

## Editorial: Dirac, Moyal, and von Neumann

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What is the most significant scientific event of the past six months? The COVID-19 pandemic continues to throw up mutations of the virus, most recently the Omicron “scariant” or “variant of concern.” We can only hope that Omicron is more infectious and less severe, so that it drives out any worse variants, such as Delta. If so, then this might be how the pandemic ends, with an endemic coronavirus that we might all expect to contract at some time (or perhaps every year), but with little serious effect for most of us, dosed with our annual vaccinations. Apparently, past pandemics have spluttered out in this fashion.

Meanwhile, I have prevailed upon Eddie Holmes FRSN to allow me to publish in this issue a paper based on a talk he gave last March, which includes a Q and A. I also include a recent short interview he gave to Fran Kelly of the ABC’s RN Breakfast after he had won the 2021 Prime Minister’s Prize for Science. I fear that any hope Eddie might have harboured of avoiding further publicity after his bold action in publishing the genome of SARS-CoV-2 online almost two years ago was illusory.

A most important paper in this issue is by Basil Hiley, professor emeritus of physics at University College, London; the title of this editorial refers to lead actors of this significant paper. As regular readers will

recall, the late Ann Moyal published a paper (Moyal, 2017)<sup>1</sup> on the exchange of letters eighty years ago between her late husband, Joe Moyal, and the Nobel laureate physicist, P. A. M. Dirac, in which Moyal was arguing for a statistical approach to quantum mechanics, in contrast to Dirac’s preferred approach for, roughly, an algebraic formulation. In my editorial in that issue (Marks, 2017), I referred to an email from Professor Hiley which confirmed that Moyal’s phase space approach had anticipated Richard Feynman’s propagator approach (Feynman, 1948) by a decade or more. Professor Hiley now adds to that insight.

As I understand the paper in this issue, Hiley recounts how he realised that the polymath John von Neumann had published an earlier paper (in German, apparently unknown to either Moyal or Dirac), which provides a foundation (and tools) for Moyal’s statistical approach. That Dirac appears to have remained ignorant of von Neumann’s approach, not referring to it in any publications, is strange, as many have remarked. I’d like to thank correspondent Douglas Roger for bringing Professor Hiley and the Society together again, four years later.<sup>2</sup>

Ian Sloan stood down as President of the Royal Society earlier this year, but following past precedent he has written a Presidential

<sup>1</sup> This paper won the Ollé Award for best paper earlier this year.

<sup>2</sup> A good summary introduction to pioneers of quantum mechanics is Physics History (2021). An amusing, non-mathematical account of the development of quantum mechanics is James (2019).

Paper, which begins this issue. As a highly cited mathematician, Ian's technical work would be beyond almost all of the Society's Fellow and Members, but he has written a non-technical paper outlining the increasing ways in which the evolution of computers and computing, over the past sixty years of his career, have affected the modelling of issues of interest to us all: weather forecasting, computing rocket and spacecraft trajectories, climate change, extreme bushfires, and quantum physics.

Following Ian Sloan's insights, we have learnt this year of two scientific breakthroughs achieved using tools of Artificial Intelligence (AI): a team led by scientists at the London-based AI company DeepMind has developed a machine-learning model that suggests a molecule's characteristics by predicting the distribution of electrons within it (Kirkpatrick et al., 1921). Earlier, DeepMind had developed an AI tool called AlphaFold, which has predicted the structure of nearly the entire human proteome (the full complement of proteins expressed by an organism). In addition, the tool has predicted almost complete proteomes for various other organisms, ranging from mice and maize to the malaria parasite (Jumper et al., 2021). Stand by for more AI accomplishments.

And with two papers in the issue concerned with quantum phenomena, there is word of detection of a "wet" quantum phenomenon breakthrough: Researchers (Xu et al., 2021) have isolated a molecule in birds' eyes that might act as a compass thanks to a quantum-mechanical mechanism called "radical pairs." The idea is that a light-sensitive molecule called a cryptochrome absorbs

light and produces a pair of electrons. The quantum-mechanical spins of those electrons are influenced by Earth's magnetic field, showing the bird the way. This is the kind of biological quantum phenomenon predicted by McFadden and Al-Khalili (2014).

