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## PROLOGUE: ASTRONOMY AT LARGE

The story begins in darkness, literally: a total eclipse of the Sun. And no ordinary eclipse, either, but the first one ever to be broadcast live on television, documenting the Moon's shadow as it progressed through France, Italy and the former Yugoslavia. The BBC's doyen of astronomy communicators, Patrick Moore, was stationed atop snow-covered Mount Jastrebac in what is now Serbia, and provided a live commentary on the progress of the eclipse. Such as it was – my recollection is that there was a lot of cloud about. There was plenty for him to talk about, though, including the oxen that had hauled the outside broadcast equipment up to the summit. As predicted, they nodded off to sleep in the darkness of totality. Rather to Patrick's chagrin, the producer immediately turned on floodlights to allow viewers to see the dozing animals. Not really what you want in the middle of an eclipse.

Watching all this as a 16-year-old on a black-and-white TV in the cold of a Yorkshire winter's morning, sleep was the furthest thing from my mind. There and then, I resolved to become an astronomer. Perhaps it was the live action of scientists using telescopes to probe the secrets of the Sun's corona – its outer atmosphere, whose mechanisms we still don't fully understand nearly

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six decades later. Or perhaps it was Patrick's skill in telling viewers exactly what was going on, when half the time he couldn't really see anything because of the cloud.

Eight and a half years later, with sixth form and university behind me, another TV programme held me in thrall, this time showing a chap called Neil Armstrong walking on the Moon. By then I was working for a renowned British company that built large telescopes for astronomers – including several I'd use later in my career. My job at the time was to fabricate the mirrors for a new space telescope that would survey the Universe in ultra-violet radiation. Because the company was truly ancient – well over a century old – it was accustomed to building telescopes so weighty they were measured in tonnes. That didn't really translate into satellite equipment, and we had all kinds of problems producing the lightweight mirrors required. Nevertheless, my telescope eventually flew aboard a robotic spacecraft with the unglamorous name of TD1A.

OVER THE YEARS, I BUILT UP A STORE OF EXPERIENCE IN many different branches of astronomy and space science, which eventually propelled me into the uncharted realm of management. So, for almost two decades, I was the Astronomer-in-Charge of what was then called the Anglo-Australian Observatory, or AAO – a bi-national venture that operated two telescopes at Siding Spring Observatory in north-western New South Wales. One of them, the 3.9-metre Anglo-Australian Telescope, remains the largest optical (visible-light) telescope on Australian soil.

In 2010, however, in a thoroughly polite and terribly British way, the UK pulled out of the deal, leaving the Australian government to run what then became the Australian Astronomical Observatory, or AAO. And eight years later, in a further deal

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involving a strategic partnership with a major European observatory, the AAO became part of the university sector. The telescopes at Siding Spring would now be operated by the Australian National University and the instrument building division in Sydney rebadged as – wait for it – Australian Astronomical Optics, or AAO. One thing you can say for the AAO is that it knows how to save money on logos. The same one has sufficed since 1991, and still proudly proclaims the organisation’s heritage.

So, what happened to the Astronomer-in-Charge amid all these reorganisations? The structure of the observatory had changed, and my management role had metamorphosed into education and outreach with a generous sprinkling of airtime on the national broadcaster, the ABC (Australian Broadcasting Corporation). So the AAO’s parent government department decided they’d quite like to hang onto me after the 2018 transition. That suited me very well, of course, since my addiction to communicating astronomy and space science to anyone who would listen remained undiminished.

But what would my new job be called? Someone suggested that if my title was tweaked to Astronomer-at-Large, we’d only have to change four letters on the office door. We sniggered at the criminal overtones. ‘Police have issued a warning that there’s an astronomer at large. Do not attempt approach or capture.’ But Australia’s Minister for Industry, Science and Technology, the Honourable Karen Andrews, really liked the idea, and who was I to argue?

AS ASTRONOMER-AT-LARGE, I GET TO ENGAGE WITH researchers all over the world, and relish keeping up to date with their work so I can bring it to the Australian public on-air. Not to mention anyone else who’s interested. Over the years, it has been

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my privilege to select a broad and quirky range of topics for fun radio segments, ranging from asteroid-mining to astrophysics and from Galileo to gravitation. And what a great trove to include in a book.

So *Exploding Stars and Invisible Planets* is based on the ‘Astronomer-at-Large’s Pick’ of seriously interesting astronomy topics. It’s an opportunity to bring you some of the less well-known stories from the frontiers of astronomy and space science. Stuff you might not have thought about before, together with a look at what the future might hold. Some of the fields of study featured here are developing very quickly, so what you have is a snapshot of our knowledge as of the middle of 2019.

Let’s take a look at what you’re going to find within these pages. We’ll start on our own planet with some earthy topics that don’t normally find their way into books about astronomy and space. The focus of part one is the magical interface between humans, our planet and the sky. Where else would you find an exposition of the glories of sunset, for example, or the place of citizen science in astronomy? Not to mention the way our planet is continuously being bombarded by ancient debris left over from the Solar System’s formation. We’ll also have a look at the burgeoning space economy, before taking a trip to our marvellous Moon in search of its origins. How appropriate, given that I’m writing this in the fiftieth anniversary year of the first moonwalk.

I mentioned Galileo a minute ago, and we’ll revisit his crimes at the start of the section exploring the Solar System. The history of astronomy gives wonderful insights into the science and, as you’ll find, its controversies don’t stop with Galileo. Then, coming right up to date, we find that planetary studies are conducted today with more than half an eye on the prospects of discovering life elsewhere in the Sun’s family. Several chapters in this section follow that trail, before we wind up with the latest on the hunt

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for a mysterious planet on the outer fringes of the Solar System.

And then we'll turn to the wider Universe. Here, we cover a pretty complete selection of the hot topics in contemporary astrophysics. Light echoing around the cosmos, uncanny radio bursts, the mechanics of black holes – and not one, but two varieties of enigmatic stuff permeating the Universe that make astronomers look silly because we don't know what they are. And just to settle everyone down at the end, we'll take a romantic look at unrequited love. Make sure you have a good supply of tissues handy.

I can't tell you what a privilege it has been to write about all the wonderful research being carried out, as well as relating a little of the curious and occasionally comical history of our science. Honestly, it's nearly as good as watching an eclipse.

