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Worlds Beyond Earth: Auroras of Other Worlds

Light Shows on Distant Planets

Aira Astralis

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Contents

Introduction

Chapter 01: The Discovery of Auroras of Other Worlds

Chapter 02: Understanding Auroras of Other Worlds

Chapter 03: Key Characteristics of Auroras of Other Worlds

Chapter 04: The Science Behind Auroras of Other Worlds

Chapter 05: Observation and Measurement of Auroras of Other Worlds

Chapter 06: Important Features of Auroras of Other Worlds

Chapter 07: Auroras of Other Worlds in Context

Chapter 08: Modern Understanding of Auroras of Other Worlds

Chapter 09: Research and Exploration of Auroras of Other Worlds

Chapter 10: Significant Discoveries About Auroras of Other Worlds

Chapter 11: Challenges and Mysteries of Auroras of Other Worlds

Chapter 12: Future Directions in Auroras of Other Worlds Research

Chapter 13: Fun Facts and Trivia About Auroras of Other Worlds

Chapter 14: Conclusion: The Significance of Auroras of Other Worlds

Conclusion

This free sample contains the Introduction and Chapter 1. The complete book contains the full contents above.

Introduction

Imagine standing under a clear Arctic sky when the darkness above you begins to move. Ribbons of green light unfold, ripple, and fold again like curtains stirred by a wind you cannot feel. Sometimes the glow burns violet at its edges; sometimes it shoots toward the zenith in pale rays that seem almost close enough to touch. For thousands of years, people have watched this light and wondered what it was - spirits, omens, fires of the gods. Today we know it is something even more remarkable: a visible sign of invisible forces, the meeting point of a planet's magnetic shield and the storm of particles blown from the Sun.

This light is the aurora, and Earth is not the only world that has one. Auroras glow around the poles of Jupiter and Saturn, flicker above the icy crust of Ganymede, shimmer in ultraviolet above Mars, and have even been detected on objects far beyond the solar system. The same basic physics - charged particles guided down magnetic field lines into an atmosphere - plays out again and again across the universe, but always with a different twist on each world.

The region that currently displays an aurora is called the "auroral oval", and it is centred about 3-5 degrees nightward of the magnetic pole, so that auroral arcs reach furthest toward the equator when the magnetic pole in question is in between the observer and the Sun, which is called magnetic midnight. Early evidence for a geomagnetic connection comes from the statistics of auroral observations. Elias Loomis (1860), and later Hermann Fritz (1881) and Sophus Tromholt (1881) in more detail, established that the aurora appeared mainly in the auroral zone - a ring of sky around each magnetic pole where the lights are seen most often.

Auroras have stories attached to them, too. In Sami mythology, the northern lights are caused by the deceased who bled to death cutting themselves, their blood spilling on the sky. Other cultures heard the footsteps of spirits or the gleam of fish scales in a celestial river. Those old stories are a reminder that the aurora is not only a scientific puzzle but a human one: a light that people have lived under, feared, and celebrated for all of recorded history.

In this book we will look at how auroras were discovered and explained, how they work on our own planet, and how they appear on worlds beyond Earth - the giant planets, the ice giants, Mars, Mercury, and even failed stars called brown dwarfs. We will see how astronomers find auroras they cannot see with their eyes, what these lights reveal about the invisible magnetospheres that wrap every protected world, and what mysteries still remain. The story of the

aurora is, in the end, the story of how a planet defends itself against its own star - and lights up the sky while doing it.

Chapter 01: The Discovery of Auroras of Other Worlds

The discovery of the aurora is really two discoveries. The first happened slowly, over thousands of years, as humans watched the lights and tried to make sense of them. The second happened within a single century, as scientists realised that the same lights shine on other worlds too.

The word "aurora" itself comes from ancient Rome: Aurora was the goddess of the dawn, and the name was borrowed for the northern lights because the glow often resembled the blush of morning. In 1619, the Italian astronomer Galileo Galilei used the term "aurora borealis" - the northern dawn - to describe the phenomenon, and the name stuck. A few years later, the French philosopher Pierre Gassendi described a great aurora seen over southern Europe and kept the name in use. Before that, the lights were known by many names: "dance of the spirits" among some northern peoples, "fire of the heavens" in older European accounts.

The first great scientific clue came in 1741, when the Swedish astronomer Anders Celsius and his assistant Olof Hiorter noticed that compass needles twitched and wandered whenever the aurora appeared. The lights, they realised, were somehow connected to magnetism. That single observation tied the aurora to the invisible magnetic field of Earth - and it opened the door to everything that followed. In 1773, the explorer Captain James Cook reported seeing lights far to the south during his voyage through the Southern Ocean, confirming that the southern hemisphere had its own aurora, the "aurora australis".