Earlier this year, the inaugural Warren Prize was awarded to Simon Devitt FRSN of UTS, and he has contributed a long paper based on his work with others on the architectures being explored for building quantum computers. The sensitivity of the set-up (the risk of decoherence due to thermal noise etc.) means that much thought and effort must go in to designing these platforms.

Devitt's paper follows two earlier published papers by authors who wished to be considered for the Warren Prize: Holman (2019) and Li et al. (2021). The application process has changed and no longer requires submission of a paper, but I hope that future prize-winners will continue to submit papers outlining their work.<sup>3</sup>

"Stop laughing, this is serious," the caption to a classic Australian cartoon by Stan Cross, could also be applied to a talk and following paper that Dr Jessica Milner Davis FRSN has produced on the multi-disciplinary field of humour studies. This refereed paper started life as an address to the Society.

In his recent book, *Revivalistics*, Professor Zuckermann recounts arriving in Australia, deciding to stay here, and to help redress "the injustice done to the Aboriginal people." But how? As an Israeli linguist, he had written on the revival of Hebrew and the emergence of what he titles the Israeli language (from the ancient liturgical and

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<sup>3</sup> Because of its length, Devitt's paper has been held over to the June 2022 issue.

literary language, Hebrew — not spoken as a living language for over 1900 years — and Yiddish, with secondary contributions). He tells us he decided to use his linguistic skills for the “reclamation, revitalisation, and reinvigoration” of Aboriginal languages in Australia, bringing his competence and global perspectives to the task, building on preceding work, especially by Aboriginal communities. I approached Professor Zuckermann and asked whether he would write a paper outlining his approach. His paper is below. I thank Peter Keeda for introducing me to this work.

The Society was very pleased when Professor Stan Grant FRSN agreed to give the first address to the newly formed Western NSW branch of the Society. The address, “With the falling of the dusk,” also available on-line, has been turned into a paper. It apparently reflects the conclusions of his 2021 book. The paper includes a Q and A.

Although the grand synthesis of relativity (and gravity) with quantum physics remains elusive, seventy years ago, after the first nuclear bombs had been exploded and nuclear power was to herald a new world, there was a palpable interest in how gravity would be incorporated into physics, and perhaps might result in anti-gravity devices. Dean Rickles has been interested in the ideas and people that emerged at this time, and his paper gives a summary of a 1957 conference on these issues.

At my request, Malte Ebach FRSN and Patrick Smith have written a personal account of their satisfaction at finding and discovering fossils — no, finding and discovering are not the same — a good introduction to paleontology for the rest of us.

Soon after becoming the Editor in 2016, I set to work to produce the Contents pages for the Journal, by searching through the NLA’s Trove database of newspaper articles, as well as the U.S. Biodiversity Library, where almost all papers since 1867 had been scanned and made available on-line. But there were no listings of papers within issues. I extracted the URLs of the individual papers and constructed the Contents pages. I had hoped that the Google bots would index these pages and so make the *Journal* and its articles accessible for anyone on the Internet to find a particular author or paper. I also hoped that someone would make an alphabetical bibliography by author of the complete collection. I’d like to thank Councillor Davina Jackson FRSN for undertaking this task, which will mean that a researcher could easily find all papers that we have published with the word, say, “meteorite” in their titles. At the moment, there is such a bibliography for all publications from 1822 to 1900 on-line,<sup>4</sup> and Davina continues to extend the bibliography.

Geoff Harcourt AC FRSN died earlier this month. In a future *Journal* we shall include an obituary to this outstanding economist and man.

#### *Important note for member subscribers*

We have moved to a new database that members and fellows access when renewing their memberships. Previously, if you were a subscriber to the paper copy of the *Journal*, this subscription and its cost were rolled over to the new year, unless you opted out. I fear that the new system is an “opt-in” system: unless you specifically ask to subscribe, you won’t receive a paper copy of the *Journal*.

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<sup>4</sup> <https://royalsoc.org.au/images/pdf/journal/Bibliost822-1900.pdf>

If you discover too late that you no longer subscribe to the paper copies, it might be too late after the print run: we will not print extra copies on the off-chance that some members have not opted-in.

### Housekeeping

As always, I'd like to thank Jason Antony for his thorough help in producing the *Journal*.

December 10, 2021.

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