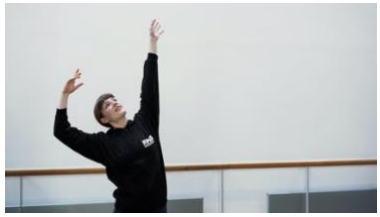
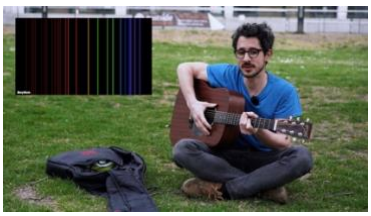
Elemental dances *notes*

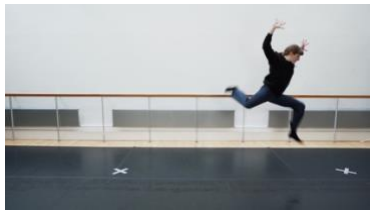
Discover the tiny things that make up the world with scientists from Imperial College London and dance artists from The Place.











Who are these videos for?
Students of Nature. They were made for children aged 7-11, their families and teachers. However, the more we share them, the more we find students of all ages are using them, for example in secondary schools in projects with drama departments, and for undergraduate students taking introductory physics courses.

Who made them?
The project was led by award winning artist and physicist Geraldine Cox, and dance artist and producer Emma Bellerby from The Place's 'Creative Learning Team'. The scientists are atomic physicists from Imperial College London's' 'Centre for Cold Matter'. The dance artists in the film are from The Place in London.

The project team is:

- Physicists – Xavier Alauze, Chris Ho, Kyle Major and Izzie Rabey.
- Dance Artists: Yanaëlle Thiran, Akeim Toussaint Buck.
- Musician: Michael Sebastian.
- Film Maker: Alice Underwood.

The project is funded and supported by: The American Institute of Physics, The Arts Council and The Engineering and Physical Sciences Research Council (EPSRC).

Why did you make them?

- To introduce important ideas about atoms using movement exploration, allowing children to learn in a physical way.
- To encourage creativity and imagination by highlighting the cross-curricular links between art and science.
- To encourage curiosity in the world around us and show the beauty in the scientific theories.

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- To reach more minds and bodies more effectively and provide a resource for families and schools in teaching this work.
- To have fun.

What are the videos about?
The videos are about the tiny building blocks of our world – atoms and molecules. They are structured and colour coded as follows:

Episode 0: Size. *How big is an atom?* An introductory episode of only 2:02 minutes.

Episode 1: Clues. ***Why do we think atoms exist?* 24:43 minutes.** Exploring Brownian Motion and how we can infer the existence of atoms from the jiggly motion of larger particles. This jiggling motion is explored via dance, imagining different body parts are being pushed and pulled through space, like the particles in Brownian Motion.

Episode 2: World Ingredients. ***What are the atoms that make the world?* 22:42 minutes**. An introduction to the periodic table and its structure. Students explore different atoms, discovering aspects of their character through different movements.

Episode 3: **Atom Light. *How do atoms colour the world?* 31:16 minutes.** This episode looks at how atoms absorb and release different colours of light to make atomic spectra* and colour our world. This is an advanced topic, but through the detailed explanations and links to music and dance, the content can be adapted for different levels. We will look at how light frequencies absorbed and emitted by atoms operate in a similar way to music frequencies and use this analogy to explore how atomic spectra are created by atoms, using high, medium, and low energy movements.

Episode 4: The Water Molecule. *How do atoms behave when they combine to make a water molecule?* 26:51 minutes. Atoms combine to make larger units called molecules. A water molecule is made up of two hydrogen atoms and one of oxygen atom. We explore the 6 ways that a water molecule can vibrate and rotate using symmetry, twists and counterbalances to inspire dancing.

