

Accepted Manuscript

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PII: S0393-0440(18)30066-4

DOI: <https://doi.org/10.1016/j.geomphys.2018.02.014>

Reference: GEOPHY 3162

To appear in: *Journal of Geometry and Physics*

Received date: 25 September 2017

Revised date: 7 February 2018

Accepted date: 14 February 2018

Please cite this article as: B. Iochum, T. Masson, Heat asymptotics for nonminimal Laplace type operators and application to noncommutative tori, *Journal of Geometry and Physics* (2018), <https://doi.org/10.1016/j.geomphys.2018.02.014>

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Heat asymptotics for nonminimal Laplace type operators and application to noncommutative tori

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Abstract

Let P be a Laplace type operator acting on a smooth hermitean vector bundle V of fiber \mathbb{C}^N over a compact Riemannian manifold given locally by $P = -[g^{\mu\nu}u(x)\partial_\mu\partial_\nu + v^\nu(x)\partial_\nu + w(x)]$ where u, v^ν, w are $M_N(\mathbb{C})$ -valued functions with $u(x)$ positive and invertible. For any $a \in \Gamma(\text{End}(V))$, we consider the asymptotics $\text{Tr}(a e^{-tP}) \underset{t \downarrow 0^+}{\sim} \sum_{r=0}^{\infty} a_r(a, P) t^{(r-d)/2}$ where the coefficients $a_r(a, P)$ can be written as an integral of the functions $a_r(a, P)(x) = \text{tr}[a(x)\mathcal{R}_r(x)]$.

The computation of \mathcal{R}_2 is performed opening the opportunity to calculate the modular scalar curvature for noncommutative tori.

Keywords: Heat kernel, nonminimal operator, asymptotic heat trace, Laplace type operator, scalar curvature, noncommutative torus

PACS: 11.15.-q, 04.62.+v

2000 MSC: 58J35, 35J47, 81T13, 46L87

1. Introduction

As in [1], we consider a d -dimensional compact Riemannian manifold (M, g) without boundary, together with a nonminimal Laplace type operator P on a smooth hermitean vector bundle V over M of fiber \mathbb{C}^N written locally as

$$P := -[g^{\mu\nu}u(x)\partial_\mu\partial_\nu + v^\nu(x)\partial_\nu + w(x)]. \quad (1.1)$$

Here $u(x) \in M_N(\mathbb{C})$ is a positive and invertible matrix valued function and v^ν, w are $M_N(\mathbb{C})$ matrices valued functions. The operator is expressed in a local trivialization of V over an open subset of M which is also a chart on M with coordinates (x^μ) . This trivialization is such that the adjoint for the hermitean metric corresponds to the adjoint of matrices and the trace on endomorphisms on V becomes the usual trace tr on matrices.

For any $a \in \Gamma(\text{End}(V))$, we consider the asymptotics of the heat-trace

$$\text{Tr}(a e^{-tP}) \underset{t \downarrow 0^+}{\sim} \sum_{r=0}^{\infty} a_r(a, P) t^{(r-d)/2}. \quad (1.2)$$

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