

# Introduction

We are happy and proud to present volume four of *Annals of the Deep Sky*, in which we continue our survey of prominent stars and deep-sky objects in all 88 constellations. With this volume, we are approaching a quarter of the way to completion, though, speaking realistically, we know we have only just begun. (Ever notice how many constellations begin with the letter C?)

We always welcome reader feedback and from what we have heard, the response from the first three volumes has been overtly positive, even enthusiastic. We are thankful (and not a little relieved) that we seem to have pleased just about everyone. Among the numerous reviews, online discussion boards, and remarks from star party attendees, we've not heard one discouraging word. Most gratifying was the reader who likened receiving a new volume to embarking on a journey of exploration.

Readers may not be aware of this, but our labors on this series have taken us on an exciting journey as well. If you dig deeply into almost any subject you come across interesting tidbits sooner or later, but when the subject is the *universe*, one never ceases to be amazed. For us, it is a constant state of being. Each day we come across some eye-opening perspective that allows us to depict the celestial objects we profile as real, physical entities, not abstractions removed across vast gulfs of space. We strive to present stars, nebulae, and galaxies as objects you can pick up and examine as you would an interesting shell or piece of driftwood on the beach, except that we also relate how the shell or driftwood got there, why it has its unique shape, and what form it will take over time. Our discoveries are your discoveries, as is our surprise and astonishment.

This volume spotlights four constellations: Canis Minor, Capricornus, Carina and Cassiopeia. Canis Minor is not often at the top of anyone's observing list, but like its bigger brother, Canis Major, it contains a prominent first-magnitude star, Procyon, with a white dwarf companion nearly hidden in the primary's glare. The orbit of Procyon B itself is nearly circular, but the periastron and the apastron junctures are rather extreme, ranging from a minimum distance of 9 AU to a maximum of 21 AU. Given that apastron occurs sometime around the year 2027, now is a good time to begin looking for Procyon B.

Procyon has been studied using the rapidly developing technique of asteroseismology, the analysis of stellar oscillations. The different oscillation modes act as seismic waves, allowing astronomers to probe its internal structure and determine the physics occurring deep within its various layers. Starlight tells us much about a star's temperature and chemical makeup, but asteroseismology allows us to view the star from the inside out.

A running theme in the Galactic section of Canis Minor is the number of asterisms and suspect star clusters to be found within its bounds. NGC 2394 is one of these. Although most research suggests it is not a real cluster, other studies contradict this conclusion. There doesn't seem to be as much debate about the reality of Dolidze 26, other than it consists of about 30 or 40 unrelated stars scattered about 4.5-magnitude 6 Canis Minoris in the northern reaches of the constellation. Still, we include this one and a few others because we know there are a number of observers out there who like to seek out these faux clusters.

Capricornus is another low-profile constellation, but it does contain Dabih ( $\beta$  Capricorni) that forms a quadruple system definitely worth telescopic scrutiny. Without doubt, the jewel of the Sea Goat is the globular cluster M30, an old object with an extremely dense core and radiating star chains. It is thought that the central density may exceed a million stars per cubic parsec, making it one of the highest-density environments in the Galaxy. Life forms living on a planet in such a locale would never know a night sky, except, perhaps, under

rare conditions, reminding us of Isaac Asimov's science fiction short story, "Nightfall."

For the galaxy enthusiast, Capricornus also features a double galaxy, NGC 6907 and NGC 6908. The larger system, NGC 6907, is an easy find, but see if you can spot its companion, "hidden" in the other's easternmost spiral arm.

Our next starry fare is Carina, the Keel, formerly known as Argo Navis. What can we say about this sprawling and incredibly bountiful constellation? Dennis has deemed it our masterpiece, and truth be told, there was no shortage of celestial marvels to chronicle and illustrate. We think it safe to say (as much as modesty allows) that our review of the uncanny, volatile star Eta Carinae is one of the more comprehensive available in the popular literature today. Given its enduring observational history and abundance of cutting-edge research, it is deserving of its own book-length treatment. Be sure to check out our three-dimensional presentation of the curious bipolar nebula encompassing this star, called the Homunculus, as well as the star's laser emission and light echoes from the "Great Eruption" in the 1840s.

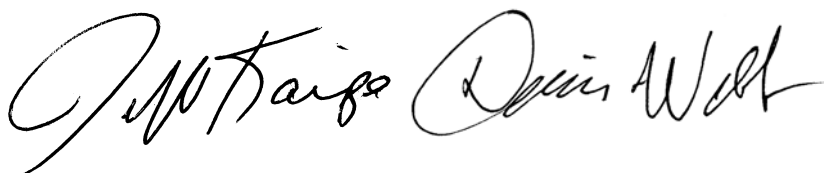
Of course, there are numerous other objects to explore in Carina, not the least of which is the Carina Nebula (NGC 3372), which lies just east of the dark, hourglass-shaped Keyhole Nebula; NGC 2516, also known as the Southern Beehive; the planetary NGC 2867 with its hot Wolf-Rayet central star; and the extremely rich globular cluster NGC 2808. The southern region of Carina, away from the Milky Way, also harbors a number of fascinating galaxies, including the pair IC 2554 and NGC 3136B, NGC 3136, a bright elliptical with some internal structure, and, for imagers, an intriguing face-on spiral, NGC 3059.

Given its location immersed in the northern Milky Way, Cassiopeia features myriad stars and nonstellar objects of all kinds. Among the former, we offer Caph ( $\beta$  Cassiopeiae), the brightest member of the class of Delta Scuti stars, four Mira-type variables, the triple star Iota ( $\iota$ ) Cassiopeiae, and the massive binary AO Cassiopeiae. Of the latter selection, we include

the young planetary nebula IC 289, the bright open clusters M52 and M103, and the extensive star-forming region (with associated star cluster) IC 1805. In the northern part of the constellation, we find two satellites of the Andromeda Galaxy, the dwarf ellipticals NGC 185 and NGC 147. Those with an abiding interest in the history and ongoing research into the supernovae remnants Tycho's Star (SN 1572) and Cassiopeia A will find plenty to mull over, as well as a sidebar on the eccentric Tycho himself.

If each volume is truly like a journey of exploration, we hope you think of us as travel guides, pointing out the most interesting aspects of the astronomical sights we encounter. We are all at the beginning of an adventure without comparison, and without end.

September 2016

The image shows two handwritten signatures in black ink. The signature on the left is 'Jeff Kanipe' and the signature on the right is 'Dennis Webb'. Both are written in a cursive, flowing style.

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