In northern latitudes, the effect is known as the aurora borealis, or the northern lights. The southern counterpart has features almost identical to its northern twin and changes at the same time - when the northern lights flare, the southern lights flare too, as if the two were connected through the planet itself. The southern lights are visible from Antarctica, Patagonia, southeastern Australia, New Zealand, and the Falkland Islands. The northern lights favour the skies over Alaska, northern Canada, Iceland, Greenland, the Faroe Islands, Scandinavia, Finland, Scotland, and the vast northern stretches of Russia. During a geomagnetic storm, the auroral ovals of both hemispheres expand, carrying the lights far toward the equator - on rare, memorable nights, the aurora has been reported from the Mediterranean and even the Caribbean.

The nineteenth century turned the aurora from a curiosity into a science. The

Norwegian explorer and scientist Kristian Birkeland led daring expeditions into

the Arctic winter to measure the lights directly, and in his laboratory he built a small magnetised sphere - a "terrella" - inside a vacuum chamber and fired electrons at it. Light appeared around its poles. It was a miniature Earth with a miniature aurora, and it proved that the lights are powered by charged particles streaming along magnetic field lines. Birkeland argued, correctly, that the currents flow from space down into the atmosphere. Many scientists of his day disagreed; satellites would later prove him right.

Carl Stormer, another Norwegian, used cameras stationed at separate locations to triangulate more than 12,000 auroras. He found no auroras below

70 km (43 mi) and only 6.5% above 150 km (93 mi), with a maximum in the height distribution around 100 km (62 mi). The aurora, it turned out, lives in a thin shell of the upper atmosphere.

The lights kept their own calendar, and the seventeenth and eighteenth centuries were lucky to catch them at all. In 1716, the astronomer Edmond Halley described a great aurora seen over England and northern Europe, noting that nothing of the kind had been seen there in living memory; displays in those latitudes were so uncommon that a single one could launch pamphlets, sermons, and years of correspondence. When the aurora is quiet for decades, as it was during periods of low solar activity, whole generations in central Europe can grow up without once seeing it - and then a single stormy night rewrites everyone's idea of what the sky can do.

By the nineteenth century, the study had become organised. Observatories in Finland, Norway, and Russia logged every display; networks of correspondents compared notes by letter and discovered something remarkable - the lights appeared on the same nights across whole continents, and compass needles everywhere swung together. The aurora was not a local weather of the sky but a planet-wide event, connected through the Earth itself. That realisation turned a spectacle into a science, and the men and women who timed and sketched the lights from frozen observatories became the ancestors of today's space physicists.

The discovery of auroras on other worlds had a strange beginning: it started with noise. In 1955, two radio astronomers named Bernard Burke and Kenneth Franklin detected odd, crackling radio bursts coming from the direction of Jupiter - the first time any planet had been heard as a radio source. Those emissions, it was later understood, are produced by the same processes that make auroras: charged particles spiralling along magnetic field lines. When spacecraft finally reached Jupiter in 1979 and photographed its poles in ultraviolet light, there it was - a permanent, towering aurora, the largest in the solar system. The northern lights of Earth had cousins, and they had been

hiding at the edges of our solar system all along.

Before science took over the story, the lights accumulated a library of human meanings. Norse tradition saw the lights in the context of the sky bridge and the glimmer of the world of the gods; medieval European chronicles recorded "blood-red" skies as armies or omens marching in heaven - accounts now prized by scientists, because they extend the record of great solar storms centuries into the past. East Asian chronicles described "red vapours" in the same spirit. In the far north, where the lights were a nightly companion rather than a marvel, they were treated with respect: some traditions held that the lights should not be mocked or whistled at - an etiquette our ancestors invented for the strongest electromagnetic phenomenon they ever witnessed.

Why does this book speak of "auroras of other worlds" rather than simply the northern lights? Because the greatest discovery in the long history of aurora-watching is that the lights belong to no single sky. Every magnetic world in the solar system wears them; every brown dwarf broadcasts them; and the planets of other stars are now being searched for them. Earth's aurora, beautiful as it is, turns out to be a single dialect of a language spoken across the universe - the language that magnetised worlds use to answer the storm that made them. Learning the other dialects, planet by planet, is what the rest of this book sets out to do.

End of free sample. The full book is available at putrabooks.github.io

ABOUT THE AUTHOR

Aira Astralis is a science writer specializing in astronomy and space exploration. Her work spans the full breadth of humanity's relationship with the cosmos -- from the earliest naked-eye observations to the engineering marvels of modern space missions.

Her books are built on a foundation of primary sources: peer-reviewed research, mission archives, and direct engagement with the scientific community. She writes for readers who want to understand not just what we know about the universe, but how we came to know it.

She believes that the most important frontier is not out there but in the gap between what scientists discover and what the public understands. Her books exist to close that gap.