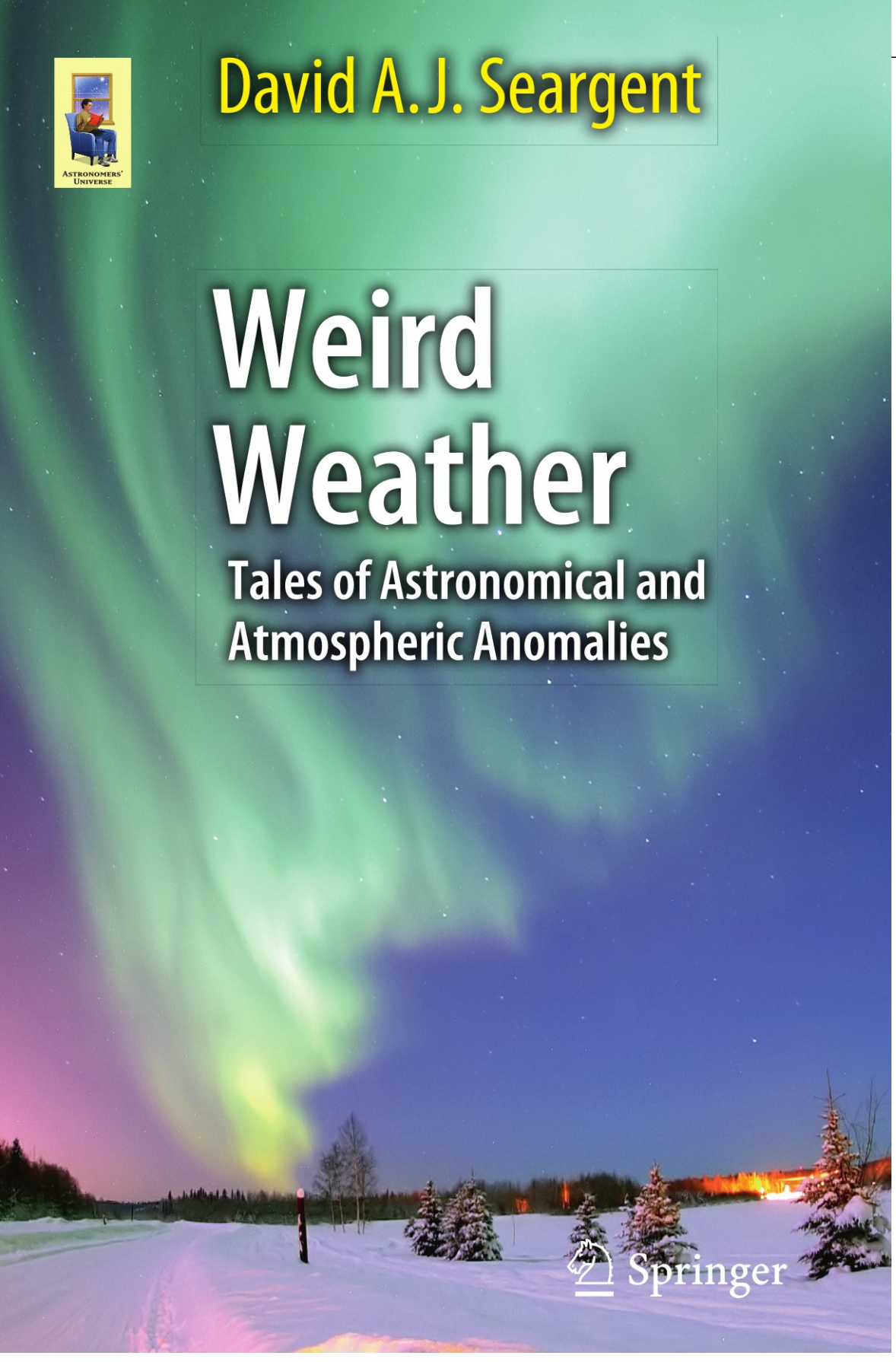
Astronomers' Universe
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Weird Weather
Tales of Astronomical and Atmospheric Anomalies
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# Weird Weather

## Tales of Astronomical and Atmospheric Anomalies

Springer

David A.J. Seargent
The Entrance
NSW, Australia

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*For Meg*

# About the Author

**David A.J. Seargent** holds an M.A. and Ph.D., both in Philosophy, from the University of Newcastle NSW, where he formerly worked as a tutor in Philosophy for the Department of Community Programs/Workers' Educational Association external education program. He is also an avid astronomer and is known for his observations of comets, one of which he discovered in 1978. Together with his wife Meg, David lives at The Entrance, north of Sydney on the Central Coast of New South Wales, Australia. He is the author of three published astronomy books; "Comets – Vagabonds of Space" (Doubleday, 1982), "The Greatest Comets in History – Broom Stars and Celestial Scimitars" (Springer, 2008), and "Weird Astronomy – Tales of the Unusual, Bizarre, and Other Hard to Explain Observations" (Springer, 2010). Currently he is the author of a regular column in *Australian Sky & Telescope* magazine.

