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*Non-commutative Fejer theorems, and Arens regularity of the projective tensor product of C*-algebras*

We present solutions to several problems concerning crossed products and tensor products of operator algebras. The common theme is our use of completely bounded module maps.

We prove that a locally compact group $G$ has the approximation property (AP) if and only if a non-commutative Fejer theorem holds for the associated $C^*$- or von Neumann crossed products. We deduce that the AP always implies exactness. This generalizes a result of Haagerup-Kraus, and answers a question by Li. We also answer a problem of Bedos-Conti on discrete $C^*$-dynamical systems, and one by Anoussis-Katavolos-Todorov on bimodules over the group von Neumann algebra $VN(G)$ for all locally compact groups $G$ with the AP. We also obtain a version of our von Neumann algebraic Fejer theorem for discrete quantum groups. (Joint work with J. Crann and S. Kazemi.)

It has been open for about 40 years to characterize when the projective Banach space tensor product $A \otimes_\gamma B$ of two $C^*$-algebras $A$ and $B$ is Arens regular. We solve this problem for arbitrary $C^*$-algebras: Arens regularity is equivalent to $A$ or $B$ having the Phillips property; hence, it is encoded in the geometry of the algebras. For von Neumann algebras $A$ and $B$, we conclude that $A \otimes_\gamma B$ is Arens regular only if $A$ or $B$ is finite-dimensional. This does not generalize to non-selfadjoint operator algebras. For a commutative $C^*$-algebra $A$, we prove that the centre of $(A \otimes_\gamma A)^{**}$ is Banach algebra isomorphic to the extended Haagerup tensor product $A^{**} \otimes_{eh} A^{**}$.