SAMPLE

Worlds Beyond Earth: Jupiter

The Giant of Storms and Moons

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Free sample: Introduction & Chapter 1

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

Introduction

Of all the objects that share the Sun with the Earth, none asserts itself like Jupiter. It is the largest planet, more massive than every other planet combined, and again over again: its striped face is the most recognizable feature in the sky after the Sun and the Moon, its moons were the first new worlds humanity ever saw, and its gravity has run the solar system's traffic for the whole four-and-a-half-billion-year span.

The planet's visibility earns a mention as well, the book's subject being also a presence in the reader's own sky. Jupiter is the third-brightest object in the night, after the Moon and Venus, outshining every star, and the reader can find it on any clear night it is up, a steady, unblinking point that does not scintillate as the stars do, and a pair of binoculars, held steady, shows the four Galilean moons strung out around it, the same four points Galileo saw, the reader seeing them four centuries later with the same instrument's power. The planet's twelve-year circuit puts it in a different constellation each year, and the reader who finds it once can keep it, watching it drift against the stars month by month, the king's own pace, which is the nearest thing to watching the solar system's deep structure move that the unaided eye is given.

The planet's apparitions, the reader should know, are worth planning around, because the show changes. The planet's twelve-year circuit brings it to opposition, its closest and brightest, once each year, and the oppositions cluster in a season, the planet riding high in the dark hours in the years it stands in the winter constellations, and the reader who wants the moons' dance at its best should take a year and follow the four points nightly, watching the alignments shift, the resonances the moon chapter described turning visibly, the same lock that feeds Io's fire playing out as a slow shuffle of lights.

The reader with a telescope, any telescope, will see the stripes and the Spot's hollow, and the view this book has explained, the patient reader will find, is the view that pays: the longer the reader watches, the more the planet moves, and the more it moves, the more of this book the reader can see. This book is the story of that planet, told from its formation to the spacecraft that now circle it, and told for the reader who wants to understand the king of the planets on its own terms.

The planet rewards a full telling, because Jupiter is not merely large; it is extreme in nearly every property a planet can have. It is the fastest-spinning planet, whipping through a day shorter than ten hours. It carries the strongest planetary magnetic field in the solar system, a magnetosphere that, projected

onto our sky, would dwarf the full Moon. The planet also carries the solar system's largest storm, a vortex that has been spinning for at least the better part of two centuries and that could swallow the Earth whole. It commands a family of more than ninety confirmed moons, four of them worlds large enough to be planets in their own right, and its gravitational influence reaches so far that it has sculpted the asteroid belt, captured comets, and shielded, or at least herded, the inner planets since the era of formation.

The chapters unfold in the planet's own order. The first chapters establish the object: its place among the planets, its formation in the solar system's first million years, and its interior, which the reader will find stranger than the word gas giant prepares them for. The middle chapters are the visible planet and its family: the atmosphere and its storms, the magnetosphere and its radiation, the great moons and the rings, and the small worlds of the swarming retinue. The later chapters are the human record: the planet's place in ancient astronomy, the telescopic era and the discovery of the moons, the flyby era of Pioneers and Voyagers, the Galileo orbiter's years among the moons, and the Juno mission that lifted the veil on the deep interior. The closing chapters weigh the planet's influence on the solar system and the questions the next missions, now on their way, will answer.

A note on the book's stance, made once and kept throughout: this is a descriptive natural history, not a mission report or a textbook, and it uses the series' established voice, addressing the reader directly, defining every technical term at first use, and preferring plain arithmetic to jargon. Where the scientists themselves are still arguing, over the core's composition, the atmosphere's water content, or the origin of the Great Red Spot, the book says so plainly and gives the competing cases fairly. The reader will finish with a working picture of the planet, assembled from four centuries of observation and four decades of spacecraft visits, and will know which parts of that picture are settled and which are still being redrawn as the data arrives.

A word on the book's evidence, because the reader should know what stands behind its sentences. Jupiter is the best-observed planet after the Earth and the Moon: four centuries of telescopic record, six spacecraft encounters, two dedicated orbiters, one atmospheric entry, and an ongoing orbiter still transmitting as these words are written, and every fact in the chapters ahead carries that provenance. Where the book states a number, the number is the current consensus of the mission teams and the modelers; where it states a range, the field is arguing; where it uses the future tense, the flagship missions now in transit will decide. Anyone who finishes the book will, in effect, have read a progress report on a live investigation, and the investigation's next data are, at this writing, already on their way.

One framing number, before the planet begins: if the reader took all the planets of the solar system and combined them, Jupiter would outweigh the combination roughly two and a half times over. Everything else in this book, the storms, the moons, the magnetosphere, the four-billion-year reign, follows from that one overwhelming fact, and the chapters that follow are, in one way or another, the story of how mass makes a world.

The book's place in its series should be said plainly, because the reader may come to this volume from the others. The Worlds Beyond Earth series walks the solar system's worlds one by one, and the giant planets, this volume and its siblings, present a category problem the series' early volumes did not: a gas giant is not a world in the solid sense, has no surface to stand on, no horizon, no ground, and the books' approach to the giants is therefore the approach this book takes, treating the planet as an ocean of sky, describing the depths as a mountaineer describes altitude, and reserving the solid worlds, the moons, for the ground-level treatment the series' other volumes give. The reader who has read the volumes on Mars or the Moon will find the same voice here, applied to an object with no floor, which is, the reader will agree by the end, the right way to tell it.

