SAMPLE

Solar System Missions: Juno

Jupiter Up Close

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Contents

Introduction

Chapter 1: The Discovery of Juno

Chapter 2: Understanding Juno

Chapter 3: Key Characteristics of Juno

Chapter 4: The Science Behind Juno

Chapter 5: Observation and Measurement of Juno

Chapter 6: Important Features of Juno

Chapter 7: The Instruments: Nine Ways to Read a Giant

Chapter 8: The Lineage: Jupiter Observed

Chapter 9: Juno in Context

Chapter 10: Modern Understanding of Juno

Chapter 11: Research and Exploration of Juno

Chapter 12: Significant Discoveries About Juno

Chapter 13: Challenges and Mysteries of Juno

Chapter 14: Future Directions in Juno Research

Chapter 15: Fun Facts and Trivia About Juno

Chapter 16: Conclusion: The Significance of Juno

Conclusion

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

Introduction

Juno is the spacecraft that finally made Jupiter give up its truths. Launched by NASA on 5 August 2011 and inserted into orbit around the solar system's largest planet on 4 July 2016, Juno spent years looping over Jupiter's poles in a long ellipse designed to duck beneath its radiation belts and peer beneath its clouds, and the answers it returned have redrawn the giant planet: a core that is not solid but diluted, weather that reaches thousands of kilometers deep, cyclones stacked at the poles in geometric arrangements nobody predicted, a lumpy magnetic field with a spot of surprising intensity, and lightning in places the textbooks said it could not be.

The mission's name is its thesis. In Roman myth, Juno, the wife and sister of Jupiter, had the power to see through the clouds her husband drew to hide his mischief; the spacecraft named for her was built to see through Jupiter's clouds in the same spirit, using microwaves, infrared, ultraviolet, and gravity itself instead of divine eyes. The naming, like everything about the mission, is deliberate: Juno was proposed as a bargain, a focused, solar-powered orbiter that would answer a small list of huge questions about Jupiter's interior, atmosphere, magnetosphere, and origins, and it answered them with the discipline the bargain required.

The whole story follows here: the mission's origins in the New Frontiers competition and the choices that made it cheap, the five-year cruise and the Earth flyby, the risky orbit and the titanium vault that made it survivable, the instrument-by-instrument campaign that mapped Jupiter from its auroras to its core, the discoveries that rewrote the giant-planet textbooks, the extended mission's tours of the moons Ganymede, Europa, and Io, and the planned finale, a deorbit into the planet the goddess's namesake spent a decade interrogating. Juno is the deepest look humanity has ever taken at the king of the planets, and the chapters that follow carry what it saw, whole.

A note on sources and scale: the account given in these pages rests on the mission's published science, the gravity and interior papers, the atmosphere and magnetism results, and the mission's own releases, all public documents, and the numbers quoted, the orbit's period, the vault's mass, the depths and the altitudes, are the mission's own. Where the science is still being argued, the core's cause, the cyclones' stability, the text says so, because a mission this recent deserves the honesty its own scientists practice, and the reader who wants the frontier's edge can find it in the journals this book's results were first told in.

Chapter 1: The Discovery of Juno

The discovery story of Juno begins with a failure and a competition. In 2005, NASA selected the New Horizons mission to Pluto as the first flight of its New Frontiers program, the mid-sized, principal-investigator-led mission class created to do flagship-class science on a budget, and in 2007 the agency announced the competition's second round, soliciting proposals across a menu of targets that included a Jupiter orbiter.

The concept that won came from a team led by Scott Bolton of the Southwest Research Institute, built around a set of questions the Galileo mission had left unanswered: What is Jupiter's structure beneath the clouds? Does it have a rocky core, and how much water does it hold? What drives its magnetic field, and what does the planet's interior say about how the solar system formed?

The proposal's answer was an orbiter with a single radical choice: skip the friendly equatorial orbits of previous missions, whose radiation doses made close work impossible, and instead dive over the poles in a long, looping ellipse that slips through the gaps in Jupiter's radiation belts on every pass, spending as little time as possible in the killing zones.

The polar orbit, powered by sunlight and armored with the first titanium radiation vault flown on a planetary spacecraft, let a modest, roughly one-billion-dollar probe go where a flagship would have been needed before, and the selection of the mission in 2005-06 made it the second New Frontiers flight.

The name announced the mission's character. Juno, in myth, sees through the clouds her husband Jupiter hides behind; the spacecraft was built to do the same to the planet, and the naming, along with the mission's public outreach camera, the LEGO figurines of the god, the goddess, and Galileo bolted aboard as a joke that became a trademark, told the public what the mission intended: an unmasking.

The launch, on 5 August 2011 atop an Atlas V from Cape Canaveral, began a five-year cruise whose economy defined the mission: too heavy to reach Jupiter on a direct throw with its rocket, Juno used a deep-space maneuver and an Earth flyby, on 9 October 2013, borrowing the home planet's gravity for the final push and using the flyby to rehearse its instruments on the Earth-Moon system. The cruise's endgame, on 4 July 2016, was the mission's riskiest hour, a thirty-five-minute engine burn in Jupiter's shadow that the spacecraft had to execute on its own, with a radio silence the whole world listened past; the burn succeeded, and Juno entered the orbit it would hold for the rest of its life.

The discovery of Juno, as this chapter uses the word, is the finding that the bargain worked: the cheap, focused, polar-orbiting mission arrived intact, and the giant planet, for the first time in the space age, found itself watched from above its clouds by a patient goddess who could see through them.

The discovery chapter should record the mission's people, because New Frontiers missions are personal: Scott Bolton's team, the Southwest Research Institute and Lockheed Martin build, the navigation teams who threaded the orbit, and the scientists, co-investigators from across the country and the Italian and French partners whose instruments, the infrared imager above all, broadened the mission's reach. The team's character, a small group holding the questions for a decade, shows in the mission's tone, the public talks and the image releases that treat Jupiter as a shared inheritance, and the reader who has heard the mission's presentations knows the style, the cowboy-hatted principal investigator telling the planet's story like a neighbor's news.

The launch chapter should also credit the Atlas V, the rocket's first use for a planetary mission of this class, and the cruise's economy, the gravity assists and the deep-space maneuvers that turned a five-year wait into the mission's rehearsal period, since every instrument was checked, every sequence practiced, and the Earth flyby, the closest the spacecraft came to anything for five years, was the full dress rehearsal that found the instruments ready and the team sharp. The discovery of the mission, in the launch sense, is the discovery that the team's economy held: no crisis, no improvisation, a mission flown as drawn, the rarest thing in spaceflight and the standard this book's chapters will measure the mission by.

The discovery chapter's close belongs to the mission's founding document, the proposal's own promise: to look beneath Jupiter's clouds and learn how the giant formed, the promise the team wrote to win the competition and spent a decade keeping. The document's existence, public like everything in the program, means the reader can check the mission against its word, and the check is the discovery chapter's closing lesson: Juno promised four questions and answered them, a fidelity rare enough in any enterprise, and the mission's discovery story ends where it began, with the questions, now answered, printed in the record for anyone to read.

The mission's numbers deserve their plain statement early, because the design's audacity is arithmetic: a solar-powered craft flown where sunlight is a twenty-fifth of Earth's, three huge panels to make the fraction enough, a polar orbit threaded between the radiation belts and the cloud tops, and a bus built around a vault, the mass of the shielding a tenth of the spacecraft, all bought for the cost of a focused mission rather than a flagship's. The reader who

wants to know how the bargain worked should watch these numbers recur through the account, the arithmetic, conservative at every joint, the mission, affordable because it is precise, the cheapest way to weigh a planet, priced.

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.