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Hopf-algebraic deformations of 3d spacetime symmetries

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It is widely argued, especially in the phenomenological approach to quantum gravity, that at the Planckian scales the geometry of spacetime may become noncommutative. A closely related effect is the generalization of classical spacetime symmetries into quantum-deformed algebras and groups, which are expected to have the structure of Hopf algebras and be characterized by the (classical) r-matrices - solutions of the Yang-Baxter equations. The best known example is the κ-Poincare algebra. Such quantum algebras and groups actually arise in the convincing way in 2+1 dimensions, where gravity can be described as a Chern-Simons theory with the gauge group given by the isometry group of spacetime, the latter depending on the metric signature and cosmological constant. For non-vanishing cosmological constant the relevant algebras are $\mathfrak{o}(4)$, $\mathfrak{o}(3,1)$ and $\mathfrak{o}(2,2)$. They can also be treated as real forms of the complex algebra $\mathfrak{o}(4;\mathbb{C})$, which has recently been applied to classify all of their possible quantum deformations. We have further expanded this line of inquiry by studying the quantum Inonu-Wigner contractions, i.e. calculating the limit of vanishing cosmological constant of deformations of the $\mathfrak{o}(4)$, $\mathfrak{o}(3,1)$ and $\mathfrak{o}(2,2)$ algebras, which leads to either deformed 3d inhomogeneous Euclidean algebras or deformed 3d Poincare algebras. The obtained algebras form a subclass in the known classification of quantum 3d inhomogeneous symmetry algebras and can be compared with e.g. the recent results concerning deformed symmetry algebras that are associated with the Drinfel'd double structures (the latter are claimed to be a necessary ingredient in the quantization of 2+1d gravity).

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