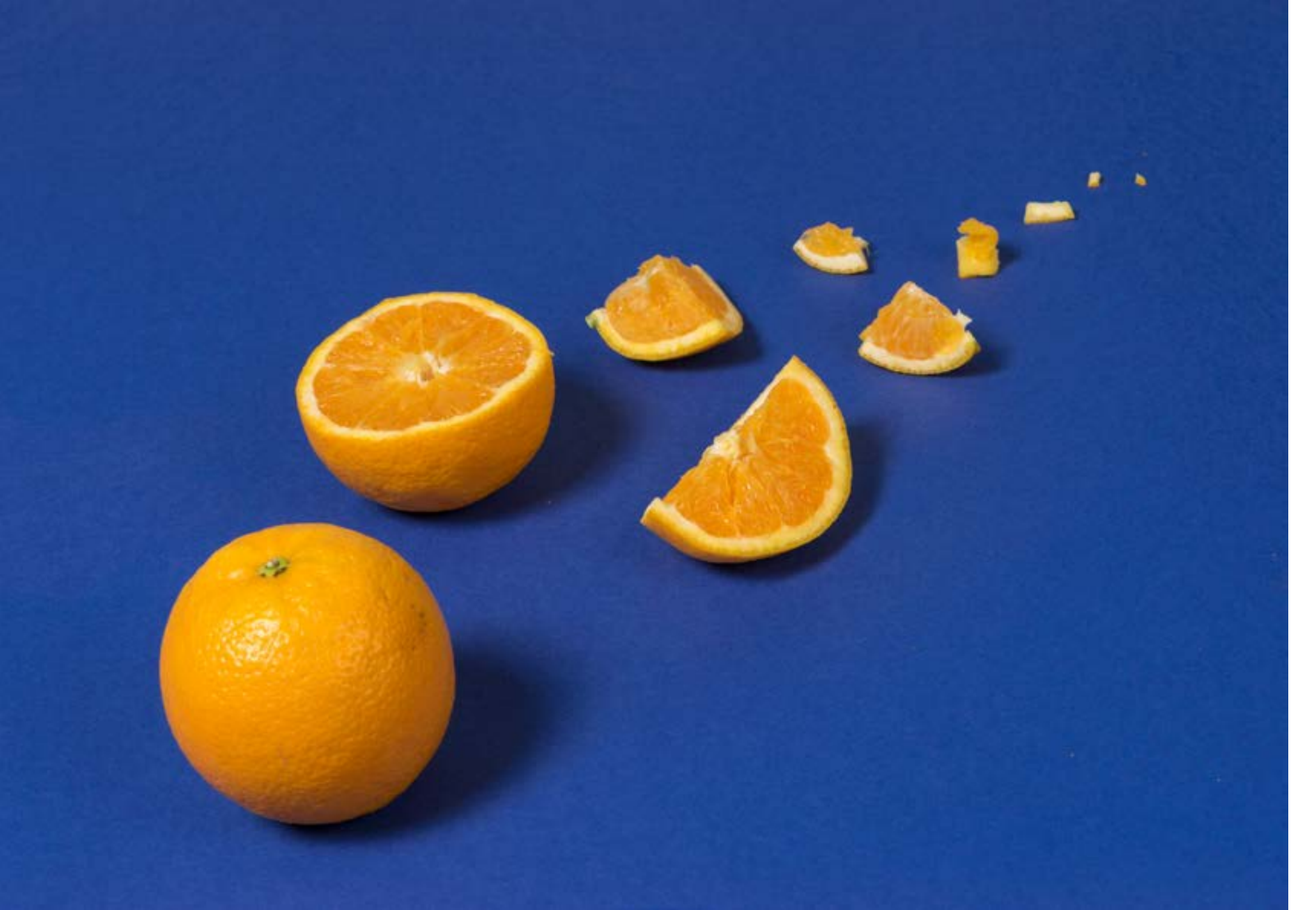
ATOM ODYSSEY

FROM DEMOCRITUS TO SCHRÖDINGER

THE ATOMIC STORY
IN TEN DISCOVERIES
WITH TEN COMPOSITIONS OF OBJECTS



400 BCE — DEMOCRITUS

Our journey begins with an orange, Twenty-four centuries ago.

