at least the second two of these characteristics, Daniel Greenberg's book, the product of almost four decades of close observation of the Washington science scene by one of its most acute analysts and sharpest critics, is essential reading.

Greenberg, a former news editor of *Science*, for many years chronicled in his fortnightly newsletter, *Science and Government Report*, the complex interaction between the scientific community and the political establishment. No one, therefore, is better placed to document how each has successfully managed to meet the needs of the other since the end of the Second World War.

Greenberg does not deny that this symbiotic relationship must take much of the credit for the current strength of US science and its dominance of the world stage. But he argues that there has been a heavy price to pay in terms of the intellectual and ethical cost of getting there.

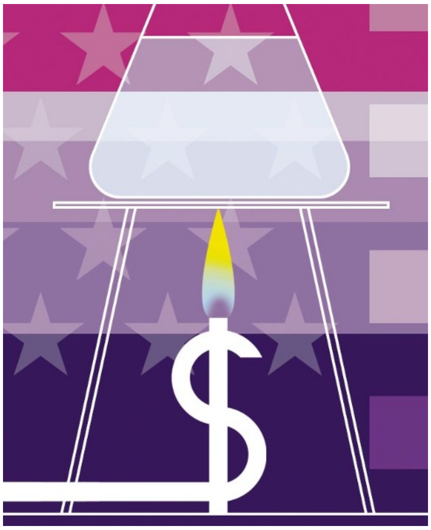
For example, one consequence of the successful pursuit of self-interest by the scientific community — the "political triumph" referred to in the book's title — has been an innate conservatism that Greenberg claims has, ironically, led to its increasing estrangement from mainstream politics.

A second consequence, he argues, has been a lowering in the intellectual integrity of the political discourse around science. Greenberg points out, for example, that many still invoke the name of Vannevar Bush to justify the protection of basic research funding from direct political interference. But few of these, he claims, are aware of the extent to which Bush's ideas were modified — and some of them rejected — during the process of setting up the system for funding science after the Second World War with which his name is identified.

At the same time, Greenberg argues, scientists have become increasingly disinclined to take up the moral causes that fired a previous generation of scientific leaders to campaign against issues such as nuclear-weapons testing or environmental degradation. He describes the main preoccupation of today's scientist, outside his or her scientific work, as "grubbing for money", and laments that "the demobilisation of science from politics and social engagement is a fact of scientific life".

Greenberg is at his best when tracking in painstaking detail, often using internal documents obtained in the course of preparing material for his newsletter, the way in which dubious lines of argument can take on a virtually unquestioned life of their own if they are found suitable for building a case for greater science funding.

Such, for example, was the case when the National Science Foundation set out in the mid-1980s to argue the case, based on a remarkable lack of hard data, that the United



States faced a damaging shortfall in the production of scientists and engineers. The argument was dropped in the early 1990s when it became clear that this was unlikely to occur.

He is also adept at undermining some of the myths about the degree of influence that scientists have over political affairs outside their direct spheres of activity. Their impotence is reflected, for example, in Greenberg's documentation of the continuous failure of the scientific community — or the "scientific enterprise", as he calls it — to establish a strong scientific presence in the Department of State. As a result, he writes, the department "has persisted in a benighted indifference to things scientific, sometimes to the astonishment and dismay of scientists who cross its path".

Many scientists continue to believe that science's generous support from the federal government is based primarily on the innate value of its potential contribution to social well-being. Greenberg's analysis of such events may well cause them to reconsider their view of how decisions about science funding are taken in practice.

There are shortcomings in his analysis that will no doubt be eagerly leapt on by those reluctant to accept the relatively unflattering portrait of US science that Greenberg presents. One is that, for all its institutional conservatism and self-serving politicking, US science has been remarkably productive in the period he describes. As far as science itself is concerned, and whatever Greenberg says about its innate conservatism, it is difficult to see how different strategies could have led to even greater achievements.

Second, there are some significant gaps in the analysis. For example, Greenberg spends considerable time analysing the misguided hubris that accompanied the collapse of political support for the Superconducting Supercollider in the early 1990s — and the political factors that ensured the survival of a far less scientifically deserving project, the International Space Station.

