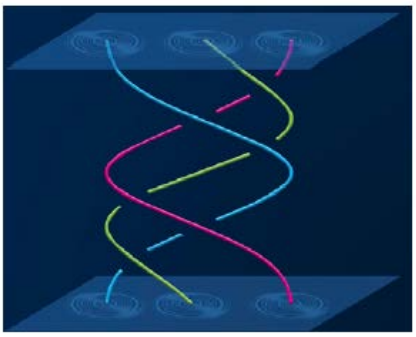
Theo Johnson-Freyd

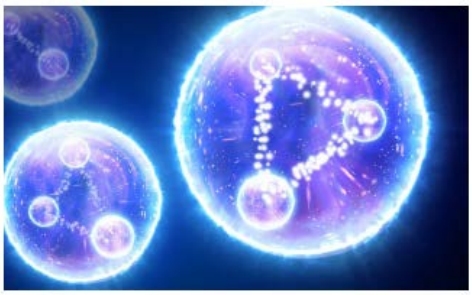
Category Theory and Physics

Dr. Johnson-Freyd studies topology, noncommutative algebra, and higher category theory through the lens of quantum field theory. His main research focuses on generalizations of the notion of "symmetry" that are dictated by quantum physics.

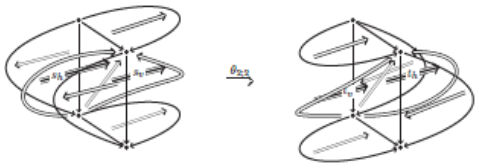


Global categorical symmetries: Symmetries are a powerful tool throughout mathematics and physics. Symmetries in quantum field theory have higher structure: symmetry operations can occur at points in spacetime, along curves, or along higher-dimensional objects, and their "group" laws depend on the linking and knotting of these extended objects; thus symmetry groups become objects of topology.

Superposition provides quantum objects with a natural additive/linear structure. Because of this, groups become algebras, and there can be "symmetries" which are not invertible. Combining algebras with higher structure leads to (higher) categories. The goals of global categorical symmetry are to identify interesting noninvertible and higher symmetries in quantum field theories, and then to use them analogously to the well-developed use of ordinary symmetries in order to analyze the dynamics (e.g. the long-range behaviour) of the system.



Categorical constructions from physics: Dr. Johnson-Freyd and his collaborators have constructed a universal target for topological field theory, in the same way that an algebraically closed field is a "universal target" for polynomial equations (since they always have solutions there). This construction involved methods from algebraic and differential topology as well as from the theory of fusion categories, which one should think of as finite noninvertible symmetry groups.



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