EDITORIAL

Check for updates

Then and now

The neutron and the positron were both discovered in 1932. Looking back at these discoveries we find that we have more in common with early 20th century physicists that one might suspect.

Ninety years ago, James Chadwick published a letter to *Nature* entitled 'Possible existence of a neutron'[1]. In it, he described experiments he had done to characterize the radiation emitted by beryllium when bombarded by alpha particles. His work built on that of Irène and Frédéric Joliot-Curie, who had proposed that the radiation was a high-energy photon, but through his further tests Chadwick was able to show that the energy and momentum of the radiation were better explained by invoking a then-hypothetical particle, namely, the neutron. A few months later he followed up his letter with a paper in *Proceedings of the Royal Society A*, with the more emphatic title 'The existence of a neutron'[2]. For this work, Chadwick received the Nobel Prize in 1935.

Chadwick's short note on his preliminary results published as a letter to the editor might come as a surprise, yet it is common practice today. The letter was in a sense a preprint and Chadwick was simply putting into practice what Ernest Rutherford had pioneered 30 years earlier. In the early 1900s Rutherford was in a rush to disseminate his results in the booming field of radioactivity, feeling particular pressure from the senior Curies (Pierre and Marie), so he started writing letters to the editor of *Nature* to provide updates on his research. By the time Chadwick was doing the same the practice had become more common and physicists were using the column as a venue for communicating research results.

Today physicists instead use the arXiv preprint server, which was born from the needs of the particle physics community (see this retrospective piece). However, there are differences between Chadwick's letter and the modern preprint. Chadwick was sole author on his publications and could release his preliminary results after just a few weeks. Now, scientists typically work in collaborations, and their preliminary results undergo careful scrutiny inside the collaboration before being publicly released. In addition, Chadwick was working before peer review had been formally established everywhere[3]. (It was in the 1930s when Albert Einstein was outraged with the editor of *Physical Review* for having shown his paper to a referee[4].) However, Chadwick's experiment was relatively straightforward to his peers who would have been able to scrutinize its detailed description in the paper in *Proceedings of the Royal Society A* — and likely reproduced it if they wished. This is clearly not the case for current experiments, given their complexity, and reproducibility is a much more complicated issue. In fact, interpreting experimental data was already tricky in 1932 as the discovery of another particle attests.

In 1932, Carl David Anderson was sifting through photographs of tracks of cosmic rays recorded in a cloud chamber when he spotted a track that only made sense to him if it came from a positively charged particle with approximately the same mass as an electron[5]. Going through the whole dataset of 1,300 photos, he found 15 such tracks in total — an early example of data mining. To put Anderson's data analysis into perspective, nearly 80 years later the OPERA collaboration examined 300,000 nuclear emulsion films to detect five events that gave a 5σ-level observation of the muon-to-tau transition in neutrinos (see this retrospective piece) — and such quantities of data to analyse are nowhere near those of current and planned experiments. Anderson received the Nobel Prize in 1936 for his discovery. (Meanwhile, the Joliot-Curies again narrowly missed making the discovery themselves, having seen similar particle tracks, but failing to see their significance.)

Although much has changed in the practice of science since the 1930s, many of these changes come from innovations in technology, rather than changes in the needs of scientists. Researchers need to quickly communicate results to their peers: in the early 20th century this was done through letters to the editor, today scientists use preprints. Physicists need to sieve through increasingly large volumes of data, looking for anomalies that may point to new discoveries. Anderson had to do this by hand, today increasingly complex statistical methods are used (see this recent Review). And peer review, albeit widely accepted today, still makes some authors unhappy. One of our goals as a journal is to understand the needs of the physics community so we can better cater to them. To do this we engage in conversation with our authors, readers and referees, but we also look back to understand how and why things were done in the past, to help shape better ways to do them in the future.

1. Chadwick, J. Possible existence of a neutron. *Nature* **129**, 312 (1932).
2. Chadwick, J. The existence of a neutron. *Proc. R. Soc. Lond. A* **136**, 692–708 (1932).
3. Csiszar, A. Peer review: Troubled from the start. *Nature* **532**, 306–308 (2016).
4. Kennefick, D. Einstein versus the Physical Review. *Physics Today* **58**, 43–48 (September, 2005).
5. Anderson, C. D. The positive electron. *Phys. Rev.* **43**, 491 (1933).