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Hardy inequalities, entropy numbers, spectral theory

In the unit ball B in $\mathbb{R}^n$ we estimate entropy and approximation numbers of the compact embedding

$$\mathrm{id}: \quad E^m_{p,\sigma}(B) \hookrightarrow L_p(B), \quad 1 \le p < \infty,$$

where $E^m_{p,\sigma}(B)$ is the completion of $D(B)$ in the norm

$$\Big(\int_B |x|^{pm} \big(1 + |\log |x||\big)^{p\sigma} \sum_{|\alpha|=m} |\mathrm{D}^\alpha f(x)|^p \, \mathrm{d}x \Big)^{1/p},$$

$m \in \mathbb{N}$, $\sigma > 0$. This is based on Hardy inequalities and used to say something about the distribution of eigenvalues of positive definite self-adjoint degenerate elliptic operators of type

$$A^m_\sigma f = (-1)^m \sum_{|\alpha|=m} \mathrm{D}^\alpha \Big(|x|^{2m} \big(1 + |\log |x||\big)^{2\sigma} \, \mathrm{D}^\alpha f \Big).$$