



A waterfall in Grand Canyon National Park, Arizona.

MATERIALS SCIENCE

Wine, water, oil and spit

Derek Lowe enjoys Mark Miodownik's sparkling journey through liquids.

We humans can't help but have our views of reality skewed by our own experience. We take the physical conditions around us as the normal state of affairs and regard others as extreme. The chemist's 'standard temperature and pressure' of 0°C under 10⁵ pascals makes perfect sense as a reference in the human frame, but is quite unusual in the larger scheme of things. The rest of the Solar System, for example, often features temperatures and pressures much higher or much lower; the rest of (mostly empty) outer space is even worse. It's the surface of Earth that is the outlier.

These uncommon conditions mean we experience something very rare in the higher and lower expanses of temperature and pressure: a wide variety of liquids. It is this odd realm that materials scientist Mark Miodownik explores in *Liquid*, his enjoyable successor to his 2013 paean to materials, *Stuff Matters*.

The book explores the histories, structures and properties of many different sorts of liquid, with excursions into the larger topics each brings up. Miodownik organizes his narrative around the conceit of an aeroplane journey, with various incidents and episodes setting off trains of thought. Alcohol makes an early appearance by way of the drinks trolley. Others are introduced through ocean waves observed below, the soap dispenser in the lavatory, the thought of refrigerants in the air-conditioning system, and so on. The framework is reasonably effective, although



Liquid: The Delightful and Dangerous Substances That Flow Through Our Lives
MARK MIODOWNIK
Viking (2018)

it gets a bit wearing, and a few digressions are surprisingly lengthy. (Then again, it is a transatlantic flight.)

The liquid state is a small part of most phase diagrams, a narrow range between a large solid zone and a large gaseous one. Conditions have to be just right for a substance to condense out of the gas phase but not to firm up into some kind of solidified mass. And for many simple compounds, those liquid conditions manage to overlap with how we're used to seeing and handling them — which is why a plane journey can include so many useful examples. The one we all know best, of course, is water. The discovery of liquid water on another planet or moon, even far below the surface, somehow makes that world seem more real to us. But, as Miodownik explains, it's one of the oddest liquids of all.

H₂O is strangely sticky and viscous for a molecule with such a small molecular weight. It has abnormally high melting

and boiling points compared with anything chemically similar, such as ammonia or hydrogen sulfide. When it freezes, its solid phase is actually less dense than its liquid one. That relatively rare characteristic leads to ice cubes and icebergs floating instead of sinking as any normal solid phase should do. (If there are sentient creatures somewhere in the Universe living next to lakes

“The rest of the Solar System often features extremely high or low temperatures and pressures. It’s the surface of Earth that is the outlier.”

of superfluid liquid helium, they would probably be confused by water, which flows with weird side effects of friction and drag unknown in the superfluid world.)

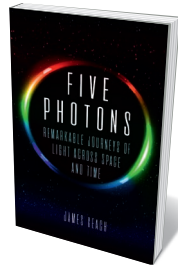
Liquid distils a great deal of interesting information in accurate, readable form. As a chemist, I find it a relief to read such an overview without being distracted by mischaracterized or oversimplified details. Solid-state physicists and materials scientists will also celebrate Miodownik’s excellent efforts at tying the everyday properties of liquids to their molecular structure. He provides many vivid examples: among these are saliva (during the flight’s meal service, naturally) and jet fuel, which he notes is not an explosive, but still has more chemical energy per unit volume than nitroglycerine.

One of the things that chemistry and physics teach is that the information given by our senses is only a small part of the story: water is wet, our fingers can tell us that much. What we don’t feel are the water molecules themselves, interacting with the protein surfaces of our skin. Their very atoms and electron clouds come within range of each other, attracting and repelling and adding up to the sensations that our vivid (but often crude) senses interpret. That hidden world underlies every object we see and handle. *Liquid* gives readers a sense of this — no small feat.