But he pays scant attention to perhaps the greatest single science project of the past decade, namely the sequencing of the human genome. This receives merely a passing comment, being linked dismissively with various ill-fated experiments in gene therapy as a product of the joint pursuit of "scientific glory and biotech profit".

Finally, Greenberg's book does little to explain how his main remedy for the ills he describes — that scientists should "come out of the ghetto" and become more directly involved in conventional politics — are likely, on their own, to change things.

None of these shortcomings, however, detracts from the value of this book as a unique and revealing perspective on the way that the science-funding process actually works in Washington. The picture it paints is not a flattering one. But — unlike many of those he writes about — Greenberg is not out to make friends in high places. ■

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An astronomical adventure story

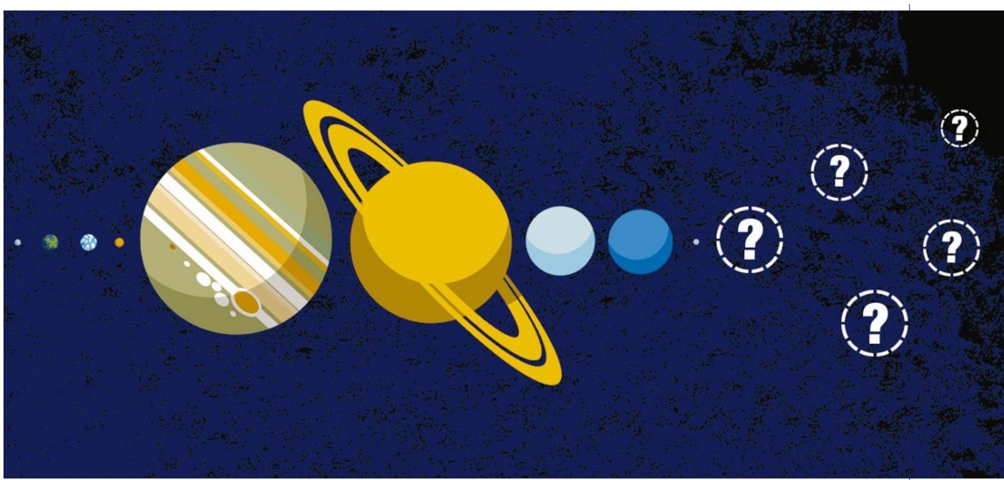
Beyond Pluto: Exploring the Outer Limits of the Solar System
by John Davies
Cambridge University Press: 2001. 244 pp. £17.95, $24.95

Joel Wm. Parker

The fact that our Solar System consists of more than just nine planets and an asteroid belt between Mars and Jupiter is still sinking into the public psyche. But among Solar System researchers, the importance of the Kuiper belt beyond Neptune has been known for quite a while. This region contains another 'asteroid belt', which is the source of comets and will provide a glimpse into both the chemical and the dynamic infancy of the Solar System.

Considering the recent public debate over the planethood of Pluto, and the on-again, off-again politics of NASA's Pluto–Kuiper Express mission, now is a particularly opportune time to publish *Beyond Pluto*. John Davies' book on the history and scientific relevance of these denizens of the outer Solar System is aimed at the general reader as well as the astronomer.

The history of the Kuiper belt is both old and recent. As early as the 1930s, after Pluto was discovered, there was speculation about the possible existence of a population of small bodies in the outer Solar System of which Pluto was just the tip of the iceberg. Kenneth



Edgeworth and Gerard Kuiper sketched out these ideas in somewhat more detail in the 1940s, and disagreement persists as to who should get the credit (and the eponymous immortality). To the dynamicist, the history of the Kuiper belt really begins in the 1980s, when models were developed to try to explain the origin and observed distribution of short-period comets (comets that take 200 years or less to orbit the Sun).

To the Solar System observer, depending on whether they are a heretic or a purist, the beginning of our foray into the Kuiper belt would be either the discovery of Pluto in 1930, the discovery of the centaur (outer-planet-crossing asteroid) Chiron in 1977, or the discovery of the first 'classical' Kuiper-belt object in 1992. The Kuiper belt is many things to many people: to the planetary scientist it holds clues to the origin of the Solar System, frozen into its distribution and dynamics during its formation. To the stellar astronomer it is a local example of extended structures we see around some other stars.