# Preface

It is said that Baden Powell advised anyone hiding from pursuers to climb a tree because people rarely look up! With due respect to tree-climbing escapees, this is a great pity. So many wonders fill our skies. From the far reaches of the cosmos to the air flowing around our heads, the sky is filled with beauty and mystery.

Among the Ancients, there existed a cosmology which saw the Universe as divided into three heavens. The First Heaven was described as being where the birds fly or, in our terminology, the atmosphere. The Second was the Heaven of the stars, i.e. outer space or the astronomical universe, and the Third Heaven was the home of the Creator. The First and Second heavens of this old cosmology together make up the sky. All atmospheric phenomena, all astronomical events, have their homes there. Some of the spectacles of the sky are well known, others are rare and yet others are truly mysterious. During the course of this book, we will meet members of each class.

In this book, we will look chiefly at events within the atmosphere – "weather" in the very broadest sense. Yet the gaseous envelope that embraces our world is not an isolated system. Our planet, including its atmosphere, is a part of a far wider environment. There is no clear dividing line between air and space, and nearly all meteorological phenomena have their deep roots in the astronomical. At the most basic level, there would not even be an atmosphere without the Sun's heat!

Our story therefore begins with the Earth in its cosmic setting; a lonely blue globe in the vastness of space. The scene looks a hostile one at first glance. Our world appears terribly vulnerable. Yet, as we look more deeply, we see how a wonderful set of circumstances conspires to make our planet the ideal home for a

species such as us. In many respects, our habitable world may be regarded as the greatest wonder of air and sky!

But if the habitability of Earth depends upon such a fine balance, is it implied that this is readily upset and catastrophe easily precipitated? Can the actions of humanity, or some random natural event, bring about our end? Many prophets of doom tell us that our actions are already doing just that. But are they correct? What does the history of the interaction of Earth, atmosphere and space tell us about long-term changes in climate and habitability?

From these background considerations, we move to the denizens of the sky itself. First of all, we look at the spectacular light displays occurring at the very interface of atmosphere and outer space. The study of aurora or "polar lights" is one place where meteorology and astronomy meet, as a true understanding of this beautiful phenomenon cannot be understood without encompassing both disciplines. But auroras are not confined to Earth. As we shall see, even grander displays occur elsewhere in our solar system.

As we move deeper down into our envelope of air, we encounter other spectacles such as lightning, mirages, vortices and a wide range of other atmospheric phenomena. We look at these, not just from the perspective of our own planet, but from that of other Solar System members as well.

During our journey, we will encounter tales of some very controversial observations and phenomena that simply don't appear to fit into accepted knowledge. What are we to make of the various types of luminous objects that have been reported from time to time, either high in the air or close to the ground? Or mystery sounds? Or meteor-like events that seem to occur at much lower altitudes than "genuine" meteors? Then there are clouds that rumble, auroras and lightning strokes that "hiss" and sparks that jump out of patches of fog. And what can one say about something that looks like a meteor appearing *within a darkened room*!?

But merely reading about the sky with its odd and interesting denizens is no substitute for going out and observing for oneself, and to this end, a number of observational exercises are included within these pages. These range from simple observations of the Moon illusion, through seeking out Haidinger's brush in a polarized twilight sky, to estimating atmospheric opacity from monitoring the darkness

of lunar eclipses, to looking for unusual lightning or controversial "sleeks" (the name given to those alleged meteor-like phenomena apparently occurring at low altitudes). Some of these make for entertaining demonstrations at star parties (exposing the Moon illusion is a case in point) while others raise the possibility of making real discoveries (a once-and-for-all demonstration of either the illusory or non-illusory nature of "sleeks" by a group of experienced meteor observers would be nice!). But most importantly, they bring us face to face with that wide open space on whose shore we all make our home; the vast and magnificent realm of air and sky, the realm of weather and all manner of wonders.

