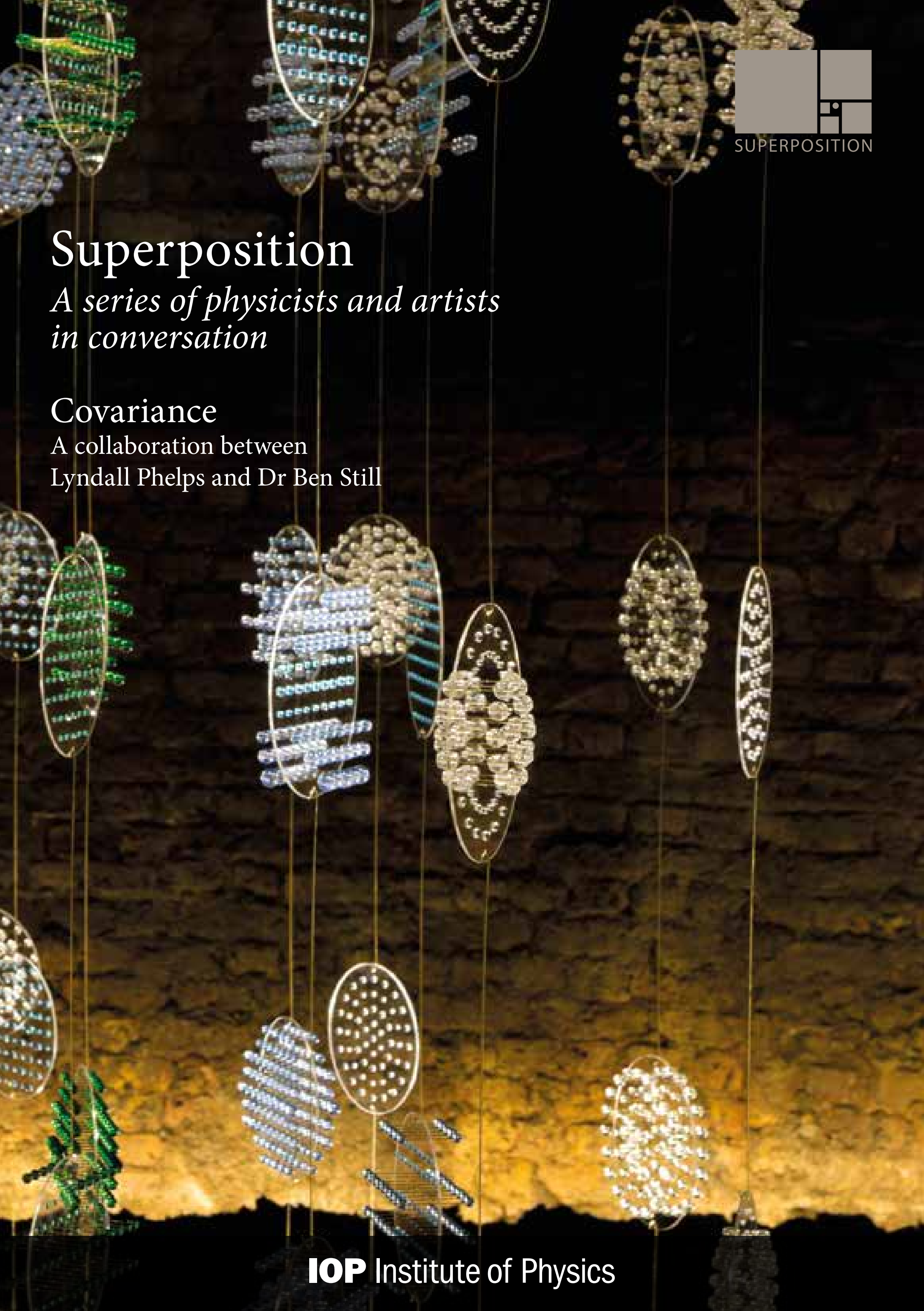


SUPERPOSITION

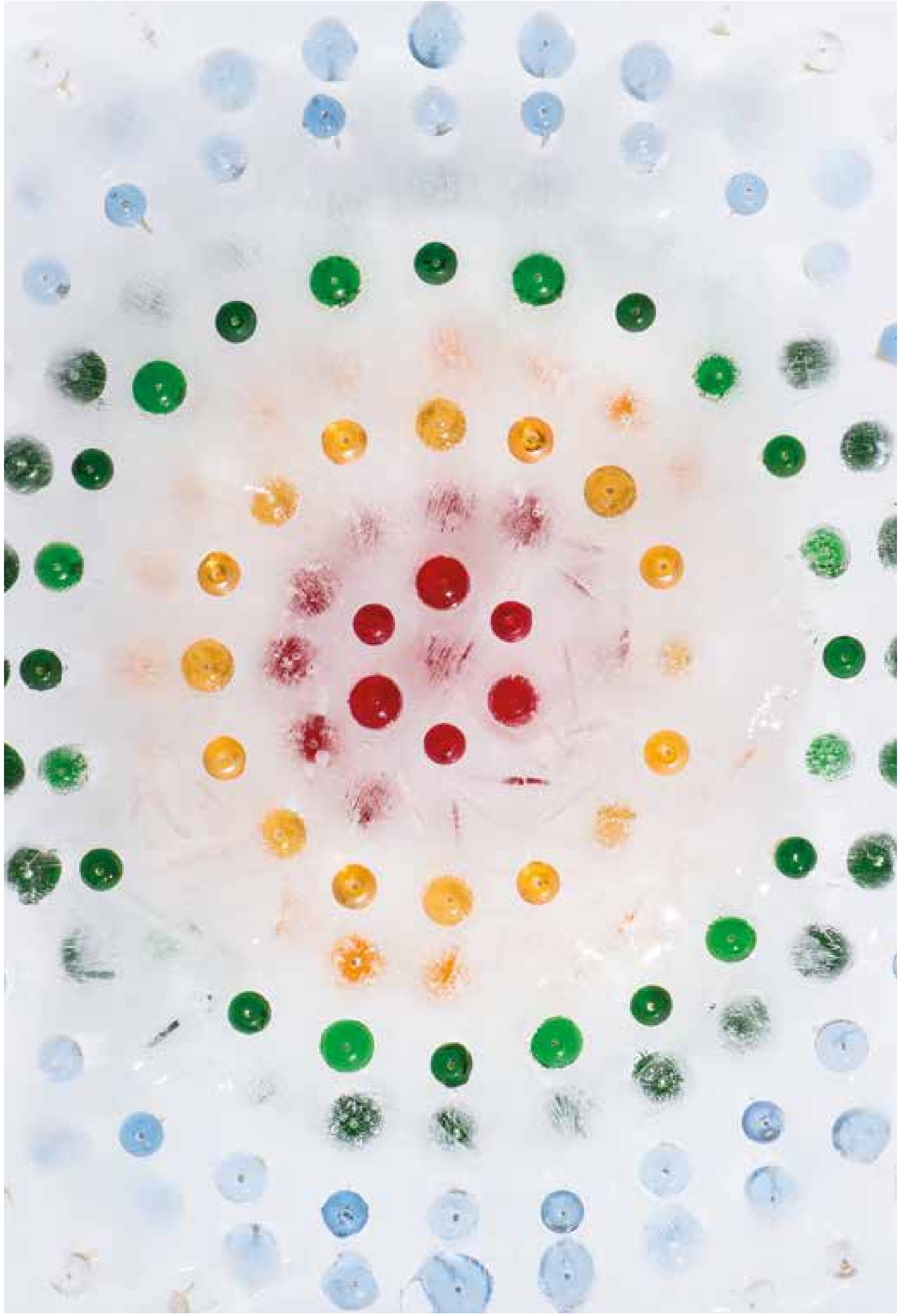
Superposition

A series of physicists and artists in conversation

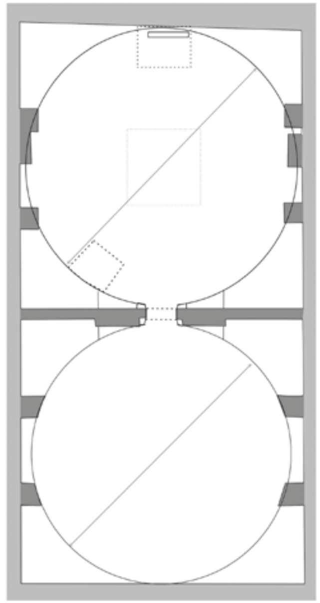
Covariance

A collaboration between
Lyndall Phelps and Dr Ben Still

IOP Institute of Physics



Photography Peter Mennim



1

Covariance: a collaboration about everything

Early in the research phase for this project, Lyndall Phelps and Dr Ben Still visited the Science Museum to help explore the context of the neutrino [1] research being undertaken by the International Tokai to Kamioka (T2K) experiment.

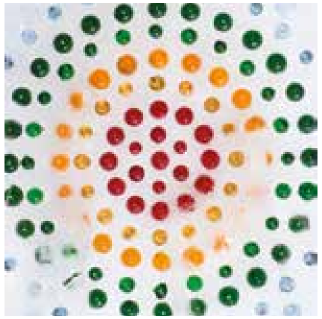
After exploring directly relevant displays, they visited the King's Gallery; an internationally significant collection of early to mid 18th century scientific instruments designed to examine the physical world in ways more sophisticated than before, from the microscopic to the cosmic. They were the cutting-edge research tools of their day.

When Phelps posed the question to Still, among the gleaming 200 year old instruments, "what in this room links to your work?", after a pause the reply came, "everything". This reveals both the fundamental nature of the neutrino observations performed at T2K and yet how distant they can seem from an everyday perception of how the world works.

