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Stepping beyond our 3-D world

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Since the dawn of time, humans have endeavoured to unravel the laws governing the physical world around us. Over centuries we have tried to discover a Theory of Everything.

Possible candidates for this cachet, such as String Theory and Grand Unified Theory, require higher dimensions or higher-dimensional symmetries, for instance ten dimensions, despite their radical difference from the world we actually experience.

One such symmetry – known as E8 – exists in eight dimensions and is the largest symmetry without counterparts in every dimension and is therefore called exceptional. It features prominently in String Theory and Grand Unified Theory.

Now a University of York scientist has constructed E8 for the first time, along with other exceptional 4D symmetries, in the 3D space we inhabit. Dr Pierre-Philippe Dechant, of the Departments of Mathematics and Biology at York, has created these exceptional symmetries essentially as 3D phenomena in disguise.

This new view of the exceptional geometries has the potential to open large areas of mathematics and physics up for reinterpretation. The research is published in *Proceedings of the Royal Society A*.

Dr Dechant, who is also a member of the York Centre for Complex Systems Analysis, developed a unique combination of working with the Platonic root systems for applications in mathematical virology and an unusual Clifford algebraic approach, to lay the foundation for this fundamental new insight.

The construction of E8, which is fundamental to String Theory and Grand Unified Theory, using the 3D geometry of the icosahedron – a polyhedron with 20 faces—is ground-breaking and completely against the prevailing eight-dimensional view. It was made possible by the fact that 3D geometric quantities (points, lines, planes, volumes) in the Clifford algebra approach actually themselves form an eight-dimensional space.

He said: "Usually when one argues for higher-dimensional theories one considers them as fundamental, and we might only experience a part of this whole structure in our 3D world. The results of this paper completely subvert this by showing that these `obscure' higher-dimensional symmetries actually have `space' to fit into the 3D geometry of our natural world.

"This was made possible by my unusual position of working on the symmetries of viruses whilst having a mathematical physics background and is thus a unique inspiration of mathematical biology back into mathematical physics."

More information: Pierre-Philippe Dechant. The birth of out of the spinors of the icosahedron , *Proceedings of the Royal Society A: Mathematical, Physical and Engineering Science* (2016). DOI: 10.1098/rspa.2015.0504

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