Because their hobby involves being out of doors at night, amateur astronomers are amongst those who have the greatest familiarity with the sky and what happens there. Clouds may not be their best friends, but astronomers probably notice them more than most! And just by being outside during the night hours, and aware of the phenomena around them, astronomers are more likely to encounter – and to notice – events (even those not especially associated with the sky per se) to a degree that many non-astronomers may not. Their familiarity with the sky and its denizens will also enable them to more readily recognize what is and what is not "normal" in the heavens. So even if the subjects covered in these pages may not always be strictly astronomical, it is hoped that amateur astronomers, especially, will be stimulated by this journey through the realm of sky and night and come to an even greater appreciation of this wonderful (and sometimes weird!) world in which we live.

NSW, Australia David A.J. Seargent

# Acknowledgements

This book is the product of long-time interests in astronomical and meteorological phenomena, including reports in both fields that do not quite fit into accepted knowledge. So many people have contributed to these interests over so many years that even attempting to trace them all would be impossible, so may I simply offer a profound "thank you" to everyone who has aroused my curiosity about these topics.

More specifically, I extend my thanks to Mr. John Watson and Ms. Maury Solomon of Springer Publishing for their encouragement and advice and for their faith in a volume which some might consider a little "left field" for the Astronomers' Universe series.

My hope is that you, the reader, will have your curiosity aroused by this tour through the wonderful, sometimes spectacular and at time mysterious denizens of our strange skies.

David A.J. Seargent
The Entrance

# Contents

# 1. This Island Earth

## A Lonely Blue Globe

For those of us old enough (sorry, mature enough) to remember the Apollo Moon landings, what is the image that first springs to mind when those heady days are recalled to memory?

There are certainly many choices. The stark lunar landscape of "magnificent desolation" as Buzz Aldrin described it, the raising of the US flag as the first men from our planet set foot on another world, or maybe the dawning of Christmas on the Moon beneath the orbiting *Apollo 8*, as the astronauts each read sections from the opening chapter of the Book of Genesis. These are all moving memories, but perhaps the most iconic of them all is the scene of distant Earth rising above the lunar landscape. The contrast said it all; a blue and white globe amid the stark blackness of space poised above a harshly beautiful, but totally hostile landscape. The contrast, the loneliness, the fragility of our home planet was so striking that it is not for nothing that the Apollo Moon program is credited by some as the catalyst for the age of environmental awareness on Earth. Mankind went to the Moon – and discovered Earth! Not the Earth that had hitherto been our whole world, strong and indestructible, but Earth the planet, isolated and alone; a tiny island of life in a vast ocean of sterility.

If space exploration has taught us one thing, it is the "anomalousness" of our home planet. In fact, the more we learn about the universe around us, the more anomalous Earth appears to be. Back in the days when little was known about the other worlds of the Solar System, these were pictured as being (more or less) other Earths. There was a wide assumption that they were populated. The great astronomer William Herschel, for instance, not only thought that the Moon was inhabited, but he also believed that beneath the hot surface of the Sun there was a cool world where intelligent creatures lived. What we see as the "surface" of the

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**Fig. 1.1.** Earth rising over lunar horizon as photographed from Apollo 8 (Credit: NASA)

Sun, Herschel believed to be more of an atmospheric envelop shrouding the green and fertile world beneath!

Solar beings (never one of Herschel's more popular ideas) have long vanished, as have Moon men and Mercurians. Martians lingered longer, with some writers even proposing their existence as late as the 1960s.

Following the first probes to Mars and Venus in the early 1960s, the true nature of our planetary neighbors started to become clearer; and for those who cherished the notion of extraterrestrial counterparts of human beings, the emerging picture was not encouraging. Not that the absence of H. G. Wellsian Martians was of itself a revolutionary discovery. Except for a mere handful of extreme hopefuls such as the unconventional writers alluded to above, few people with knowledge of the solar planets still believed in them when *Mariner 4* reached Mars in 1965. What did take most people aback was the apparent hostility of the Martian environment to life of any sort. The first images from Mars actually

made the place look less inviting than later research found it to be, but a Mars that did not obviously support an abundant growth of lichen-like vegetation so widely believed in prior to 1965 came to many as a blow against the very idea of abundant life in the cosmos as a whole. In short, if the planet deemed most similar to Earth did not even support lichen the confidence that there were human analogues populating worlds further afield suddenly looked less secure.

