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PRIOR-CERTAIN INFERENCE AS A SIGNATURE OF POST-QUANTUM CORRELATIONS

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Abstract

A central program in quantum foundations is to characterize quantum theory through the correlations it permits. Communication tasks have proven effective in this pursuit, typically involving one or more senders who transmit limited information to a receiver attempting to infer a target variable. Existing studies, however, primarily focus on inference success rates and how pre-shared correlations influence them. Here we propose a shift in perspective by introducing the notion of prior certainty – an inference is prior-certain if the receiver, before receiving any message, is already certain of its accuracy. We examine this notion within a distributed variant of random access codes (RAC) task, and find that quantum nonlocal correlations cannot support both prior certainty and optimal inference. Specifically, we prove that if the optimal inference success rate is attained by sharing quantum nonlocal resources, then prior-certain inference becomes impossible. Interestingly, this restriction is violated by certain post-quantum correlations, including those that obey known principles such as Information Causality (IC) and Macroscopic Locality. This reveals that, even within RAC-type scenarios, the violation of IC is not the sole signaure of post-quantum behavior. More broadly, our findings indicate that prior certainty, when applied to other communication settings, may further sharpen the distinction between quantum and post-quantum correlations

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