Quantum objects on show

Worlds Within Worlds: Quantum Objects by Julian Voss-Andreae
American Center for Physics, College Park, Maryland
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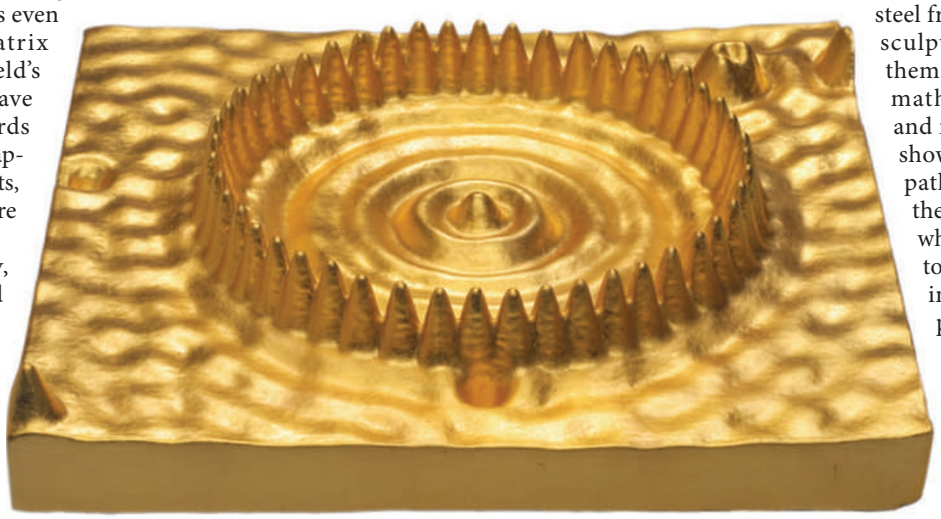
When asked what his Third Symphony meant, Ludwig van Beethoven is said to have sat down at the piano and begun playing it. Analogously, a physicist might write down Erwin Schrödinger's wave equation as an 'explanation' of quantum theory. But even this formula was Schrödinger's alternative to Werner Heisenberg's even more abstract matrix mechanics. The field's pioneers seem to have concluded that words and images fail to capture quantum concepts, and that equations are all we have left.

On the contrary, the Oregon-based sculptor Julian Voss-Andreae thinks that art, when free from the demands of literalism, "has a unique potential for indicating aspects of reality that science cannot". He is well placed to judge. Previously a quantum physicist at the University of Vienna, in 1999 he participated in a groundbreaking experiment showing that even objects as 'big' as C_{60} molecules can display the wave-like property of interference. Voss-Andreae's portrayals of quantum objects are now on show in the exhibition *Worlds Within Worlds* at the American Center for Physics in College Park, Maryland.

"There simply are no consistent mental images we can create to understand the world as it is portrayed in quantum physics, because our brains are exquisitely adapted to making sense of the world on our scale," says Voss-Andreae. "I want to increase the audience's capacity to intuit the unfathomable deeper nature of reality by sensually experiencing the works."

This impulse to leap beyond the logical has an obvious appeal to artists, and Voss-Andreae is not the first to find inspiration in modern physics. In the early twentieth century, Surrealist artists such as André Breton and Salvador Dalí were excited by the challenge posed by quantum theory and relativity to conventional notions of causality, time, geometry and objectivity (see *Nature* **453,** 983–984; 2008). Their enthusiasm was rooted mainly in the perceived radicalism of the new physics rather than in an understanding of the science.

Yet even practitioners do not claim to fully understand quantum theory. The disputes about interpretation among the early pioneers such as Albert Einstein, Niels Bohr, Heisenberg and Schrödinger are legendary, but they are still with us. The Copenhagen interpretation — with its wave-particle duality, probabilistic picture and observer-induced collapse of the wave function — is still not universally accepted. And the nature of the transition from quantum to classical behaviour continues to be debated. The failure to unify quantum theory with gravitation leaves open the possibility that the theory is a stop-gap, a mathematical convenience.



Julian Voss-Andreae's gilded wooden *Quantum Corral* depicts quantum waves within a ring of iron atoms.

PHOTO: D. KVITKA/WWW.JULIANVOSSANDREAE.COM

Voss-Andreae is therefore either brave or foolhardy to try to represent quantum phenomena tangibly. Perhaps his greatest asset as a former physicist is that he realizes how much we don't know. In some of his works, the inverted commas of analogy are explicit to the knowing eye. *Quantum Corral* (pictured) materializes something that could hardly be less material: the wave-like properties of electrons, first reported in *Nature* in 1927 (C. Davisson and L. H. Germer *Nature* **119,** 558–560; 1927). Here, they are represented in a block of wood that has been milled to the contours of electron density seen in 1993 around a ring of iron atoms on the surface of copper through a scanning tunnelling microscope. The gilded surface reminds physicists that it is the mobility of surface electrons in the metal that accounts for its reflectivity, and the coloration of gold is itself a relativistic effect of the metal's massive nuclei. For art historians, this gilding invokes the crown-like haloes of medieval altarpieces, but could also allude to the way gold was reserved in Renaissance art for the intangible: the other-worldly light of heaven.

Voss-Andreae's works *Night Path* and *Spin Family (Bosons and Fermions)*, with their webs of metal wire or silk thread in solid steel frames, hark back to the sculptures of Naum Gabo, themselves inspired by new mathematical geometries and models. Yet *Night Path* shows a quantum idea: the path-integral approach to the trajectories of light, in which the passage of a photon is considered to be the integral over all possible paths, calculated by slicing up time. Here Voss-Andreae is not trying to produce a textbook representation. Rather, "the paths emerge from one point and then keep opening up", he explains. "I made it to illustrate the 'feel' of it." In the *Spin Family* series, inspired by the quantized spin states of the two classes of fundamental particle, the diaphanous silk thread allows us to visualize superpositions of states while cautioning against too literal a picture of what 'spin' itself represents.

A feeling of intangibility and the subjectivity of points of view pervades *Quantum Man*, a walking figure created from parallel slices of steel in which the particle-like concreteness seen from the front shifts to wave-like near-invisibility when the piece is viewed from the side. This sense of an object on the point of disintegrating is a common trope of recent artistic efforts to capture ideas in physics, from Antony Gormley's *Quantum Cloud* series to Cornelia Parker's *Cold Dark Matter*. Put the pieces together yourself, they seem to say — because that's how the world works anyway. ■

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