That's cool! Flash-frozen pictures reveal molecular world

October 4 2017, by Joshua Melvin

Small is beautiful: Swiss Scientist Jacques Dubochet gives a thumbs-up after being named as one of three winners of this year's Nobel Prize in Chemistry, awarded for their work in cryo-electron microscopy, a method for imaging tiny, frozen molecules.

A groundbreaking technique awarded the Nobel Chemistry Prize on Wednesday has allowed scientists, using unearthly cold temperatures, to produce exquisitely detailed images of the tiniest structures in cells.

What is cryo-electron microscopy?

The technique

Jokingly called the "cool method" by the Nobel committee, it would more accurately be described as incredibly, terribly cold.

Scientists chill carefully prepared samples of tissue or cells to subfreezing temperatures of around minus 200 degrees Celsius (minus 328 degrees Fahrenheit), sometimes colder.

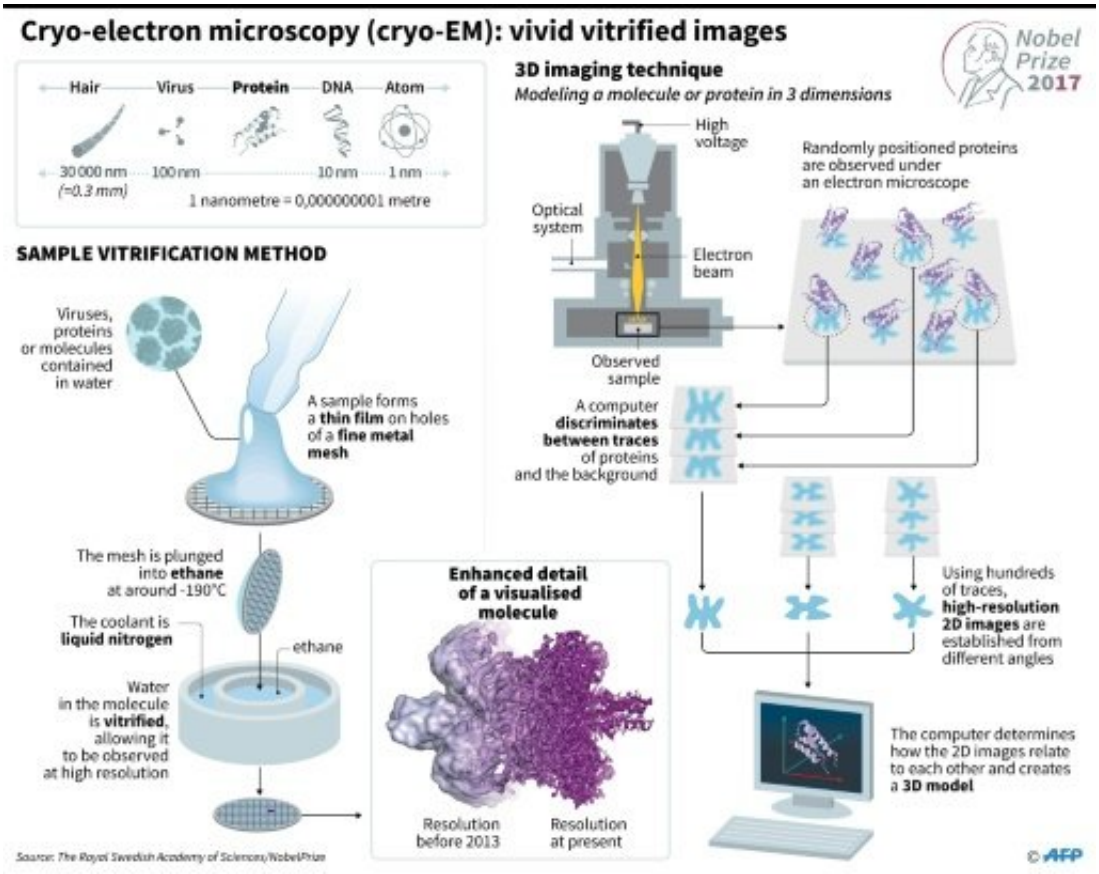
This approaches the temperature in the vast gulfs between stars and galaxies in space, which routinely drops to minus 270 degrees Celsius.

One objective of deep freezing samples is to halt the activity of molecules inside them so that researchers can take less blurry snapshots.

"Just as in the old days when people said 'cheese' and everybody had to not move (for a picture)... essentially that's what we're doing by cooling things down," Andrea Sella, a professor of chemistry at University College London, told AFP.

Similar to an old-fashioned slide projector, scientists then fire electrons through the frozen sample to illuminate it and reveal it's atomic-level detail.