All this raises the question of how one can write a history of a topic that is a moving target, and that is, in many ways, still in the first blush of youth, maturing as one writes. Even since this book went to press there have been exciting new discoveries: trans-neptunian objects (TNOs) that are comparable in size to Pluto's moon and the asteroid Ceres; the first binary TNO; TNOs bright enough to be found on pre-discovery plates dating back many decades; and objects on unexpected orbits that have yet to be explained.

John Davies solves this predicament very well by setting out to tell a story and to show the reader that this is an ongoing adventure. The book's dust-jacket describes it as "the fascinating story of how theoretical physicists decided that there must be a population of unknown bodies beyond Neptune and how a small band of astronomers set out to find them". Davies points out that the book is not intended as a textbook, although he hopes (and succeeds, it seems to me) that it gives a feeling for how astronomy is actually done. With that intention, the reader is brought into the story almost as a participant, getting to know some of the personalities involved.

Although the popular idea is that individual personality does not have a role in the impersonal pursuit of science, this story nicely illustrates that it is exactly those unique traits that drive someone to search doggedly over many years for objects they don't even know exist, or to write and wrestle with numerical simulations that must run for months at a time to step through possible billion-year histories of model solar systems. In this book, Davies blends personal histories with scientific theory to give us an astronomical primer on the outer Solar System. He includes a fair amount of self-aware humour about the public and research community's image of astronomy: "Some physicists joke that the fundamental equation of astronomy is that 1 is approximately equal to 10." This personal touch extends to an appendix listing the main belt asteroids that have been named after Kuiper-belt researchers, along with the associated citations describing their work.

Because of the informal conversational style, the story sometimes hops around a bit and reiterates certain themes. Early on, for example, Davies discusses how Edgeworth was the first to put forward the possibility of a disk in the outer region of the Solar System containing small bodies orbiting the Sun. But in the final chapter, more suspects are named (Fred Whipple, Armin Leuschner and Frederick Leonard) who, it could be argued, have the earlier or stronger claim to postulating the existence of small bodies in the trans-neptunian region. If Leonard had got the glory and his term "ultra-neptunian objects" had stuck, then we might now be talking about "UNOs in the Leonard belt".

The introduction of a new concept in the text often leads to tangents that one may find informative, amusing or distracting according to taste (star formation, photometry, the effects of oxygen-deprived observing on Mauna Kea). When discussing the introduction of charge-coupled devices (CCDs) into astronomy as the detector of choice (nearly universally replacing the old standby photographic plate), Davies takes a small sidetrack to explain how they work, which includes an analogy of how a farmer would measure rainfall in his field using labourers with buckets. I found these tangents usually enjoyable, enhancing the informal 'telling a story' style and readability of the book.

Just as the Kuiper belt means different things to different people, there is something here for everyone. For the non-professional, Davies discusses the tools and art of astronomical research in a practical manner. For this level of general consumption, a glossary would have been useful, and the more abstract parts of dynamics, orbital interactions and resonance sweeping, as well as the various orbit diagrams and orbital element plots may be somewhat difficult for non-experts to disentangle and appreciate. For the expert and research astronomer, this account provides context for the ongoing work in the field as well as an excellent overview of the driving questions and current state of knowledge. For this level, a bibliography would have been beneficial.

But it is a pleasure to have a book that is readable at so many levels and able to describe the concepts and relevance of such a new field of research. With the discovery of the Kuiper belt, our view of our Solar System has expanded in many dimensions at an amazing pace. In the nine years since the discovery of the first TNO (not counting Pluto) to the publication of this book, we have discovered as many objects in the Kuiper belt as it took 100 years to discover in the main asteroid belt. Let's hope that this momentum will continue, with more public recognition of the new worlds to be explored and understood. ■

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The other man to discover evolution

Alfred Russel Wallace: A Life
by Peter Raby
Chatto & Windus/Princeton University Press: 2001. 352 pp. £20, $26.95

Jane R. Camerini

One can only welcome a new biography of one of Britain's most interesting and least celebrated nineteenth-century naturalists, Alfred Russel Wallace. Known during the twentieth century primarily as the man who spurred Charles Darwin to publish his work on the origin of species, and to biologists as one of the founders of modern biogeography, Wallace has, by and large, been relegated to the periphery of the present-day picture of