Today, the T2K experiment is at the cutting edge of one branch of one scientific discipline: particle physics. The experiment observes neutrinos, to learn more about what they are and how they behave. Part of the experiment is located at Super-Kamiokande, an underground neutrino observatory in Japan. In a disused mine, a space 40m in diameter and 40m deep has been excavated and filled with purified water. Hand-blown glass detectors line the space, and they are triggered when light is released as neutrinos interact with the water. The data is collected in Japan, and then distributed to Still in London and collaborators around the world for analysis.

For Phelps, this has provided a rich context for collaboration. The constituent elements within the Covariance installation are drawn from her journey into the science and its context. She adopts brass hanging rods and transparent disks to allude to an earlier age of scientific experimentation and instrumentation. The decorative motifs of the suspended elements are inspired by the neutrino detector spirals and data analysis grids, and from the latter comes the colour palette and its modulation sequence.

The first part of Covariance that visitors encounter is a group of three light-boxes created by Phelps, seen through an opening in the London Canal Museum's floor. The sleek, glowing objects show photographs of colourful structures being revealed through melting ice - creating an intriguing painterly texture on a flat image. Visitors have a truly extraordinary experience: drawn away from a conventional museum setting



Photography Peter Mennim

1 Plan of ice wells. © London Canal Museum

2 The Super-Kamiokande particle detector in Japan. © Kamioka Observatory, ICRR (Institute for Cosmic Ray Research), The University of Tokyo

3 A female 'computer' capturing data from bubble chamber (early particle detectors) experiments in Atlas, 1970. © Rutherford Appleton Laboratory and the Science and Technology Facilities Council (STFC)

4 Data analysis plot © Dr Ben Still

they descend to a raw space with beaten earth floors, with different scent and temperature to the outside world. Once underground, visitors glimpse a sliver of light and sparkle through the opening to the second chamber, occupied by the main suspended installation of Covariance.

Layers of hovering disks with subtly altering patterns and colour variation capture the viewer's imagination. The attention to detail and accumulative scale reflect the artist's rigorous making practice; she has worked tirelessly, eight hours a day, every day, for over three months to create the work. Despite absorbing and processing so much source material, there is no sense of excess: the work has become what it needs to be. Working at this scale represents a significant development in Phelps's practice to consolidate a strong research-led collaboration into a single, major installation of immediacy, delicacy and power.