Can we cut this orange in half, then in halves again, then again ad infinitum?

In 400 BCE, a Greek philosopher, Democritus, had already a very precise idea : after millions of divisions, there is only a tiny particle left, a tiny particle which can't be cut anymore. And this is how Democritus chose to name it : the indivisible, which in Greek is the 'Atom'.

300 BCE — EPICURUS

The atom is so small that it is invisible. But this minuscule atom, gathered together with millions, billions of other atoms forms matter, like sand forms a beach.

At the beginning of the third century BCE, another Greek philosopher Epicurus, suggested the following: We know the beach is made of grains of sand even if it seems smooth and uniform from afar. So maybe, we can consider that matter, like the beach, is also granular.

100 BCE — LUCRETIUS

The rock doesn't become a tiny pebble instantaneously ; the river erodes the stone, grain by grain, by separating tiny atoms.
But atoms themselves aren't worn down.

This is the theory of the Latin poet Lucretius. But his long poem, one of the few vestiges of the ancient Greek atomic theory sank into oblivion for fifteen centuries.

1624 ÉTIENNE DE CLAVES

During the Middle Ages, the notion of the atom is forgotten. But in 1417, the ancient poem of Lucretius is discovered again.

This revived the atomic theory which captivated every scholar of the period. Etiennes de Claves, the most virulent of them, maintains that if atoms are invisible, they are not imperceptible. If salt dissolves in water, it doesn't disappear: we can taste it, even if we can't see it anymore.