Episode 5: Ice, Water, Steam. *How does water change its character so dramatically?* 17:33 minutes. We explore the three states of matter of water (liquid, solid, vapour) and why and how they occur due to changes in energy. Using the dynamics of a liquid, solid and a gas we think about how the movement of water molecules changes as they move through each state.

Episode 6: Atom Factories. *Where do atoms come from?* 23:48 minutes. We discover that stars, like our Sun, are big atom factories, creating the building blocks for everything including humans. This means we are also made of stardust. In the dance section, we explore how two atoms collide to create heavier atoms and we turn our bodies into atom factories just like the Sun.

How is each video structured?
Each video begins with a short introduction to the scientific theory led by one of the physicists from Imperial College London. The learning points are summarised after the explanation, allowing teachers to press pause and recap the information covered. This section is then followed by the dance exploration of the theme, featuring a warm-up, creative dance tasks and

a cool down. To close, we return briefly to the physicist, and they suggest an idea for a creative follow-on project which may be visual art, music or further dancing and research.

How should I use these films?
Clear a space. Play the short scientific explanation. When the recap slide is reached, you can pause the video and take a moment to discuss what you have learnt. Press 'play' again to go into the dance section.

Please feel free to use the videos however you like. You can follow along with the films, use them to create your own lesson plans or press pause at any time to lengthen or repeat different activities. These films might slot into your existing science curriculum, or you may wish to use them as additional content (as part of a STEAM topic, for example). They may inspire ideas about how you can incorporate dance and art into other curriculum areas. You can find additional music to accompany the activities in the Spotify playlist detailed at the end of this handout, or choose your own.

Who can I contact with questions and suggestions?
Please email your questions and feedback to geraldine.cox@imperial.ac.uk. We are keen to hear your thoughts and learn about how you have used these films. Please send us your photos!

Where can I view the films?
You can view all the films and a trailer at https://www.theplace.org.uk/elemental-dances.

*** Atomic spectra:** We are used to the idea that sunlight contains myriad colours spanning all the colours of the rainbow. In contrast atoms produce extremely precise *pieces* of the full light spectrum called atomic spectra. They look a little like colourful barcodes. Like a fingerprint, each type of atom has its own unique atomic spectrum. When we look to outer space, we can analyse the light we see and observe the spectra. This is how we know what objects like our stars are made of. By learning a little about atomic spectra, we also begin to understand how atoms and molecules bring colour to our world.

Thank you

'The Creative Learning Team' at The Place, 'The Centre for Cold Matter' at Imperial College London, and artist Geraldine Cox.

Imperial College London
THE PLACE
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UKRI Engineering and Physical Sciences Research Council
AIP American Institute of Physics

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Spotify Playlist

We have selected additional music tracks to accompany your dance explorations:

Slow, calm warm-ups

- ‘Jardin’ by Gustavo Santaolalla
- ‘Threads’ (Track 1: Prelude) by Paul Lansky/Sō Percussion
- ‘Air Molecules’ by Yutaka Hirasaka

Energising warm-ups

- ‘Jumping Jack’ by Big Bad Voodoo Daddy
- ‘Mi Mujer’ by Nichola Jaar
- ‘Bean Fields’ (Live from the Royal Festival Hall) by Penguin Café Orchestra
- ‘Stiff Jazz’ by Dzihan and Kamien

Medium tempo

- ‘Rasta La Vista’ by René Aubry
- ‘Bag of Bones’ by Felix Laband
- ‘Space Walk’ by Lemon Jelly

Slow and atmospheric music

- ‘Air Molecules’ by Yutaka Hirasaka
- ‘El Resplandor’ by Nettle
- ‘Explosions in a Four Chambered Heart’ by Moon Ate the Dark

Mechanical and rhythmic

- ‘The Unremarkable Atoms’ by Xopichtli
- ‘Messy Machinery’ by Extrawelt
- ‘Glass Eye’ by Pearson Sound
- ‘Heavy Machinery’ by Scuba
- ‘Could’ by Elderbrook