Introduction

The sun is many things: beauty, beacon, battery, belligerent. It sustains us yet threatens, too. That it burns our skin from 150 million kilometres away is a hint at its raw power. It's been worshipped as a god and feared as a demon, drives the weather and helps paint vivid aurorae across polar skies. Its magnetic mood swings flood the solar system with dangerous radiation. Birds sing to greet its daily arrival, only to flee for the safety of their nests when it departs for the night. Plants spring from the earth and unfurl their flowers in its presence. Its ancient energy is liberated from fossil fuels, as banks of solar panels attempt to usurp them by drinking in its light.

Yet for something so familiar to us, and so crucial to almost everything that happens on its third planet, the sun remains a confounding mystery. Our understanding tentatively improved when temples made way for telescopes. The last century has seen particular progress, starting with a solar observatory built in California by an astronomical visionary. The Space Age brought orbiting telescopes and since the 1990s we've dispatched an armada of dedicated solar space probes to surveil and scrutinize our nearest star like never before. Thanks to their work we've finally confirmed where all the sun's energy comes from and how that light meanders towards the solar surface before making its way to Earth. Modern telescopes have witnessed star formation elsewhere in the universe,

showing us how our own star came to be. But we have so much left to learn. We're still largely in the dark when it comes to explaining the dizzying array of solar activity. For a century and a half we've watched the number of dark spots on the sun rise and fall every eleven years or so, but we still cannot forecast the timing or strength of the next cycle. Most pressing is the need to understand – and predict – the technology-crippling stellar explosions that could send us back centuries. They have the ferocity to fry satellite circuitry, throw power grids into meltdown and ground international air travel. The sun even nearly triggered a nuclear skirmish at the height of the Cold War. This threat is so serious that governments around the world now see the sun as a foe equal to earthquakes, hurricanes and terrorism. The sun could cause a trillion dollars' worth of damage to our electrical infrastructure from which it would take months, if not years, to recover.

Astronomers are so desperate for answers that we now stand on the verge of another sea change in our understanding. Buoyed by these previous successes, the next generation of solar observatories is currently swinging into action. Giant mirrors are being hauled up the sides of enormous volcanoes to peer more closely at the solar surface. They're powerful enough to spot a human at a distance equal to the Earth's width. New space probes are being lofted into the solar system to swing closer to our star than ever before. In November 2018, the Parker Solar Probe broke the record for proximity to the sun. Eventually, it will inch within 6 million kilometres – far inside the orbit of Mercury – tolerating temperatures soaring above 1,000 degrees Celsius. Solar Orbiter will soon use Venus to gradually shuffle its orbit in order to climb high above the sun–Earth line to get an unprecedented peek at the solar poles – regions crucial in understanding the sun's cyclical nature. In the decade ahead these intrepid travellers will send back more data on the sun than we've ever had before. There's now so much of it that even an

army of stargazers simply wouldn't have time to trawl through it. Artificial-intelligence algorithms are being developed around the world to help us make sense of it all.

So now is the perfect time to look simultaneously backwards and forwards, returning to a time when the sun was no more than an orb in the sky, and ahead to how our understanding could be about to seismically shift. Charting our journey from monuments to mega-observatories, this book will showcase the stunning reality of life beside a stellar powerhouse, shining a light on its perplexing mysteries and exploring the feats of physics that have seen our knowledge grow. Yet this is more than just a story about a single star. It is also a very human tale; one of our ingenuity and unquenchable desire to learn more. Legions of astronomers have worked for centuries to further our understanding of the sun, with many overcoming significant personal and professional hurdles to add to what we know, such as the astronomers who escaped wars to witness eclipses, or those who smashed the patriarchy to make huge strides forwards and fled political revolutions to kick-start astronomical ones.

After seeing how the sun arrived in this otherwise unremarkable corner of the Milky Way, we'll plunge into the core to learn how our star's energy is made, against all the odds, in a place of unimaginable hellfire. From there we'll fly ever outwards, through the solar atmosphere, for a brief stop off at the Earth to see how astronomers are trying to tackle the threat of the space weather the sun unleashes upon us. Then it is on past the remaining planets, seeing how they too survive the solar onslaught, until we reach the edge of its influence way out beyond even Pluto, before heading into the wider Milky Way galaxy. Our odyssey will end with an account of how the sun – that great giver of life – will ultimately take it away.

But our journey starts by looking back at how our understanding evolved from the superstition of the past to the science of today.