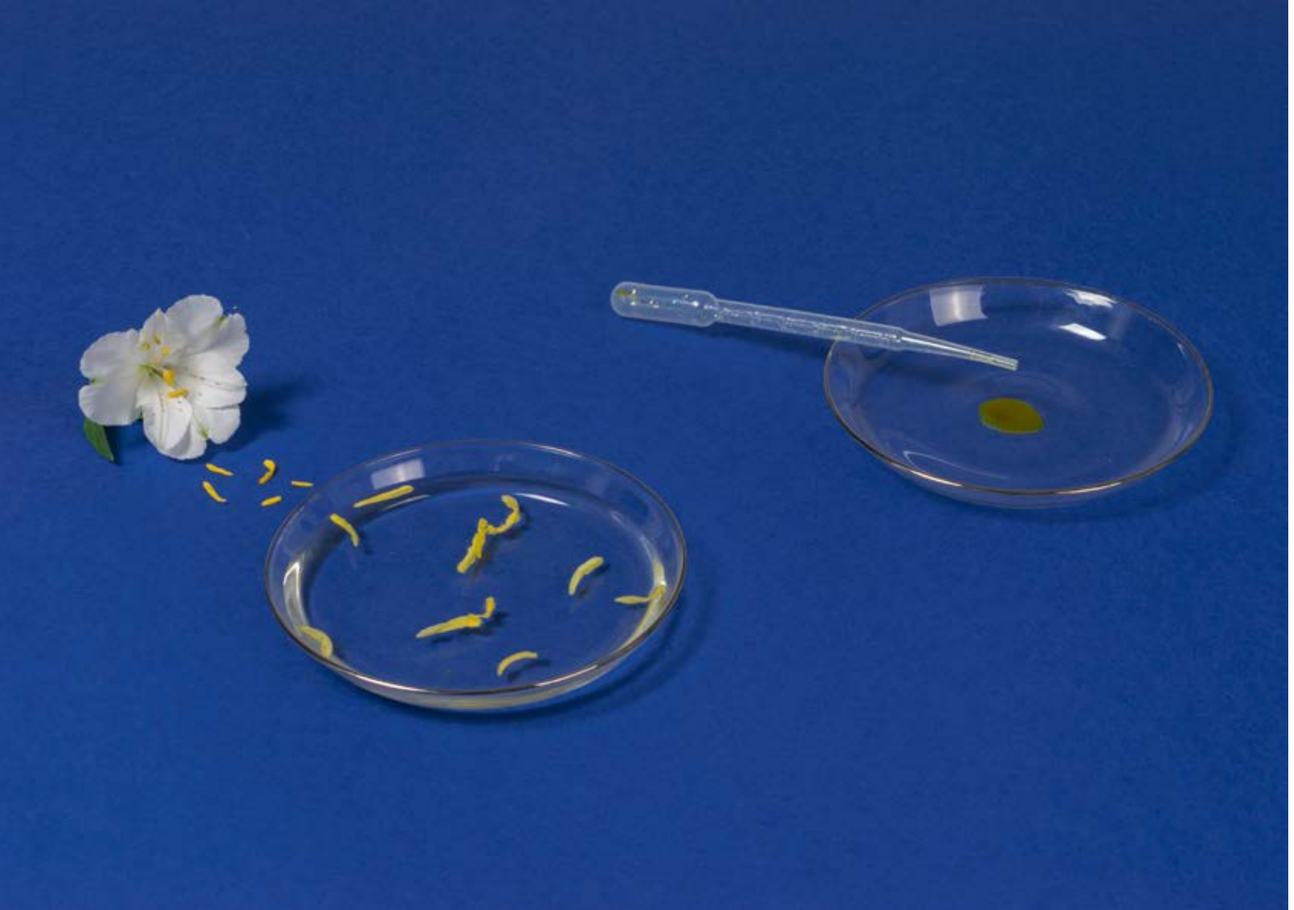
1785
1808

ANTOINE LAVOISIER
JOHN DALTON

A self-consuming candle, does that mean transformation or disappearance of matter ?

The eighteenth century brings the period of experimentation, when observation is no longer enough. Mercury turns red when a candle burns under a cloche, but its weight remains exactly the same.' Nothing is lost, nothing is created, everything is transformed', say Lavoisier and Dalton, the chemists proposing this experiment.

Matter is conserved, and yet matter has changed. Perhaps matter is actually made of small particles, of atoms, whose number remains the same, yet combine in new ways to create different things.

