalization of the cosmological constant and the Newtonian gravitational constant. The running obtained for these dimensionful coupling constants has new relevant contributions, not predicted by previous analysis. We point out that the running of the couplings has to be taken into account when solving the renormalized backreaction equations, for example in the case of the Schwinger pair creation effect [6, 7] in de Sitter space or in preheating of fermions after inflation [8].

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[1] L. Parker and D. J. Toms, *Quantum Field Theory in Curved Spacetime: Quantized Fields and Gravity*, Cambridge University Press, Cambridge, England (2009).

[2] N. D. Birrell and P. C. W. Davies, *Quantum Fields in Curved Space*, Cambridge University Press, Cambridge, England (1982).

[3] S. Fulling, *Aspects of Quantum Field Theory in Curved Space-Time*, Cambridge University Press, Cambridge, England (1989).

[4] A. Landete, J. Navarro-Salas and F. Torrenti, *Phys. Rev. D***88**, 061501 (2013); *Phys. Rev. D* **89** 044030 (2014). A. del Rio, J. Navarro-Salas and F. Torrenti, *Phys. Rev. D* **90**, 084017 (2014). S. Ghosh, *Phys. Rev. D* **91**, 124075 (2015); *Phys. Rev. D* **93**, 044032 (2016). A. del Rio and J. Navarro-Salas, *Phys. Rev. D* **91**, 064031 (2015).

[5] A. Ferreiro and J. Navarro-Salas. *Running couplings from adiabatic regularization*, arXiv:1812.05564 , accepted for publication in PLB, 2019

[6] A. Ferreiro and J. Navarro-Salas, *Phys. Rev. D* **97**, 125012 (2018).

[7] A. Ferreiro, J. Navarro-Salas and S. Pla, *Phys. Rev. D* **98**, 045015 (2018).

[8] A. del Rio, A. Ferreiro, J. Navarro-Salas and F. Torrenti, *Phys. Rev. D* **95**, 105003 (2017).

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