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Mathematicians solve E8 structure (Update)

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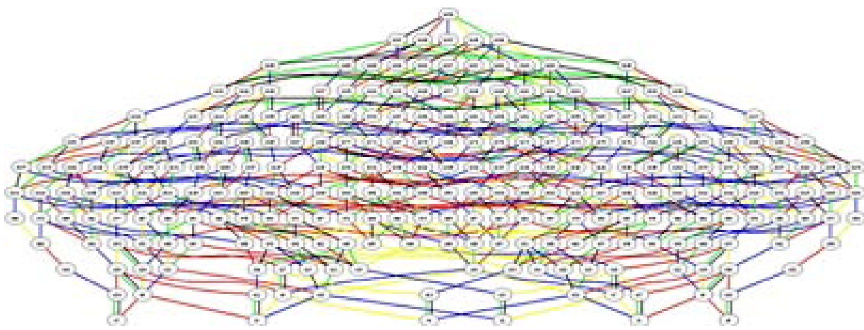
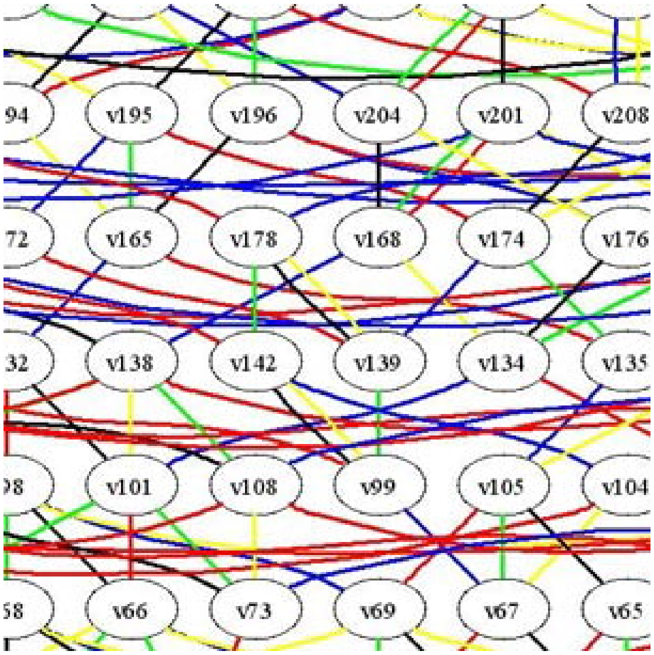


This graphic describes a mathematical structure similar to but much smaller than E8. Image courtesy / David Vogan, MIT

A transatlantic team of number-crunchers announced they had built a theoretical structure in 248 dimensions, resolving a 120-year puzzle that could be used to test theories about the structure of the cosmos.

Top computer scientists and mathematicians from the United States and Europe said they had mapped E_8, a problem that was discovered in 1887 but has had to wait until the era of supercomputers and Internet-linked minds to resolve.



Detail of graphic above. The connections in the graph, and the colors of the connecting edges, are shorthand describing the geometry of the structure.

E_8 is the mother of all so-called Lie groups -- a category of problems invented by a 19th-century Norwegian mathematician, Sophus Lie (pronounced "Lee"), to explore symmetry.

Spheres, cylinders or cones are familiar examples of simple, symmetrical objects in three dimensions. But E_8 is a piece of geometric origami that comes in 248 dimensions.

"(E_8) is as complicated as symmetry can get," David Vogan, a mathematics professor at the Massachusetts Institute of Technology (MIT), who took part in the calculation, said on Sunday.

"Mathematics can almost always offer another example that's harder than the one you're looking at now, but for Lie groups, E_8 is the hardest one."

Resolving E_8 was a gigantic undertaking, the scientists said. They compared it to the Human Genome Project, which patiently unraveled the human genetic code.

The human genome is less than a gigabyte in size, but the E_8 calculation is 60 gigabytes, enough to store 45 days of continuous music in MP3 format. The printout would cover an area the size of Manhattan.

The reason was that the input -- the E_8 equations themselves -- was comparatively small but the answer itself was enormous.

"This groundbreaking achievement is significant both as an advance in basic knowledge, as well as a major advance in the use of large scale computing to solve complicated mathematical problems," said Jeffrey Adams, project leader and mathematics professor at the University of Maryland.

A low-definition picture of E_8, released by MIT, showed something like a multicolored circus tent made, like a child's constructor set, of densely-packed, connected rungs.

"We can never hope to represent the structure in its entirety, it's a mathematical abstraction," Dutch researcher Marc van Leeuwen, of France's University of Poitiers, told AFP.

"You can make some nice pictures with it, but a sheet of paper has only two dimensions, so you will never see the real object.

It took four years to produce the E_8 calculation. Exceptionally -- for mathematics is usually a solitary activity -- the achievement came through close collaboration, mixing theoretical mathematics and intricate computer programming on both sides of the Atlantic.

"The literature on this subject is very dense and very difficult to understand," explained Vogan. "Even after we understood the underlying mathematics, it still took more than two years to implement it on a computer."

One of the biggest headaches was finding a computer big enough to crunch the calculation.

For a whole year, the team tried to slim down the calculation a thousand-fold, trying to make it more efficient so that it could fit on existing supercomputers.

Even so, the calculation was still beyond the current generation of computing power.

Just as the team was despairing of seeing their work realized, one of them came up with a way to break up the calculation in such a way that parts of it could be digested in separate batches.

The results from each batch were then assembled to give the ultimate solution, which took 77 hours to run on a US supercomputer called Sage.

An independent expert told AFP said the E_8 breakthrough was "a very important advance" in physics, for it could be used to test a key theory about the fundamental symmetries in nature.

Among these mooted symmetries is the structure of the cosmos, created by the Big Bang some 13 billion years ago, and basic particles themselves, said Hermann Nicolai, director of the Albert Einstein Institute in Potsdam, Germany.

The 18-member research team, called Atlas, included mathematicians from France's universities of Poitiers and Lyon.

In a press release, MIT said Vogan would present the work on Monday in a talk entitled "The Character Table for E_8, or How We Wrote Down a 453,060 x 453,060 Matrix and Found Happiness."