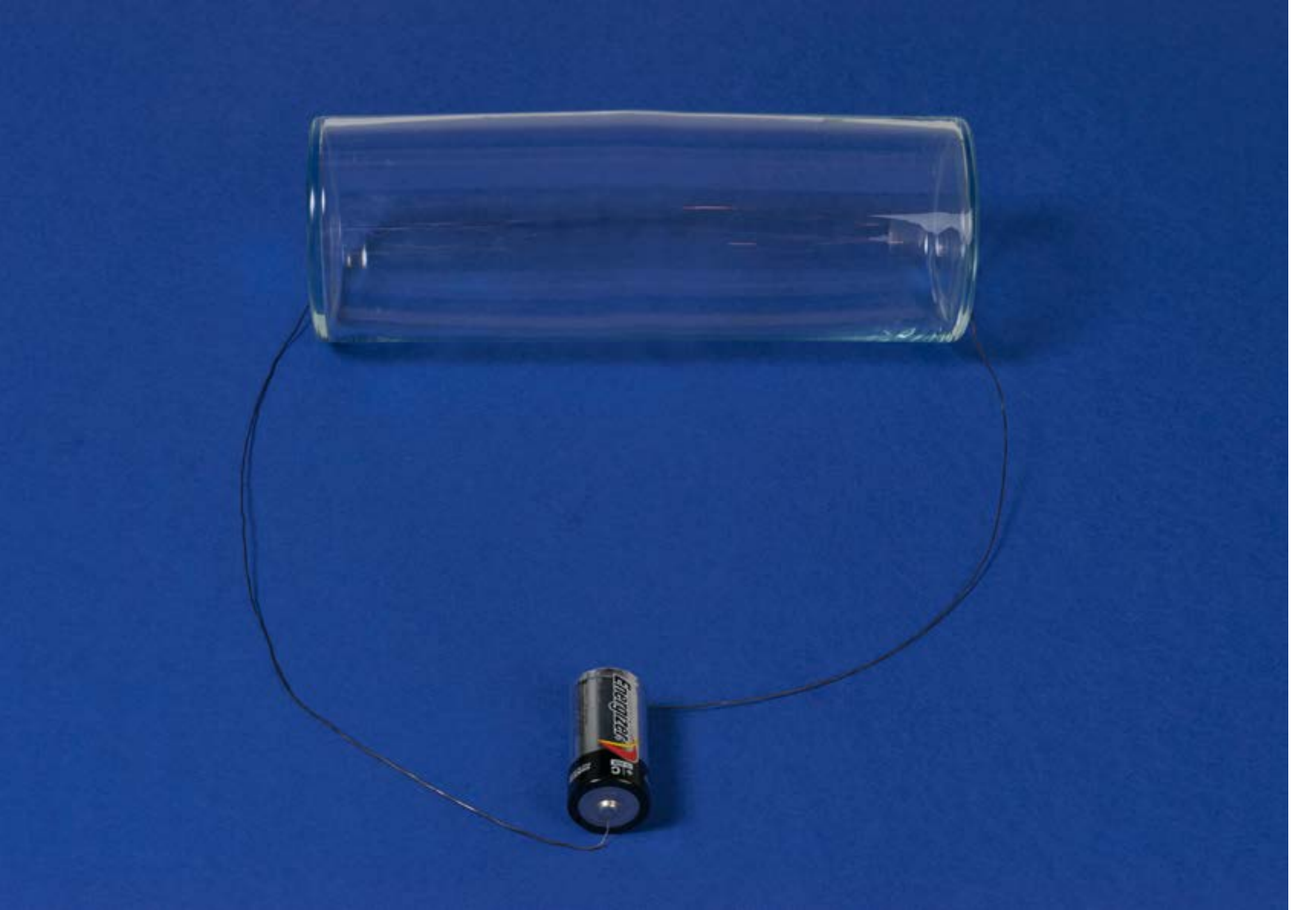


1827 ROBERT BROWN
1905 ALBERT EINSTEIN
1909 JEAN PERRIN

Observing the pollen of a rare flower floating in a drop of water, the botanist Robert Brown saw, at the beginning of the 19th century, the pollen wiggle in a strange way.

This frenetic motion, later measured by Einstein and modeled by Jean Perrin, was the atom dance.

It is the dance of the water molecules, banging into the grains of pollen. Thus, atoms are in perpetual motion: they deflect the light pollen when they hit it. But objects bigger than pollen are hit by so many atoms because of their size, that the motion of atoms is cancelled out.



1896 JOSEPH THOMSON

However, the basis of this reasoning was not quite true. After twenty-three centuries of careful reflection, one experiment was enough to overturn the atomic theory.

