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Super-zeta functions and regularized determinants

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Abstract

A question to define determinants of Laplacians, or related spectral operators, on Riemannian manifolds is a very important in mathematical physics and related areas. The classical approach, as explained by Hawking (1977) relies on regularization by starting with the trace of a heat kernel. Unfortunately, there are many instances when such heat kernels are not of trace class, such as when the hyperbolic Riemann surfaces has finite volume yet is not compact. Many authors have succeeded in defining regularized traces of heat kernels in this setting and developed zeta regularized products. However, in doing so, one does not see very clearly the underlying sequence of eigenvalues.

The purpose of this talk is to describe a different approach to defining determinants of Laplacians, or related spectral operators using super-zeta functions. Super-zeta functions are the Hurwitz-type zeta functions associated to the sequence of zeros of a certain zeta function; this terminology was introduced in a series of papers by A. Voros. When the underlying zeta function is the Selberg zeta function of a cofinite Fuchsian group, then its super-zeta function carries information about the spectrum of the Laplacian operator and of the Lax-Phillips scattering operator. We describe how to define the regularized determinant of those operators in terms of the derivative of the meromorphic continuation of the associated super-zeta function at zero. We also explain the formal relation of our regularized determinant to the sequence of eigenvalues and resonances, thus showing why our regularized determinant is a natural extension of the classical determinant (i.e. of the product of finitely many eigenvalues).

As the time permits, we will briefly discuss the more general setting of hyperbolic manifolds with cusps.

The talk is based on the joint work with Joshua Friedman and Jay Jorgenson.

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