# SAMPLE

## Cosmos Unveiled: Brown Dwarfs

Failed Stars

Aira Astralis

Free sample: Introduction & Chapter 1

putrabooks.github.io

**Buy the full book:**

Carousell carousell.sg/p/cosmos-unveiled-brown-dwarfs-ebook-pdf-1468089278

Payhip

# Contents

Introduction

Chapter 01: The Discovery of Brown Dwarfs

Chapter 02: Understanding Brown Dwarfs

Chapter 03: Key Characteristics of Brown Dwarfs

Chapter 04: The Science Behind Brown Dwarfs

Chapter 05: Observation and Measurement of Brown Dwarfs

Chapter 06: Important Features of Brown Dwarfs

Chapter 07: Brown Dwarfs in Context

Chapter 08: Research and Exploration of Brown Dwarfs

Chapter 09: Significant Discoveries About Brown Dwarfs

Chapter 10: Challenges and Mysteries of Brown Dwarfs

Chapter 11: Future Directions in Brown Dwarfs Research

Chapter 12: Fun Facts and Trivia About Brown Dwarfs

Chapter 13: Conclusion: The Significance of Brown Dwarfs

Chapter 14: Conclusion: The Significance of Brown Dwarfs

Conclusion

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

# Introduction

Somewhere between the smallest true stars and the largest planets lies a class of objects that took most of the twentieth century to find. They are built of the same stuff as stars, they form the same way stars do, collapsing out of cold clouds of gas, and they shine briefly with the heat of their own birth, but they never gathered enough mass to light the hydrogen fusion that keeps a star burning. These are the brown dwarfs: substellar, lukewarm, and common enough that they may outnumber the stars themselves.

The hunt for them was long precisely because they are so dim. For decades they were a category without a specimen, predicted in theory, named in frustration, and mistaken in practice for red dwarfs, for distant giant planets, and for each other. Once the infrared sky opened to surveys in the 1990s, the logbooks filled fast: hundreds, then thousands, spanning a range of temperatures cooler than a kitchen oven and a menagerie of atmospheres where iron falls as rain and weather is made of mineral dust.

This book follows that story in full: the naming and the century-long search, the physics that both powers and limits these objects, the spectral classes invented to sort them, the disks and planets found around them, and the deep questions they now anchor about where stars end and planets begin. They are also, quietly, one of the best-studied warnings in astronomy about how much of the universe hides in plain sight, warm little worlds glowing feebly at the edge of visibility, waiting only for instruments built to see them.

# Chapter 01: The Discovery of Brown Dwarfs

Because of this, alternative names for these objects were proposed, including planetar and substar. In 1975 Jill Tarter, as part of her PhD thesis at University of California at Berkeley was the first to suggest that the term to describe these objects should be brown dwarf, using brown as a color "somewhere between red and black", suggesting that the dwarfs appeared dim, dark, and dull, even though not exactly brown.

The term black dwarf continues to be used to refer to a white dwarf that has cooled to the point that it no longer emits significant amounts of light. However, the time required for even the lowest-mass white dwarf to cool to this temperature is calculated to be longer than the current age of the universe; hence such objects are expected to not yet exist.

Early theories concerning the nature of the lowest-mass stars and the hydrogen-burning limit suggested that a population I object with a mass less than 0.07 solar masses (M solar masses) or a population II object less than 0.09 M solar masses would never go through normal stellar evolution and would become a completely degenerate star. The resulting brown dwarf is sometimes called a failed star. The first self-consistent calculation of the hydrogen-burning minimum mass confirmed a value between 0.07-0.08 solar masses for population I objects.

The discovery of deuterium fusion down to 0.013 M solar masses (13.6 MJ) and the impact of dust formation in the cool outer atmospheres of brown dwarfs in the late 1980s brought these theories into question. However, such objects were hard to find because they emit almost no visible light. Their strongest emissions are in the infrared (IR) spectrum, and ground-based IR detectors were too imprecise at that time to readily identify any brown dwarfs. Since then, numerous searches by various methods have sought these objects.

