

# Seminario de Análisis (IMAC)



**Conferencia a cargo de  
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*Tensor product of Banach spaces, volume ratio, and the failure of cotype.*

**ABSTRACT:** It is a long standing open problem whether the projective tensor product  $\ell_2 \otimes \pi \ell_2 \otimes \pi \ell_2$  has finite cotype. In 1974, Nicole Tomczak-Jaegermann proved that  $\ell_2 \otimes \pi \ell_2$ , which can be identified with the Schatten trace class  $S_1$ , i.e., the space of all compact operators  $T: \ell_2 \rightarrow \ell_2$  with norm  $\|T\|_{S_1} = \text{tr} T^* T$  is of cotype 2. Recently, using involved constructions from the theory of locally decodable codes, Jop Briët, Assaf Naor, and Oded Regev were able to show that  $\ell_p \otimes \pi \ell_q \otimes \pi \ell_r$  ( $p, q, r \in (0, \infty)$ ) fails to have finite cotype if  $1/p + 1/q + 1/r \leq 1$ . We study the geometry of 3-fold projective tensor spaces  $\ell_p \otimes \pi \ell_q \otimes \pi \ell_r$  via the notion of volume ratio, an influential concept going back to Boris Kashin, Stanislaw Szarek, and Nicole Tomczak-Jaegermann. The volume ratio and cotype 2 constant of a Banach space are bridged by a deep result of Jean Bourgain and Vitali Milman. Using this, we obtain that in certain cases these spaces fail to have cotype 2. Main tools are estimates for the unit balls in Banach spaces and an extension of the famous Chevet theorem for Gaussian processes. (Joint work with Ohad Giladi, Carsten Schütt, Nicole Tomczak-Jaegermann, and Elisabeth Werner).

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