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A strange cat in Dublin



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Smiles all round

Erwin Schrödinger (left) with fellow physicists Max Born, Kathleen Lonsdale and Paul Peter Ewald, the Irish President Douglas Hyde (in wheelchair) and Prime Minister Éamon de Valera (far right), in Dublin in 1943.

Erwin Schrödinger and the Quantum Revolution

John Gribbin
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Not many life stories in physics involve Nazis, illicit sex, a strange cat and the genetic code. Thus, a new biography of the great Austrian physicist Erwin Schrödinger is always of interest, and with *Erwin Schrödinger and the Quantum Revolution*, veteran science writer John Gribbin does not disappoint.

Many *Physics World* readers will be aware of Walter Moore's 1992 biography *Schrödinger: Life and Thought*, which remains the definitive text on this colourful quantum pioneer. In fact, Moore also published an edited (and sadly neglected) version of his book for a popular audience, and Gribbin's book is pitched more at this level. The new biography offers little new historical material, but Gribbin's lucid style makes for an excellent introduction to this intriguing scientist and, indeed, to the world of quantum physics.

Gribbin sets the stage with a brief introduction to classical physics, followed by a description of the first quantum revolution. The work

of Planck, Einstein and Bohr is described accurately yet succinctly in the author's characteristic clear prose. The story continues with a description of the second quantum revolution, from Louis de Broglie's hypothesis of wave-particle duality to Schrödinger's brilliant wave mechanics (with Heisenberg's matrix mechanics along the way). This is a familiar story for physicists, but one we never tire of reading.

The debate concerning the philosophical implications of the new theory is explained carefully, with a clear description of what became known as the "Copenhagen" interpretation. Einstein's distrust of this interpretation is well known, but it is often forgotten that Schrödinger shared his views. As Gribbin points out, it is interesting that the father of wave mechanics had no faith in the idea of a wavefunction that collapses on observation, as posited by the Copenhagen camp. This objection is best exemplified by Schrödinger's famous thought experiment of a cat

that is neither dead nor alive before observation. Gribbin has written on Schrödinger's interpretation of the quantum wavefunction many times before, notably in *In Search of Schrödinger's Cat* (Bantam 1984) and *Schrödinger's Kittens and the Search for Reality* (Phoenix 1996). Still, the wavefunction pioneer's objection to the Copenhagen interpretation is worth restating.

The fascinating story of Schrödinger's life and career is skilfully interspersed with the science. This is no easy task, given that he spent chunks of his career in Vienna, Jena, Zurich, Berlin, Oxford, Graz and Dublin, but Gribbin manages to maintain the reader's interest throughout these sojourns without sacrificing accuracy. A good example is Gribbin's description of the infamous Graz episode, when – having unwisely returned to Austria from Oxford in 1936 – Schrödinger penned a cringeworthy letter of apology to the Nazis, who had come to power in Austria following the *Anschluss* with Germany. As Gribbin explains, the publication of this letter damaged Schrödinger's reputation abroad, while doing little to allay the Nazis' suspicions of him.

Into this crisis came a life-saving offer from neutral Ireland. Impressed by the Institute of Advanced Studies in Princeton, the Irish premier Éamon de Valera had decided to set up a similar institute in Dublin, with Schrödinger at the helm. The peripatetic professor accepted with alacrity and with the help of De Valera, he arrived safely in Dublin in October 1939.

He and his ménage, that is, Schrödinger set up house in Dublin with his wife Anna, his mistress Hilde and Ruth, his daughter by Hilde. As Gribbin points out, this arrangement was quite unusual in holy Catholic Ireland, yet it is a curious fact that the Schrödingers felt much more at home in Ireland than they had in Oxford. Gribbin offers the explanation that in Ireland "there was a marked contrast between what was officially approved and what people actually did", which I think is about right. In any event, Schrödinger indulged in numerous romantic affairs in Dublin without sanction, producing two further children out of wedlock.

The description of Schrödinger's years in Dublin is the most enjoy-

able part of Gribbin's story and there are many moments of humour. For example, Gribbin describes how, in its early years, the Dublin Institute for Advanced Studies attracted the attention of the *Irish Times* satirist Myles na Gopaleen, who caused a stir when he observed that "Professor Schrödinger has been proving lately that you cannot establish a first cause. The first fruit of the institute, therefore, has been to show that there is no God." The institute's authorities were furious; Schrödinger himself was unperturbed. At the same time, Gribbin is careful not to underestimate the work Schrödinger did in Dublin, from his research in general relativity to his attempts at a unified field theory, from his work on the interpretation of quantum theory to his speculations in molecular biology.

