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Editorial: *Gravvy* waves, serendipity, and regeneration

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Editor

This issue includes eight papers, one book review, two obituaries, and nine abstracts from recent PhD theses. Following Hugh White's paper in the June issue on Australian-Chinese relations, the December issue has two related papers: one, by Gus McLachlan and Andrew Condon, which brings their active service experience to the Society, in their discussion of how the war in Ukraine has spurred the use of different weapons. The second, by James Renwick, is a paper on the evolution of the international law of war crimes, prompted by the Russian attack on Ukraine. There is a paper on an exhibition to celebrate the Darlinghurst Gaol and its history, as revealed through the scrapbook of John Cecil Read during his tenure from 1861 to 1888.

Another paper in this issue provides two examples of the role of serendipity in commercial life. It raises the question: just how important is luck in life? Is Mr A truly talented in his success, or has he been merely lucky? What of Ms B? Is she "down on her luck" or does her poverty reflect her lack of talent or drive? To discuss this, two observations: first, human attributes (including intelligence, height, strength, athletic prowess, etc.) have been measured as normally (Gaussian) distributed in the population (that is, a frequency plot is bell-shaped). On the other hand, consider the distribution of success in life — wealth, for example. Adult wealth is not normally distributed on a bell curve. Instead, wealth exhibits a power-law (Pareto) distribution:[1] the vast number of people have low or medium incomes; vanishingly few are billionaires.[2]

This issue — luck or talent — has been addressed by several authors, including Frank (2016). An approach close to my simulator's heart is that of Pluchino, Biondo, and Rapisarda (2018), who developed a simple agent-based simulation model in which talent is normally distributed across agents, but in which there are random elements ("luck") affecting agents' outcomes. They find that, if it is true that some degree of talent is necessary to be successful in life, it is almost never the most talented people who reach the highest peaks of success, rather they are overtaken by luckier individuals of average talent.

The late Stephen Gaukroger won the 2022 the Royal Society History and Philosophy of Science Medal. At our request, he submitted a paper which was due to appear in the June issue, but with other papers was held over to the December issue. Stephen had signed off on the galleys before his unfortunate death. He asks to what extent technical progress has resulted from engineers solving problems rather than from scientists' theories.

Another paper held over was a report from Len Fisher of a conference, "Complexity, Criticality and Computation," held

1 https://en.wikipedia.org/wiki/Power_law

2 A good example of a power-law distribution is the spread of per-capita greenhouse gas emissions across the world. See Oxfam (2023). And read the paper by Falk et al. (2023) in this issue.

earlier in 2023 on Heron Island, Qld., which brought together complex-systems experts from around the world to discuss the latest in complex-systems research. Nothing daunted, the participants discussed three questions: first, are there universal principles across both physical and biological phenomena; second, what are the principles underlying the emergence of consciousness, language, and intelligence; and, third, are there fundamental physical constraints guiding the rise and fall of civilisations?

A recent decision of the NSW Government is to allow culling of the up to 15,000 feral horses at large in the Kosciuszko National Park. This has been a contentious issue (see "The Man from Snowy River") for years, with some vested interests appealing to "heritage" values. And yet there was an earlier use of the Park involving sheep and cattle, not horses. This managed summer grazing was ended after the ecological damage was realised, and extensive rehabilitation and regeneration of the fragile alpine ecosystem was undertaken over some years (Good and Johnston 2019).

So another paper in this issue is of topical interest: Coyne (2023) describes how three islands in the South Pacific — Phillip Island (near Norfolk Island), Lord Howe Island, and Macquarie Island — were infested by exotic species of animals (rats, rabbits, cats etc.) and plants, which degraded the local ecosystems. After some time (years, centuries) successful attempts were made to eradicate the invaders, and then to regenerate the islands' ecosystems. Despite the almost complete denuding of Phillip Island, a blanket of green has covered the small island, including the discovery of a plant new to science. On Lord Howe Island a relic population of stick insects was discovered and is now thriving around the world. And on Macquarie Island the populations of birds are recovering. All this suggests that removal of horses from Kosciuszko National Park will also reveal the survival of plants and animals now at risk of extinction.

Falk and 29 others (2023) is the (reprinted) consensus statement from the Regional Action on Climate Change Symposium (RACC-15) held on September 30, 2023, as an adjunct session of the 20th Annual Meeting of the Science, Technology and Society Forum (Kyoto), which included participation of nearly 1,500 global leaders in science and technology, policymaking, business, and media from over 80 countries, regions, and international organisations. This statement is a timely input for the 28th session of the Conference of the Parties (COP28) to the UN Framework Convention on Climate Change (UNFCCC) held at Expo City, Dubai in the United Arab Emirates (UAE), on November 30 to December 12, 2023.

Finally, the issue includes a review by Wilfred Prest of the 2022 book, *The Search for Truth: History and Future of Universities*, by Max Bennett.

What is the speed of gravity?

How fast does gravity travel? I don't mean how fast objects move under the influence of gravity: the rate of acceleration is a function of the two masses. What I mean is how fast does gravity propagate through space-time? The question would have been purely hypothetical until the existence of gravity waves (the ripples through space-time from the interactions of massive objects in space) was confirmed in 2015 by the use of extraordinarily sensitive detectors. Einstein was right. These instruments provide a new dimension of observing the heavens — detecting via gravity waves the collisions of neutrons stars and even black holes, the end products of pairs of neutron stars as they circle inwards and then collide.

But, until recently, there has been no concurrent observation of electro-magnetic radiation (light, gamma rays) associated with these collisions, and so no way to compare the speed of gravity waves with that of light. Would the light and gravity waves (we need a better term than "gravity waves" my suggestion is *gravvy* or *gravvies*) from these collisions arrive here simultaneously, or might gravvies lag?