Other elements of the work reflect social aspects of scientific endeavour. The use of diamanté and glass beads within the work is specifically to give a connection to a form of femininity. Historically, within the world of particle physics women were employed to manually process data and were known as the first 'computers'. The role of these anonymous women was to perform sophisticated calculations at the behest of their male scientific 'superiors'. Phelps is keen to emphasise the equally collaborative nature of her work, both conceptually and physically. Dr Still has participated in the manufacture of the suspended installation, and the work developed through intense discussions between artist and scientists.

Covariance also developed in response to the site found for its installation, which builds further resonances into the work. The London Canal Museum is housed within a huge ice warehouse built for 19th century ice cream maker Carlo Gatti. Ice was imported from Norway by ship and canal boat to be stored in the underground ice wells below the warehouse. Purified still water is a fundamental part of the T2K detector, with other research facilities boring into Arctic ice. There is an element of post-industrial mirroring, too: the act of repurposing two underground chambers in London to host the installation occurs just as plans for a second set of underground chambers are being proposed at Super-Kamiokande. These links across the world within the artwork echo the global community of scientists linked to the T2K experiment.

Within the multitude of examples where collaboration has been facilitated between artists and scientists in recent years, there has often been an over-emphasis on the artistic outcome to 'communicate science'; that is, to aid the transmission of understood facts to a public audience. Art has its own practice (way of working) and agency (power to change), as distinct from science. To limit the role of art to merely a fact-communication vehicle for science defeats the purpose of cross-disciplinary collaboration. By contrast, exchange of ideas between artists and scientists should have a mutually beneficial outcome to both disciplines: "behind these diverging streams of intention runs a turbulent river of shared intuitions about the order and disorder of things" [2].

Artistic outcomes from such rich collaboration are independent art works: they resonate, and exist in parallel, with scientific knowledge and are not subordinate to it. Such art works may be viewed as a form of lateral – as opposed to literal – interpretation: they provoke the viewer to desire more knowledge through a rich, multi-sensory, intellectual and emotional experience. Key funders and supporters of rich collaborative initiatives such as the Wellcome Trust and the Science Museum – and now the Institute of Physics – are to be lauded.

Phelps has prefigured the best aspirations of these established programmes through her interactions with Still. At times their interaction has influenced Still's thinking and methodology; mirroring Phelps's previous project with radar researchers at Cranfield University (Softkill project, 2011) where their collaboration precipitated new developments in radar technology [3].

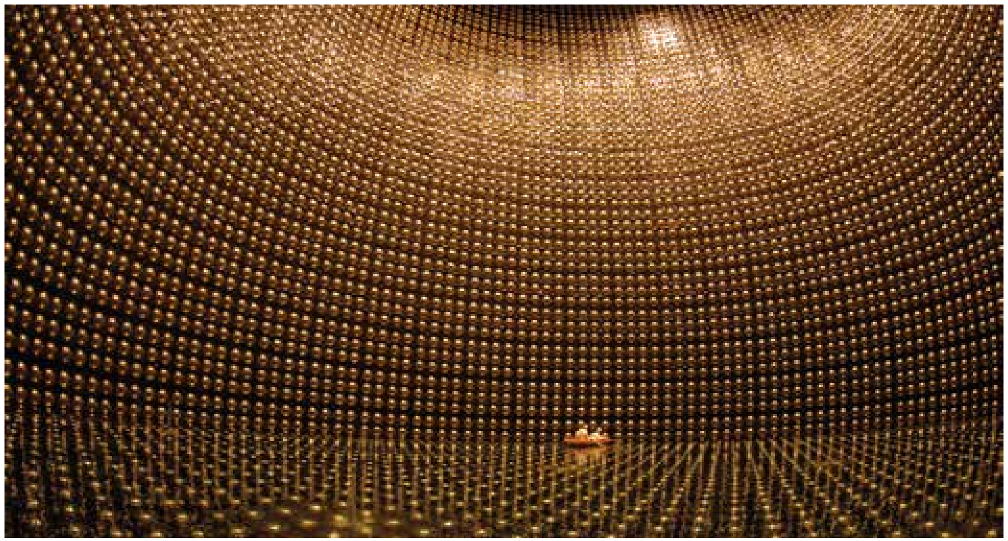
On a global stage, there is a currency to the themes and circumstances of this collaboration, and specifically Covariance. The 55th Venice Biennale [4] stages The Encyclopedic Palace, a huge exposition of contemporary art practice exploring different systems of understanding the world by artists and others. Psychological approaches of Carl Gustav Jung are included, as are the radical educational approaches of Rudolf Steiner. Seen in this context, Covariance establishes Phelps's work as being engaged with current critical and artistic practice from around the world. As research science uncovers ever more detail about the fundamental particles of life, there is a danger that it becomes distant from the wider public. We all need systems to understand the world, and artists of Lyndall Phelps's power and rigour to provoke us with their vision.

