Generalised probabilistic theories: from convex geometry to category theory

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In this talk I will give a whirlwind tour of the framework of generalised probabilistic theories (GPTs). This is a branch of research that sets quantum and classical theory within a broad landscape of logically conceivable physical theories. It does so by applying an operational methodology, based on the principle that ultimately any physical theory must be able to provide probabilistic predictions about the outcomes of experiments.

This framework has found many applications, but to list just a few, it has allowed us to: i) understand quantum theory from the 'outside', i.e., to find axioms that single out particular quantum features, or the entirety of quantum theory, from this landscape; ii) explore information processing in these hypothetical theories, e.g., are there potential physical theories which can have computers even more powerful than quantum computers?; iii) understand how different physical theories relate to one another, e.g., how does classical theory emerge from quantum theory, and could quantum theory similarly be just an effective theory of nature?

The mathematical tools that are used in this field of research are as diverse as its applications including, amongst others, convex geometry, group theory, computational complexity theory, and category theory. Nowadays not only are these branches of mathematics finding application within the study of GPTs, but the study of GPTs is now leading to new results in these fields, in particular, within the study of convex cones.