## Planets, Planets Everywhere (But Not a Single One Like Home?)

With the discovery, from the 1990s, of planetary systems beyond our own, our understanding of Earth's place in the order of things took another turn, but not the one that many people had expected. Just as pre-space-age concepts of the other planets of our Solar System saw these as being (more or less) Earth-like, so pre-1990 ideas about other planetary systems pictured these as basically clones of the Sun's family. Not in detail of course, but the general "plan" for the majority of solar systems was thought to be one of small rocky planets orbiting relatively close to the parent star and giant gaseous orbs located at greater distances. Essentially, "Earths" and "Venuses" close in and "Jupiters" and "Saturns" further out.

The very first planets discovered outside the Solar System were so bizarre that they simply did not fit the mould at all. They were at the "Earth" end of the size spectrum, but orbiting a neutron star or pulsar – the ultra dense remnant left behind by a massive star blown asunder in a supernova explosion. Nobody had expected to find planets in such locations. It seemed incredible that planets could survive their parent star going supernova. Presumably, these objects were not original companions of the ill-fated star. They must have snowballed together from the debris left over from the explosion. The system was, clearly, an anomaly and it was quite pointless to compare it with the Solar System. But the first "regular" solar systems – systems of planets around more or less sun-like stars – provided an even bigger shock. These were the systems of hot Jupiters or gas giants wheeling around their stars in orbits whose radii made Mercury look distant!

The early technique of planet detection relied on the wobble of the parent star caused by the nearby planet's gravitational tug upon it. For this reason, hot Jupiters were the only ones capable of being found during the first several years of planet seeking. The planet needed to complete an orbit of the star for the detection to be made, so the technique greatly favored large planets having very short orbital periods and, *ipso facto*, very small distances from their parent star. But that did little to ease the shock. The very existence of such planets was the real surprise. Perhaps if the first hot Jupiter discovered had been a one-off like the pulsar planets, it could have been dismissed as an anomaly. But it was not a one-off. Hot Jupiters kept turning up again and again. Then, after enough years of data collection had elapsed to permit the detection of more "temperate" Jupiters (those orbiting further from their central stars and having longer orbital periods) another surprise was waiting. Unlike our own system's giant planet, most of *these* "temperate" Jupiters orbited their suns in highly eccentric orbits. Some of them moved more like comets than planets! A big surprise.

In the face of this, astronomers began asking themselves if our familiar Solar System was really the norm at all. Maybe these other planetary systems were the regular ones and *ours* was the anomaly!

We still do not know the answer to that question. Most of the other solar systems discovered to date have not been clones of ours, although the observational selection already mentioned partially explains this by making those systems harboring very large planets at small distances from their central stars the prime targets for discovery. Still, with longer periods of observation now enabling the detection of planets at distances from their stars comparable with that of Jupiter from the Sun, a few approximate solar system analogues have emerged. Yet, to date, nothing has been found that *exactly* replicates our home planetary family. Other methods of planetary sleuthing (detection of planets transiting their parent stars – evidenced by very slight drops in the light of the star – gravitational lensing and even direct observation in a few cases) have also added to the tally of extrasolar worlds and families of worlds and it may not be long before the question of just how typical the Solar System is can be answered with some degree of confidence.

Whether our Solar System is or is not more "typical" of its species than the often odd and sometimes outright bizarre systems discovered during the last couple of decades, one thing is sure. Not every planetary system is like our own. Astronomical discoveries during the latter years of the twentieth century and the opening years of the Twenty-First have taught us that there is a great variety amongst the solar systems out there. The lesson has a definite whiff of *déjà vu* about it. It is just another level of the lesson that, only a very few decades earlier, space probes taught us about planet Earth. Other planets are not simply different versions of Earth and, it is now becoming clear, not all solar system's are modeled on the Sun's.

For many people, the interesting question raised by all of this is "What about life beyond Earth?" "Is the prospect of finding life elsewhere altered in view of these discoveries?" Or, to approach this from a contra point of view "Is Earth especially fortunate in being the verdant planet that we know?"

The answers to these questions imply a more fundamental one. "Can life exist under a wide range of circumstances, or is it dependent upon a very narrow set of parameters?"