Tom Freshwater
Contemporary Art Programme Manager, National Trust

[1] Neutrinos are a type of sub-atomic particle and are one of nature's most basic building blocks.

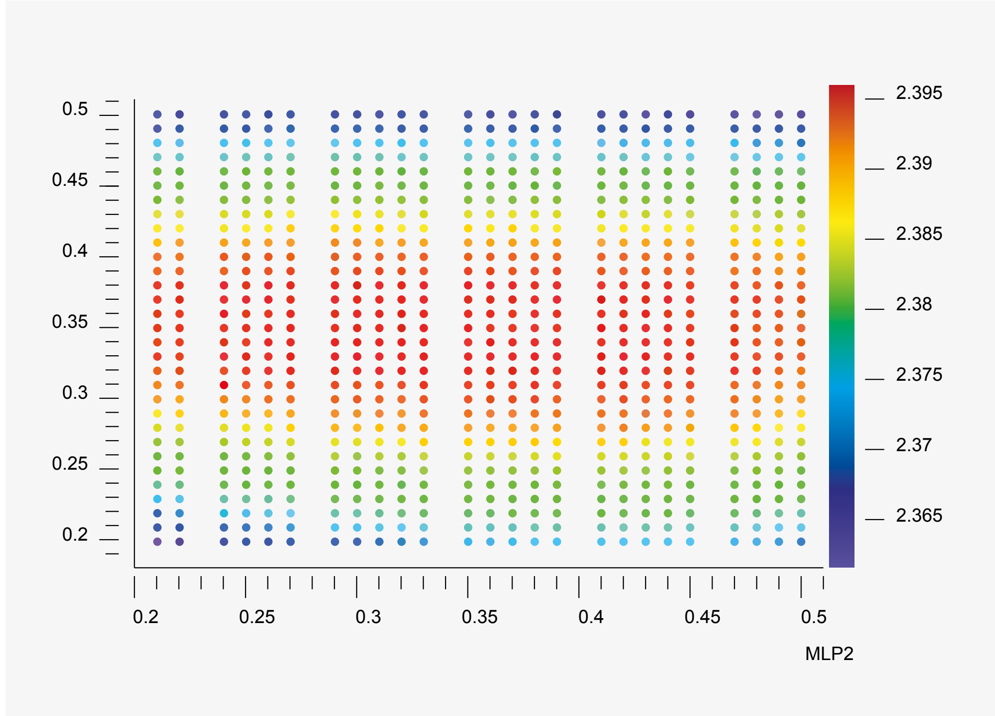
[2] Kemp, M., "From science in art to the art of science", Nature 434, 309 (2005)
[3] Shaul, M., "Softkill: Lyndall Phelps", University of Hertfordshire Galleries, (2011)
[4] http://www.labiennale.org/en/art/exhibition/55iae/

2



Photography Richard Davies

3



4

The quiet voice of the neutrino

The neutrino is the shyest of all of what physicists call "fundamental particles", the basic building blocks of everything in the universe. This year has seen great leaps in our understanding of neutrinos, but we still have limited knowledge of exactly what secrets they might hold.