The technique, known as cryo-EM for short, is considered a major advance on X-ray crystallography, itself still a crucial tool.



Presentation of the "cool method" of cryo-electron microscopy (cryo-EM)

It allowed scientists to capture the first image of DNA. But the trouble is that it requires samples to be "crystallised" before they can be zapped with X-rays to produce an image.

"Actually crystallising proteins is very difficult and you cannot do this with all proteins," said Sjors Scheres from the Medical Research Council Laboratory of Molecular Biology in Cambridge, England.

On top of that, crystallography requires scientists remove the molecules from a cell, thus altering their natural state.

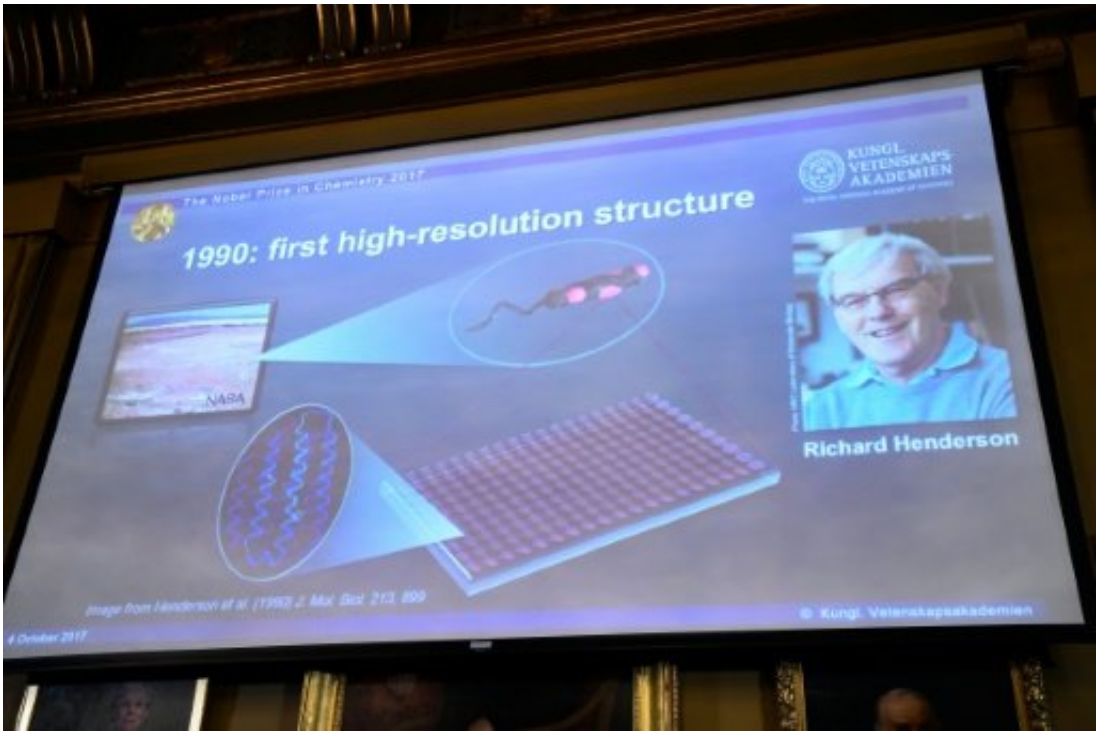
Cryo-EM, on the other hand, freezes a molecule in time and space.

"It (cryo-electron microscopy) really gives you an exquisitely detailed picture of the inside of the machinery of our world, whether it is materials or cells," said Sella.

Its uses

Images of the most minute details of cells and their machinery, provide scientists with the tools for understanding the very building blocks of life.

Actually seeing the structures of a cell, how they are linked and work together, has massive implications for treating and preventing illness ranging from Alzheimer's to Zika.



A picture of Richard Henderson shown at the Nobel announcement on a screen

In the case of Alzheimer's, cryo-EM has unveiled the structure of an enzyme called secretase. It produces a substance believed to contribute to dementia.

"It's like a map," said John Hardy, professor of molecular biology at University College London, referring to images produced by cryo-electron microscopy.

"You want to know where to target your bombs... it gives us exactly the structure so we know exactly what we need to attack," he added.

The Nobel chemistry committee noted the technique has helped fill scientific journals with "images of everything from proteins that cause antibiotic resistance to the surface of the Zika virus."

It also has the potential to capture key moments in a cell's life, such as being attacked by a virus, thus providing invaluable clues about how infections invade.

Scientists are hopeful the most important cryo-EM discoveries are yet to come.

"Tomorrow, nothing will change for the (average) man on the bus, but for his children it will hopefully have led to a whole range of new cures," said Scheres.

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