Following Siegel (2023), on August 17, 2017, the signal from an event that occurred 130 million light-years away finally arrived on Earth. From somewhere within a distant galaxy, two neutron stars had been locked in a gravitational dance where they orbited one another at speeds that reached a significant fraction of the speed of light. As they orbited, they distorted the fabric of space owing to both their mass and their motion.

Whenever masses accelerate through curved space, they emit tiny amounts of radiation that's invisible to all light-based telescopes: gravitational, rather than electromagnetic, radiation — that is, gravvy rather than light. Gravvies behave as ripples in the fabric of spacetime, carrying energy away from the system and causing their mutual orbits to decay. As time went on, the two neutron stars began to in-spiral, with gravvies carrying orbital energy away, causing the two objects to migrate closer and closer together. At a critical moment, these two stellar remnants spiralled so close to one another that they collided.

Immediately, the gravvy signal came to an abrupt end. The gravity-wave instruments LIGO and Virgo detected gravvies from the in-spiral phase up until that moment, followed by total gravvy silence. According to our best theoretical models, this was two neutron stars in-spiralling and merging together, likely resulting in the formation of a black hole.

But then, 1.7 seconds later, after the gravvy signal had ceased, the first electromagnetic (light) signal arrived here — gamma rays, which came in one enormous burst. From the combination of gravvy and electromagnetic data, the location of this event was soon calculated, the galaxy known as NGC 4993.

Now, NGC 4993 is 130 million light years away. The waves — both light and gravvy — had taken 130 million years to get here. This gave us the most impressive physical measurement of the speed of gravity ever: it is equal to the speed of light to better than 1 part in a quadrillion (10^{15}), as 130 million years is around four quadrillion seconds, and the signals arrived less than two seconds apart.

Before 2017, we had excellent theoretical reasons for believing that the speed of gravity was equal to the speed of light, but only had indirect constraints that the two were equivalent to within 0.2% or so. The improvement in measurement of more than 12 orders of magnitude, with one single observation, represents the most significant leap from a single measurement of all time.

Why didn't the two events — the end of the gravvies and the arrival of the light — occur simultaneously? Siegel (2023) discusses possibilities: for instance, the black hole took a second or two to form from the colliding neutron stars. Further observations might shed light (no pun intended) on these events, but Siegel believes that the observation of what is now known as the gravvy event GW170817 reveals that gravvies propagate at the speed of light.

In a related piece, Siegel (2019) discusses whether we could ever detect gravity particles — so-called gravitons — analogous to light particles, photons. Since all objects can exhibit the characteristics of both particles and waves, suitably measured, gravvies likely do comprise gravitons oscillating, but it will take great technical advances in our devices to detect them. After all, we have only just developed the technology to detect gravvies, or gravity waves.

Housekeeping

There are two obituaries in this issue of the *Journal*: Stephen Gaukroger FRSN died after his article in this issue had been signed off on; his obituary was written by a colleague, Conal Condren. The second obituary is for Adrian Lee FRSN, whose long piece on his role in verifying that *Helicobactor pylori* was the cause of gastric ulcers was published two years ago (Lee 2021). This paper laid out Adrian's research career in a very clear way, but it did not reflect his passion for quality teaching. In the obituary, I borrowed from Mitchell et al. (2023) to gather more information on his life and interests. But how useful it would be to have, from the horse's mouth, so to speak, the deceased's judgments of their best achievements. At the request of Council, I have contacted all 19 Distinguished FRSNs, asking what accomplishments of theirs they would wish to be known for. So far I have heard from several Fellows. The responses will be kept for the future.

I have also started contacting our Exchange partners, asking whether they want to continue exchanging printed copies of their journals with ours. Seven years ago I did the same thing, after taking over the editorship. So far, one yes and one no.

I am very glad to note here that my longtime collaborator on producing the *Journal & Proceedings*, Jason Antony, has been honoured for his work here and on the *Bulletin* with a Royal Society Citation. Thank you, Jason, and congratulations.

Balmain, November 26, 2023.

References

Frank RH (2016) *Success and Luck: Good Fortune and the Myth of Meritocracy*. Princeton U.P.

Good R and Johnston S (2019) Rehabilitation and regeneration of the Kosciuszko summit area, following the removal of grazing — an historical review. *Ecological Management & Restoration* 20(1): 13–20. https://doi.org/10.1111/emr.12363

Lee A (2021) Adventures with spiral bugs and *Helicobacter*. *Journal & Proceedings of the Royal Society of New South Wales* 154: 34–43.

Mitchell H, O'Rourke J, Lutze-Mann L, Ferrero R and Hazell S (2023) Obituary: Emeritus Professor Adrian Lee AC BSc PhD FASM (1941–2023). *Microbiology Australia* 44(3): 172. https://doi.org/10.1071/MA23047

Oxfam (2023) *Climate Equality: A planet for the 99%* November 20. https://www.oxfam.org/en/research/climate-equality-planet-99

Pluchino A, Biondo AE and Rapisarda A (2018) Talent versus luck: the role of randomness in success and failure, *Advances in Complex Systems* 21(3&4): 1850014. https://doi.org/10.1142/S0219525918500145

Siegel N (2019) Can we test gravitational waves for wave–particle duality? *Forbes*. https://www.forbes.com/sites/startswithabang/2019/08/15/can-we-test-gravitational-waves-for-wave-particle-duality/

Siegel N (2023) Light and gravitational waves don't arrive simultaneously. *Big Think*, Oct 26. https://bigthink.com/starts-with-a-bang/light-gravitational-waves-arrive/