To see a neutrino, we first go underground. This removes any interference from the showers of particles originating in deep space that constantly bombard the surface of the Earth. On the Earth's surface the neutrino is a quiet voice and these particle showers a loud concert. Underground, the noise is all but removed, and the neutrino's quiet voice is easier to pick out.

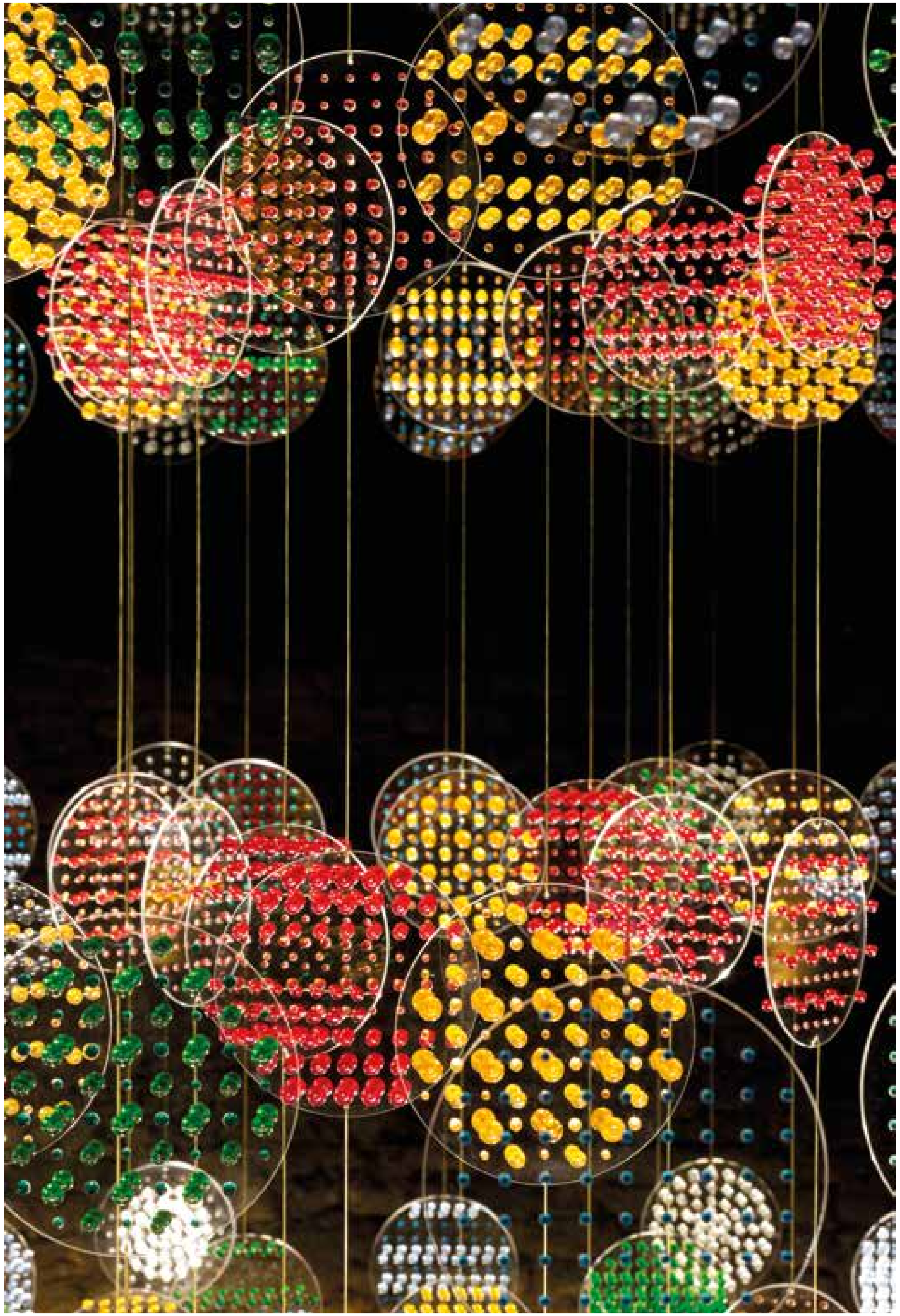
A neutrino rarely interacts with its surroundings, but when it does it produces new particles: electrons, muons or tauons. These particles have an electric charge, and so interfere strongly with their environment – and we can see this effect in particle detectors. Most detectors use materials that transform the energy of these particles into some form of light. This light is then turned into electrical signals by sensitive electronics, and then into information stored on computer. With thousands of sensors we can build up an image of the interference and link it back to the original neutrino that started the whole chain of events.