And that brings up the question of who might read it. As with *Stuff Matters*, Miodownik is inspiring those in search of science in an accessible, entertaining format. Today, materials scientists are preparing exotic fluids packed with nanoparticles that can turn them into magnets or optical sensors, and nanotechnologists and molecular biologists are exploring the behaviour of water and other liquids on very small scales. *Liquid* will come in very useful for people eager to understand these advances. ■

Derek Lowe has worked in early-stage drug discovery for decades. His *In the Pipeline* is one of the longest-running science blogs. e-mail: derek.lowe@gmail.com

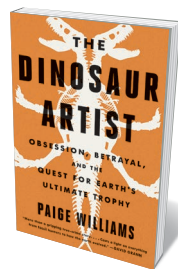
Books in brief



Five Photons

James Geach REAKTION (2018)

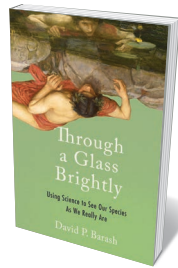
Light illuminates cosmic origins and decodes quotidian realities. But what is it? This deft primer by astrophysicist James Geach captures the elusive electromagnetic wave in five processes. His meditation on ‘old’ light takes us back to the singularity: the “cosmic seed” that expanded into the Big Bang. A study of starlight plunges us into the seething stellar surface. We peruse dark energy, radio waves and quasars — beacon-like galaxies in which supermassive black holes feed off interstellar gas and release vast amounts of energy. A masterclass in elucidating hard science with elegance and brevity.



The Dinosaur Artist

Paige Williams HACHETTE (2018)

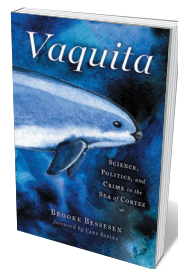
Who owns fossils? That vexed question lies at the heart of this exposé of the global trade in dinosaur remains — a messy meeting-place of commercial fossil collectors, palaeontologists, wealthy enthusiasts and natural-history museums. New Yorker staff writer Paige Williams’s packed account centres on former Mongolian president Tsakhiagiin Elbegdorj, US dinosaur hunter and restorer Eric Prokopi and a costly *Tarbosaurus bataar* fossil. An astonishing tangle of financial gain, national identity, scientific fervour and, above all, the obsessional need to possess pieces of the past.



Through a Glass Brightly

David P. Barash OXFORD UNIVERSITY PRESS (2018)

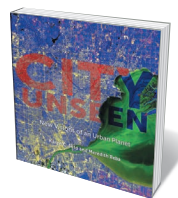
As a species, we seem to be unable to shake off the idea of our exceptionalism. Yet science regularly trounces such ideas, argues evolutionary biologist David Barash in this briskly erudite study. Barash punctures human paradigms such as the ‘anthropic principle’, rationality and even selfhood, marshalling considerable research and considered reasoning as he goes. He concludes, rather splendidly, that the loss of such illusions flings open the door “to do something really extraordinary: to see ourselves as we really are” and use that knowledge to behave with more humanity.



Vaquita: Science, Politics, and Crime in the Sea of Cortez

Brooke Bessesen ISLAND (2018)

The world’s smallest cetacean, the vaquita (*Phocoena sinus*), is also the most endangered marine mammal on the planet, found solely in northern Mexico’s Gulf of California. In this intrepid conservation detective story, marine biologist Brooke Bessesen deconstructs the species’ demise, showing how the tiny porpoises drown in gillnets used for poaching a prized black-market fish, *Totoaba macdonaldi*. As she shows, the effort to conserve remaining vaquitas is a tortuously uncertain challenge — but ever driven by the idea, articulated by field biologist George Schaller, that “we cannot recover a lost world”.



City Unseen: New Visions of an Urban Planet

Karen Seto and Meredith Reba YALE UNIVERSITY PRESS (2018)

Cities are a tug-of-war between nature and humanity — their configuration shaped by topography even as they mould the environment in and around them. This stunning study by Karen Seto and Meredith Reba explores this uneasy symbiosis through surreally hued satellite images of 100 cities. Snaps of Phoenix, Arizona, taken 31 years apart reveal serious urban sprawl, and a shot of grain fields around Semikarakorsk, Russia, is a controlled riot of colour and line with the verve of early modernist art. **Barbara Kiser**