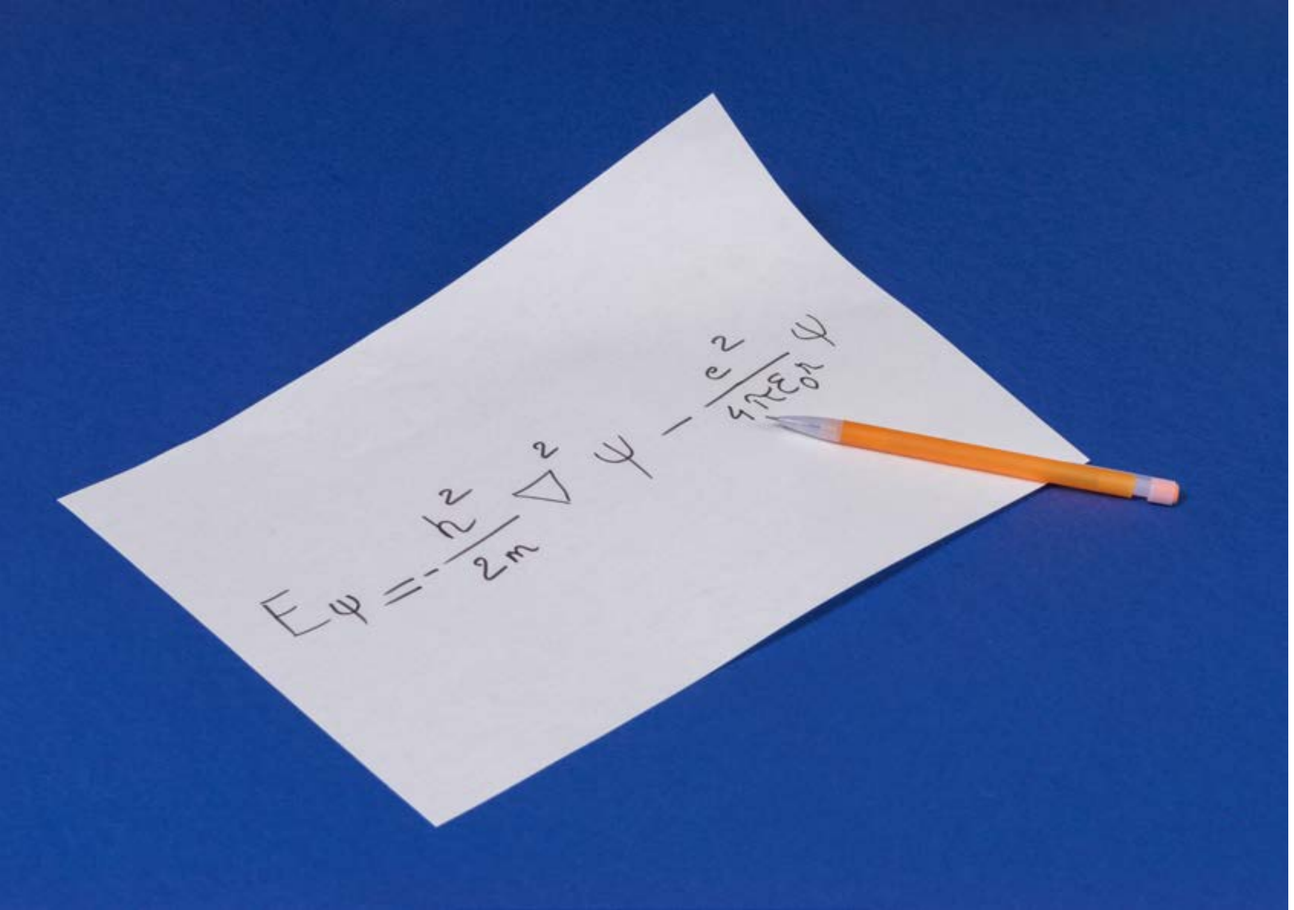
Electricity passing through a gas can create, in specific conditions, a beam of green light, a cathode ray. And this ray is always the same, no matter which gas is used. Joseph Thomson, the physicist who did this experiment at the end of the nineteenth century, deduced that the ray was made of particles torn from the gas atoms.
But if we can tear these particles, these electrons, from atoms, it means the atom can be divided… It isn't the little marble we thought for centuries. Instead of a marble, Thomson proposed the image of a plum pudding, in which plums are the electrons. What we have been calling 'atom' for such a long time, isn't an 'a-tom' anymore, it is not indivisible.

1909 ERNEST RUTHERFORD

A very thin sheet of gold leaf is formed of just a few layers of atoms. In the twentieth century, the physicist Ernest Rutherford tried bombarding this gold leaf with positive particles. Much to his surprise, most of the particles went through the gold leaf easily, suggesting that atoms are mostly made of empty space.

But some particles bounced back and appeared to be deflected by a very dense but very small mass, very small because only very few particles bounced back.

So the atom isn't solid, but it is composed of a tiny core, a lot of emptiness, and some electrons spinning around the core.



1927 — ERWIN SCHRÖDINGER

The atom's core is positive, the atom's electrons are negative, and positive and negative charges attract each other. But then, how can electrons rotate around the core without crashing into it ?
Here the solution is not provided by an experiment, but by a theory. The quantum theory, and specifically an equation established by the physicist Erwin Schrödinger. Atoms don't collapse because electrons are not little marbles, electrons act like waves. Or rather as if the electron enveloped the core like a cloud. And each electron is a cloud that overlays the previous one.
But an electron is no more a cloud than a a marble. The electron is everywhere around the atom without having a solid body, without allowing us to give it an fixed position.
With Schrödinger begins an abstract way of thinking, with new rules, in order to grasp the complexity of matter. We can draw an approximate image of those rules, but not test them with our senses.

1979 RICHARD FEYNMAN

This is how we have attempted, for twenty-four centuries and most likely for many centuries to come, to understand what is around us and within us.

“If, in some cataclysm, all of scientific knowledge were to be destroyed,’ says Richard Feynman, ‘If, all of scientific knowledge were to be destroyed, and only one sentence was passed on to the next generation of creatures, what statement would contain the most information in the fewest words? I believe it is the atomic hypothesis that all things are made of atoms — little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling when squeezed into one another.
In that one sentence, you will see, there is an enormous amount of information about the world, if just a little imagination and thinking are applied.”

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LA SCIENCE EXPLIQUÉE PAR LE DESIGN

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