Advances in Operator Theory (2024) 9:85
https://doi.org/10.1007/s43036-024-00381-2

Tusi Mathematical Research Group

ORIGINAL PAPER

Spectral theory for fractal pseudodifferential operators

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Received: 6 June 2024 / Accepted: 31 August 2024
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Abstract
The paper deals with the distribution of eigenvalues of the compact fractal pseudo-differential operator T_τ^μ,

$$(T_\tau^\mu f)(x) = \int_{\mathbb{R}^n} e^{-ix\xi}\, \tau(x,\xi)\, (f\mu)^\vee(\xi)\, d\xi, \qquad x \in \mathbb{R}^n,$$

in suitable special Besov spaces $B_p^s(\mathbb{R}^n) = B_{p,p}^s(\mathbb{R}^n)$, $s > 0$, $1 < p < \infty$. Here $\tau(x,\xi)$ are the symbols of (smooth) pseudodifferential operators belonging to appropriate Hörmander classes $\Psi_{1,\delta}^\sigma(\mathbb{R}^n)$, $\sigma < 0$, $0 \le \delta \le 1$ (including the exotic case $\delta = 1$) whereas μ is the Hausdorff measure of a compact d–set Γ in $\mathbb{R}^n$, $0 < d < n$. This extends previous assertions for the positive-definite selfadjoint fractal differential operator $(\mathrm{id} - \Delta)^{\sigma/2}\mu$ based on Hilbert space arguments in the context of suitable Sobolev spaces $H^s(\mathbb{R}^n) = B_2^s(\mathbb{R}^n)$. We collect the outcome in the **Main Theorem** below. Proofs are based on estimates for the entropy numbers of the compact trace operator

$$\mathrm{tr}_\mu : \quad B_p^s(\mathbb{R}^n) \hookrightarrow L_p(\Gamma,\mu), \quad s > 0, \quad 1 < p < \infty.$$

We add at the end of the paper a few personal reminiscences illuminating the role of Pietsch in connection with the creation of approximation numbers and entropy numbers.

Keywords Pseudodifferential operators · Fractals · Besov spaces · Eigenvalues · Entropy numbers

Mathematics Subject Classification 46E35 · 41A46 · 28A80 · 35P15

In memory of Albrecht Pietsch (1934–2024)

Communicated by Thomas Kuehn.

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Published online: 09 October 2024

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