One more definitional note, the book's last, on the word giant and what the reader should picture beneath it. The gas giants are not made of gas all the way down, and this book's interior chapter is the correction: Jupiter is a planet of fluids, gas at the top, liquid in the middle, liquid metal at the base, and the word the specialists use for the class, giant planet, is the better one, with the subdivisions, gas giant for Jupiter and its Saturnian sibling, ice giant for the two bluer outer planets, and the reader should carry the taxonomy's plain sense: the giants are the worlds that kept the disk's gas, the small planets are the ones that lost it, and the difference, as the formation chapter shows, is a game of timing and mass that the young Jupiter won and the young Mars, standing in the same disk a hundred million miles sunward, lost by an order of magnitude.

Chapter 01: The King by the Numbers

Before the story begins, the reader deserves the object itself, stated plainly, because Jupiter's record-setting properties are the vocabulary of everything that follows. This chapter is the planet's inventory.

Start with the bulk. Jupiter is eleven times the Earth's diameter and roughly three hundred eighteen times its mass, and the comparison to the Sun is just as instructive: the planet holds about a thousandth of the Sun's mass, a thousandth that matters, because it is the largest step in the solar system between a planet and a star. The planet's density is barely a quarter of the Earth's, which tells the reader the composition at a stroke: Jupiter is built of the light elements, hydrogen and helium, the raw material of the Sun itself, compressed to planetary densities by its own weight.

The composition, roughly nine parts hydrogen to one part helium by number of atoms, with traces of methane, ammonia, and water, is the same recipe as the Sun's, and the fact has a name worth remembering: Jupiter is a failed star only in the loose popular sense, since it would need some seventy-five times its mass to ignite, but it is, precisely, a planet made of the star's own stuff.

The shape follows from the spin. Jupiter turns once on its axis in under ten hours, the fastest rotation of any planet, and the spin flings the visible disk visibly out of round: the equatorial diameter exceeds the polar by about six percent, a flattening the reader could see with a good telescope, since the planet looks gently squashed. The rapid spin also stretches the planet's magnetic field and organizes its atmosphere into the banded structure the reader knows from every image, because the atmosphere's weather systems are carried around the planet at hundreds of meters per second, the fastest winds in the solar system's planetary atmospheres outside the special cases.

The distance and the year complete the frame. The planet orbits at five and a half times the Earth's distance from the Sun, an orbit that takes nearly twelve Earth years to complete, which is why the planet moves through the zodiac at the stately pace of one constellation per year, the pace that made the ancients name it for the chief of the gods. The sunlight there is faint, about a twenty-seventh of the Earth's, and the planet's warmth is therefore its own: Jupiter radiates more heat than it receives, roughly one and two-thirds times as much, the leftover glow of its formation and the slow settling of its interior, a fact the later chapters return to when they reach the deep planet.

The inventory's most astonishing number is saved for last, because it reframes everything: Jupiter's gravitational reach. The planet's gravity dominates the solar system's architecture beyond Mars; it holds the Trojan asteroid swarms

trapped at stable points along its orbit, has carved the gaps in the asteroid belt that bear its name, has flung countless comets out of the solar system or into the Sun, and has, on the evidence the reader will meet in the later chapters, shaped the history of the inner planets' impacts. The reader should hold the closing image of this inventory: the solar system is not nine, or eight, planets in independent motion, but a structure with a small yellow star at the center, and one overwhelming secondary mass, and everything else dancing between them.

The inventory deserves one more entry, the planet's family census, because the numbers have moved within the reader's lifetime. Jupiter's confirmed moon count stood at sixteen for most of the twentieth century, the four Galilean worlds, a handful of small inner moons, and the few large irregulars the surveys of that era had caught. The current count, after the systematic surveys of the current century, is near a hundred, with the outer swarms still being filled in, and the reader should read the number with its uncertainty plainly stated: the small outer moons are kilometers across, found in deep survey exposures, confirmed by weeks of follow-up, and the census is a work in progress, growing by campaigns rather than by single discoveries. The planet's family, in short, is not a fixed list but a growing file, and the reader who checks the count in any given year will find it higher than the year before.

The census's method deserves its own note, because the reader should know how a moon is found. The small outer moons are discovered in deep survey images, long exposures of fields of stars, where a moon appears as a streak of light moving against the fixed background, and a candidate's confirmation takes weeks, the object re-imaged on successive nights until its orbit is pinned. The modern finds, hundreds of candidates from the big survey cameras, are confirmed in batches, and the batches' publication is why the count jumps by campaigns rather than by ones, and the reader should hold the honest caveat the discoverers state themselves: the smallest confirmed members are a kilometer across, the census is complete only to a few kilometers' size, and the family's true population, at the smallest sizes, is estimated in the thousands, a number the surveys of the next decades will watch climb as the planet's distant family, most of it still dark, comes into the light.

The king's numbers deserve a single digest, since the later chapters cite them constantly. The planet's mass is roughly two and a half times every other planet combined; its equatorial diameter is eleven times the Earth's; its day, the shortest of any planet, spins past in under ten hours, a pace that visibly flattens its profile at the poles; and its distance from the Sun, five times the Earth's, means its surface sunlight is barely a twenty-fifth as strong. Each number alone is a curiosity; together they are the operating conditions of

everything the book describes, from the striped winds to the crushing interior to the vast magnet on which the next chapters will spend whole pages.

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.