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*Product Rigidity for Non-Prime Group von Neumann Algebras*

Since their inception, the classification problem of group von Neumann algebras has been endeavor to determine which, if any, canonical properties of the group  $\Gamma$  are detectable in  $L(\Gamma)$ , the resulting algebra. We show if  $\Gamma$  is a  $k$ -fold product of non-elementary hyperbolic groups and  $\Lambda$  is an arbitrary group such that  $L(\Gamma) \cong L(\Lambda)$ , then  $\Lambda$  is necessarily a non-trivial  $k$ -fold product of non-amenable groups  $\Lambda_1, \dots, \Lambda_k$ . In this case, the group von Neumann algebra retains the direct product structure of the underlying group.

Refining these techniques, we are able to show the class of the so-called poly-hyperbolic groups exhibit similar phenomena. Namely, if  $\Gamma$  is a group in this in this class whose group von Neumann algebra decomposes into a tensor product of  $\text{II}_1$  factors  $L(\Gamma) \cong P_1 \bar{\otimes} P_2$ , then  $\Gamma$  must necessarily be commensurable to non-trivial direct product of poly-hyperbolic groups.