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Random Kahane-Salem-Zygmund inequalities in Banach spaces

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I will discuss some recent work with Andreas Defant, concerning variants of the celebrated random Kahane-Salem-Zygmund inequalities. Using tools from probability, Banach space, and interpolation theory, I will present a coherent approach to subgaussian multivariate and Dirichlet polynomial inequalities.

On transverse vibrations of beams with discrete-continuous distributions of parameters

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In the talk, our aims is to obtain an closed-form solution the following initial-boundary value problem that simulates the transverse vibrations of a non-uniform cantilever beam consisting of n beam elements of variable cross-section with discrete-continuous distributions of mass and external load:

$$m(x)\frac{\partial^2 u}{\partial t^2} + \frac{\partial^2}{\partial x^2} \left(\alpha(x) \frac{\partial^2 u}{\partial x^2} \right) = q(x),$$

$$u(x, 0) = \varphi(x), \quad \frac{\partial u(x, 0)}{\partial t} = \psi(x), \quad 0 \leq x \leq l,$$

$$u(0, t) = \frac{\partial u(0, t)}{\partial x} = \left[-\alpha_{n-1}(x) \frac{\partial^2 u(x, t)}{\partial x^2} \right]_{x=l} = \frac{\partial}{\partial x} \left[\alpha_{n-1}(x) \frac{\partial^2 u(x, t)}{\partial x^2} \right]_{x=l} = 0, \quad t \geq 0.$$

Here $u(x, t)$ is the vertical displacement at $x \in [0, l]$ and $t \geq 0$, $\alpha(x)$ is the flexural stiffness of the beam, $m(x)$ is the mass per unit length, and $q(x)$ is the external excitation acting on the beam:

$$\alpha(x) = \sum_{k=0}^{n-1} \alpha_k(x) \theta_k(x), \quad m(x) = \sum_{k=0}^{n-1} m_k(x) \theta_k(x) + \sum_{k=1}^{n-1} \mu_k \delta_k(x),$$

$$q(x) = \sum_{k=0}^{n-1} q_k(x) \theta_k(x) + \sum_{k=1}^{n-1} [P_k \delta_k(x) + M_k \delta'_k(x)],$$

where $\alpha_k, m_k, q_k \in C[x_k, x_{k+1}]$, $0 = x_0 < x_1 < \dots < x_{n-1} < x_n = l$, $\theta_k(x)$ is the characteristic function on an interval $[x_k, x_{k+1})$, μ_k, P_k, M_k are concentrated in the beam cross-sections $x = x_k$ masses, forces and moments, $\delta_k(x)$ is the Dirac distribution whose support is $\{x_k\}$, $\varphi, \psi \in C[0, l]$.

We use the idea of introducing quasi-derivatives, which allows to weaken the conditions of smoothness for the coefficients of the equation [1]. Such approach has been successfully used to model longitudinal vibrations of a rod with a piecewise constant cross-section and δ -singularities [2]. The model results agree with those known for multiple-stepped Bernoulli-Euler beams [3].

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On (in)homogeneous fractals generated by $*$ -measures

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Let $\mathbb{I} = [0, 1]$ and let $*$ be a continuous triangular norm (i. e., $*$: $\mathbb{I} \times \mathbb{I} \rightarrow \mathbb{I}$ is associative, commutative, and monotone operation for which 1 is a neutral element). In [4], the notion of $*$ -measure on the compact Hausdorff spaces is investigated. Recall that a $*$ -measure is a functional $\mu: C(X, \mathbb{I}) \rightarrow \mathbb{I}$ satisfying:

1. $\mu(c_X) = c$ (here, c_X is constant function on X taking value $c \in \mathbb{I}$);
2. $\mu(\lambda * \varphi) = \lambda * \mu(\varphi)$, where $\lambda \in \mathbb{I}$, $\varphi \in C(X, \mathbb{I})$;
3. $\mu(\varphi \vee \psi) = \mu(\varphi) \vee \mu(\psi)$, where $\varphi, \psi \in C(X, \mathbb{I})$.

In [2], the notion of an idempotent fractal is defined for *IFS* on complete metric spaces. The aim of our talk is to formulate an analogous notion for the $*$ -measure fractal.

We prove the existence theorem for invariant $*$ -measures. Actually, two proofs are given, one of them exploits some ideas from [2], the other one is based on fixed point theorems and modification of the Bazylevych-Repovš-Zarichnyi metric on the space of idempotent measures [1].

Inhomogeneous $*$ -measures in the spirit of [3] are also introduced.

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