50 Years Ago

From the fermentation broth of a strain of *Fusidium* a hitherto unrecorded antibiotic, for which the name 'fusidic acid' is proposed, has been isolated … The activity was determined by the agar cup-plate method using *Staphylococcus aureus* as test organism … From the concentrated aqueous solution obtained, fusidic acid was precipitated as a crystalline benzene solvate on acidification in the presence of benzene … Fusidic acid is non-toxic. The subcutaneous and oral LD_{50} in mice were found to be 1.2 gm. and 1.5 gm. per kgm. body-weight, respectively … Daily oral administration of fusidic acid to rats in doses of 0.4 gm. per kgm. body-weight over a period of 6 months was well-tolerated. Post-mortem examination revealed no pathological changes.

From *Nature* 10 March 1962

100 Years Ago

Mr. G. R. M. Temple sends us from York a copy of a photograph … which illustrates very clearly the result of the expansion of water by freezing during the recent frost. The bottle was filled with clean water and tightly corked; when the water had frozen a stem of ice about 4½ in. in length was found to be projecting from the bottle … This stem represented, of course, the increase of volume undergone by the water in passing from the liquid to the solid state. The bottle must have been cracked while solidification was going on, otherwise the water would have escaped.

From *Nature* 7 March 1912

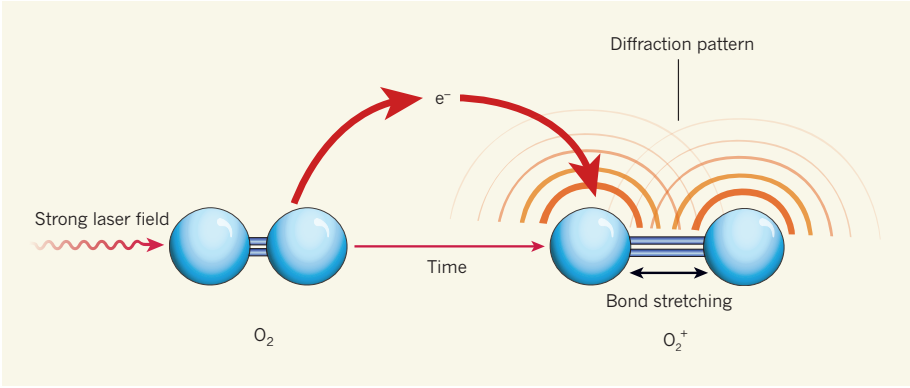

Figure 1 | Molecular movies. Blaga *et al.*[4] have used laser-induced electron diffraction to 'film' single molecules in motion. In the authors' technique, a molecule such as oxygen is irradiated with a strong infrared laser field, pulling away an electron (e^-) and causing the bond between the atoms in the molecule to stretch. The electron is accelerated in the laser field, then directed back towards the resulting ion. Collision of the electron with nuclei in the ion causes the electron to rebound and to generate a diffraction pattern — an electron spectrum. This spectrum contains information about the positions of the nuclei at the moment of collision. By performing a series of experiments in which the time delay between the electron's departure from, and collision with, the molecule is varied, a series of snapshots (spectra) of the molecular motion can be taken, much like the frames of a movie.

infrared laser field (Fig. 1). Thanks to the high intensity of the laser field (its field strength reaches several volts per ångström), a distance of less than 100 Å is sufficient to accelerate the electrons to several per cent of light speed. And because of the oscillating nature of the field, the accelerated electron can then be turned around and slammed back into the parent molecule.

The removal of an electron from a molecule sets the molecule's nuclei in motion. Subsequent re-collision of the electron with the molecule takes a snapshot of what has happened since the electron was taken away. This snapshot takes the form of an electron spectrum — the patterns of minimum and maximum electron intensity that are generated by the diffraction of electron waves by nuclei, not unlike the patterns of ripples formed when water waves are disrupted by rocks.

Even with relatively few molecules in the focus of the laser beam, there is a good chance that the removed electron will hit the target, because it never leaves the vicinity of the parent molecule. This ensures a strong imaging signal. Furthermore, everything happens in a time roughly equal to the period of the laser field's oscillation cycle (a few femtoseconds for the radiation used in Blaga and colleagues' experiment), ensuring high temporal resolution.

To make any movie, snapshots must be taken at different time delays after the motion has begun. In Blaga and colleagues' case, the delay is that between the time the electron is pulled from a molecule and the time it returns. This delay is determined by the length of the laser cycle, and so the authors simply repeated their experiment at different wavelengths to obtain a series of frames at different times. Just like Rutherford before them, they observed electrons scattering at large angles as they hit nuclei almost head-on. The scattering angles and the diffraction patterns created by scattered electrons sensitively depend on the locations of the nuclei — even if the positions of the nuclei shifted by only a fraction of an ångström, the difference was clearly visible in the experiment.

So far, so good. But Blaga *et al.* had to overcome many challenges to reconstruct molecular motion from the measured electron signals. The main difficulty arose from the presence of the strong laser field — ironically, the same field that is integral to the inner workings of their camera. In their experiments, information about molecular structure is encoded in the observed electron spectra. But because each electron is accelerated by the laser field after scattering, the patterns become distorted. Extracting images from the electron spectra therefore requires an accurate theoretical analysis[7].

The physics of laser-driven electron–molecule re-collision is rich and complex. The next step will be to perform a detailed analysis of all of the similarly complex information encoded in Blaga and colleagues' electron spectra, to deal with various side effects introduced by the strong laser field, and to extend the scope of the technique to larger molecules. This will involve a lot of work, but obtaining the ability to film the motion of electrons, holes (quasiparticles generated by the absence of electrons) and nuclei in isolated molecules, with sub-femtosecond, sub-ångström resolution, is worth the effort. No doubt Blaga *et al.* would agree with Lenin[10] that "for us, cinematography is the most important form of art". ■

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