The fact that the Dublin institute became a leading centre for the study of relativity forms an important part of Schrödinger's legacy, but it is his work on molecular biology that is surely the most extraordinary aspect of his career. In 1943 Schrödinger gave a series of public

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lectures in Dublin in which he asked how hereditary information might be encoded in living cells. While much of the work he spoke about was not original, a book based on the lectures – called *What is Life?* – went on to be a major influence in the field of genetics.

In the last chapter of the book, Gribbin considers Schrödinger's

interpretation of quantum theory from a modern perspective. He reviews several important developments of the past half-century, from the theoretical work of David Bohm and John Bell to the experiments of Alain Aspect and Anton Zeilinger. He then introduces the "many-worlds" interpretation and draws an intriguing connection between it and Schrödinger's philosophy. There is an interesting point here, but the discussion is coloured by Gribbin's own dislike of the Copenhagen interpretation.

This is a lucid biography of a brilliant scientist whose life and philosophy continues to intrigue. Although it contains little new historical material (apart from some lovely photographs and a nice surprise in the epilogue), *Erwin Schrödinger and the Quantum Revolution* is a cracking good read that will be enjoyed by physicists and non-physicists alike.

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Web life: Ask Nature

URL: www.asknature.org

So what is the site about?

Ask Nature is a site devoted to biomimicry, an interdisciplinary field in which practitioners study how animals and plants solve problems, and then use those solutions to develop better human technologies. The site lists many instances of technology imitating life, including a surgical bandage inspired by gecko feet, a fog-harvesting mesh inspired by a desert beetle and a ceiling fan inspired by the seed pod of a sycamore tree. In total, there are nearly 200 examples of actual bio-motivated inventions described on the site, but they are just the tip of an iceberg of possibilities. *Ask Nature* also contains an astoundingly large catalogue of animal and plant strategies that *might* inspire solutions to human technological problems. Known as the "Biomimicry Taxonomy", this catalogue contains around 1500 entries.

Can you give me some examples?

The Morpho butterfly keeps itself dry and clean in its rainforest environment thanks to nanostructures on its wings that make them both extremely hydrophobic and self-cleaning. Such structures have inspired new types of paint, textiles and glass that require less labour and fewer chemicals to keep clean. Another rainforest denizen – a medium-sized bird called a toucan – has an outsized beak that can be up to a third of its length, while making up only 5% of its weight thanks to the beak's foam-like interior structure and thin outer layer. This light-but-strong construction might prove useful in ultralight aircraft components, or perhaps the panels in cars that protect people from injury during crashes. Not all of the taxonomy's entries are rainforest species, but the richness and sheer biodiversity of these areas does seem to promote the development of novel adaptations. Yet another reason, if one were needed, to be concerned about their disappearance.

How is the taxonomy organized?

Each entry in the Biomimicry Taxonomy is assigned to one of eight "function groups", which are in turn divided into 30 sub-groups and 162 separate functions. For example, the high-level function group "move or stay put" is split into two sub-groups, called "attach" and "move". Attachment is further divided between permanent and temporary stickiness, while movement is grouped by travel that takes place in (or on) gases, liquids and solids. This seems sensible enough,

but taxonomy is not always an exact science, and the system used in *Ask Nature* occasionally throws up a few anomalies. For instance, it seems odd that the hairy footpads of the fennec fox (which help it move over desert sand without slipping) are classed under "movement", while the cloven hooves of the mountain goat (which help it move over rocky terrain without slipping) are categorized as "attachment".

How should I use the site?

If your interest in animal science has been piqued by this special issue of *Physics World*, the *Ask Nature* site is a great place to learn more about the amazing adaptations that animals (and plants) rely on to survive. For casual browsers, the two dozen or so "featured strategies" on the site are a good place to start. These entries are more complete than most others, with detailed explanations, references and photos as well as basic explanations of strategies and their possible applications to human technologies. If you are looking for inspiration on a particular design challenge, though, you would be better off using the site's extensive search function. To get the best results, you may need to do some lateral thinking. As the site puts it, you might want to ask "How would nature reduce drag?" or "How does nature move through air?" rather than something more direct, such as "How would nature design an efficient wind turbine blade?" In the process, you might even find that merely looking at the problem in a different way helps lead to a solution.