With a number of sightings we can start to understand the way in which neutrinos interact with the world. Mathematical models of what we think should happen are compared to what is actually seen and a confidence in how accurately the models describe the data is calculated. Day to day I work on new methods of looking for patterns in the data and fitting them to the fundamental physics. We then use the data, along with pseudo data from the mathematical models, to tease out the underlying physics. All of this is in an effort to understand the character of neutrinos.

The ghostly behaviour of neutrinos renders them the least well known facet of nature. There are many interesting theoretical, mathematical models that fit the vague picture we have of them. One such model can account for perhaps the most important question in physics today: where did all the matter come from? The model suggests that the way in which particles interact shows some small preference for matter over antimatter, its mirror-image counterpart. With further understanding of the neutrino it is hoped that they may reveal this preference.

All of this research is the pursuit of knowledge in its purest form, pushing back the boundaries of our understanding. Despite its seemingly disjointed appearance, particle physics has had a profound effect on our modern lives, from the web to medical imaging. The technologies and data analysis techniques behind the science have a direct link to our everyday lives.

Dr Ben Still
Research Associate at the School of Physics and Astronomy Queen Mary, University of London.



Photography Richard Davies

The SUPERPOSITION series seeks to engage an adult audience in contemporary physics through contemporary visual art. The series supports long-term relationships between individual physicists and artists, to generate new thinking and new artworks. Covariance is the Institute of Physics' first project in the SUPERPOSITION series.

Covariance (24 August – 20 October 2013) was commissioned by the Institute of Physics.

Curated by Annabel Lucas

Hosted by the London Canal Museum

Exhibition and publication made possible through a partnership with the London Canal Museum, with funding from The Arts Council and Gina Agnew Gallery, and generous support from ARUP Lighting, ACDC Lighting, Architectural FX, LEDLinear and Cube Lighting.

physics.org/superposition

Editors:
Annabel Lucas and Caitlin Watson

Photography:
Richard Davies and Peter Mennim

Design:
Colin Goodhew, °°0

Acknowledgements

Lyndall and Ben would like to thank:

Caitlin Watson
Dominic Galliano
Stephanie Elliott
Henry Lau
Kelly Oakes
Joseph Winters
Institute of Physics

Martin Sach
Rachel Ball
Roger Squires
Malcolm Tucker
London Canal Museum

Elizabeth Jeavans
Annabel Lucas

Sally Sheinman
Jack Hutchinson
Gina Agnew
Tom Freshwater

Grace Thorne
Maryla Twin
Aaron Head
Matthew Smith

Alison Gallager
Dwayene Shillingford
Paula Longato
Guillermo Martinez Pajares
ARUP Lighting

ACDC Lighting
Architectural FX
LEDLinear
Cube Lighting

Michael Lewis
Dale Moss
M&M Welding Fabrication Ltd

Kevin Hill
K2 Associates Limited

Richard Davies
Peter Mennim
Photography

Colin Goodhew
Lucid Design

Tabitha Globle
Rebecca Odell
Mita Solanky
Visitor Assistants

Cover image: photograph Richard Davies

IOP Institute of Physics

LOTTERY FUNDED · Supported using public funding by ARTS COUNCIL ENGLAND

LONDON CANAL MUSEUM

GINA AGNEW

ARUP

CUBE

acdc

Architectural FX
INTERIOR • EXTERIOR • LIGHTING • PASSION

LED Linear
linear lighting solutions