A lot of talk about the possibility of extraterrestrial life focuses on the relatively recent discovery of so-called extremophiles; living organisms that can exist and even flourish under conditions previously thought impossible. We have all heard account of the cores of nuclear reactors becoming choked up with the prolific growth of diatoms. These little creatures cannot just endure, but happily flourish under, conditions of radiation so intense that even large molecules are disrupted. Then there are the "water bears" or "moss piglets" (more formally known as *Tardigrades*); tiny but incredibly tough little critters that not only can survive the extremes of cold but are also capable of being desiccated, left apparently for dead, and then brought back to life and health by adding a few drops of water! But even these don't hold a candle to the biomass beneath our feet – *way* beneath our feet. Deep within the rocky mantle of this planet lives the remarkable *Bacillus Infernus*. Cut off from the rest of the terrestrial ecosystem, these micro-organisms would not miss a beat were the entire atmosphere of Earth to be blown off into outer space!

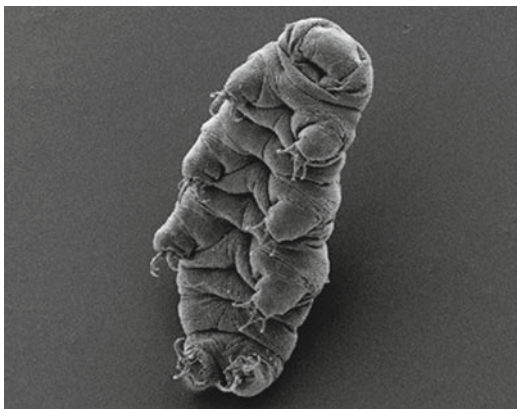

**Fig. 1.2.** Scanning electron micrograph of Tardigrade *Hypsibius dujardini* (Credit: Bob Goldstein)

The lesson to be learned from extremophiles seems to be that relatively simple organisms can live under a wide range of conditions. It is not impossible that organisms which we would think of as extremophiles might really live on Mars and/or Titan, Europa, in the higher atmosphere of Venus and maybe even in water-bearing asteroids and large comets. Interesting (if not always convincing) arguments have been put forward for life on each of these locations and there is even some purported evidence (albeit controversial) in support of these. The popular press, and even some scientists, have at times taken this a step further by suggesting that if life is ever confirmed in any of these locations, the existence of highly complex organisms of the type capable of human type minds is almost a foregone conclusion … *somewhere*. Not, to be sure, on any of these solar system bodies, but on many other more Earthlike worlds orbiting the far flung stars of the Galaxy.

Let it be said straight away, that this is far from being a watertight argument. The very fact that we speak of "*extremophiles*" gives the show away. If these organisms could talk, they would not say that their environments were extreme. *We* think of them as extreme, only because we, along with most other more complex forms of life, could not survive where they thrive. But that is only to admit that we are far more fragile than they, with remarkably narrow zones of tolerance. If the extremophiles indeed could talk, one might ponder what they would call us!

The simple nature of the extremophiles does not support the assumption that life in extreme environments will eventually evolve into more complex organisms fitted to these environments. Life is certainly adaptable. There is no argument about that. The real question is "How adaptable?" The relative simplicity of extremophiles, plus the narrow range of biodiversity in extreme environments, clearly tells us that there is a limit to this adaptability. It also tells us that these limits are increasingly restricted the higher up the scale of biological complexity we go.

The really interesting issue is not to define the limits of life per se, but rather to try to define the limits of the sort of life that could possess human minds; that sub set of organisms which Poul Anderson called *androdes* (in no way to be confused with andr*oids*!) and which C. S. Lewis, in his space fiction trilogy, called *hnau.* These are beings with which we might meaningfully communicate, share information about astrophysical problems or discuss the meaning of life.

Anderson, by the way, used the term "androde" in favor of the more popular "humanoid." He did not equate the two, and actually avoided "humanoid" as much as possible. This latter term, he pointed out, refers primarily to the physical shape and form of an organism, but his preferred "androde" related to mental characteristics, something which Anderson found far more interesting. Humanoids are not necessarily androdes. For instance, modern humans would find little in common with *Australopithecus*, although I doubt if we would have much trouble terming this extinct creature a humanoid. Whether the reverse is true – whether androdes need not be humanoids – is a more intriguing issue. Science fiction writers have happily populated their imaginary worlds with non-humanoid androdes – the infamous "bug-eyed monsters" or BEMs – but sober biologists note that there are many advantages to mental development found in humanoid features such as bipedalism and the possession of suitable hands and arms. An androde need not look strictly human of course, but it may be true that most would, in Willy Ley's words, be mistaken for humans "by somebody who does not see very well and cannot find his glasses."

Nevertheless, the only example of such creatures of which we are aware is … us! Other more or less intelligent species share this