These methods included multi-color imaging surveys around field stars, imaging surveys for faint companions of main-sequence dwarfs and white dwarfs, surveys of young star clusters, and radial velocity monitoring for close companions. For many years, efforts to discover brown dwarfs were fruitless: they are very faint and emit most of their light in the near-infrared part of the spectrum. Then in the mid-1990s several brown dwarfs were found. In 1994, Spanish astrophysicists Rafael Rebolo (head of the team), Maria Rosa Zapatero-Osorio, and Eduardo L.

Martin discovered a confirmed class "M" brown dwarf. This object, found in the Pleiades open cluster, received the name Teide 1. Teide 1 was discovered in images collected by the IAC team on 6 January 1994 using the 80 cm

telescope (IAC 80) at Teide Observatory, and its spectrum was first recorded in December 1994 using the 4.2 m William Herschel Telescope at Roque de los Muchachos Observatory (La Palma).

The distance, chemical composition, and age of Teide 1 could be established because of its membership in the young Pleiades star cluster. Using the most advanced stellar and substellar evolution models at that moment, the team estimated for Teide 1 a mass of 55 +/- 15 MJ, which is below the stellar-mass limit. The object became a reference in subsequent young brown dwarf related works.

In theory, a brown dwarf below 65 MJ is unable to burn lithium by thermonuclear fusion at any time during its evolution. This fact is one of the lithium test principles used to judge the substellar nature of low-luminosity and low-surface-temperature astronomical bodies. High-quality spectral data acquired by the Keck 1 telescope in November 1995 showed that Teide 1 still had the initial lithium abundance of the original molecular cloud from which Pleiades stars formed, proving the lack of thermonuclear fusion in its core.

These observations fully confirmed that Teide 1 is a brown dwarf, as well as the efficiency of the spectroscopic lithium test. For some time, Teide 1 was the smallest known object outside the Solar System that had been identified by direct observation.

Since then, over 1,800 brown dwarfs have been identified, even some very close to Earth, like Epsilon Indi Ba and Bb, a pair of brown dwarfs gravitationally bound to a Sun-like star 12 light-years from the Sun, and Luhman 16, a binary system of brown dwarfs at 6.5 light-years from the Sun. The first class "T" brown dwarf was discovered in 1994 by Caltech astronomers

Shrinivas Kulkarni, Tadashi Nakajima, Keith Matthews and Rebecca Oppenheimer, and Johns Hopkins scientists Samuel T. Durrance and David Golimowski.

It was confirmed in 1995 as a substellar companion to Gliese 229. Gliese 229b is one of the first two instances of clear evidence for a brown dwarf, along with Teide 1. Confirmed in 1995, both were identified by the presence of the 670.8 nm lithium line. The latter was found to have a temperature and luminosity well below the stellar range.

Its near-infrared spectrum clearly exhibited a methane absorption band at 2 micrometres, a feature that had previously only been observed in the atmospheres of giant planets and that of Saturn's moon Titan. Methane absorption is not expected at any temperature of a main-sequence star. This discovery helped to establish yet another spectral class even cooler than L

dwarfs, known as "T dwarfs", for which Gliese 229b is the prototype.

This means that the protostar is not massive or dense enough ever to reach the conditions needed to sustain hydrogen fusion.

Before the first confirmed find, the search itself had a long and instructive history of false alarms. The early candidates came out of proper-motion surveys, photographic plate collections searched star by star for faint red objects drifting against the background, and several times an announcement of a brown dwarf candidate made the news before better data revealed an ordinary red dwarf, a distant giant, or a measurement error. Those reversals taught the discipline caution: claims began to be hedged with the lithium test, the methane test, and mass estimates wide enough to be honest. By the time the 1990s infrared surveys opened the sky to the right wavelengths, the criteria had been argued so many times that confirmation could be fast, and the objects, once found, stuck.

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.