DEEP-SKY COMPANIONS

The Secret Deep

In this fresh list, Stephen James O'Meara presents 109 new objects for stargazers to observe. *The Secret Deep* list contains many exceptional objects, a piece of the only supernova remnant known visible to the unaided eye; the flattest galaxy known; the largest edge-on galaxy in the heavens; the brightest quasar; and the companion star to one of the first black hole candidates ever discovered. Each object is accompanied by beautiful photographs and sketches, original finder charts, visual histories, and up-to-date astrophysical information to enrich the observing experience. Featuring galaxies, clusters, and nebulae not covered in other Deep-Sky Companions books, this is a wonderful addition to the series and an essential guide for any deep-sky observer.

Author of several highly acclaimed books, including others in the celebrated Deep-Sky Companions series, Stephen James O'Meara is well known among the astronomical community for his engaging and informative writing style, and for his remarkable skills as a visual observer. O'Meara spent much of his early career on the editorial staff of *Sky & Telescope*, before joining *Astronomy* magazine as its Secret Sky columnist and a contributing editor. An award-winning visual observer, he was the first person to sight Halley's Comet on its return in 1985, and the first to determine visually the rotation period of Uranus. One of his most distinguished feats was the visual detection of the mysterious spokes in Saturn's B-ring before spacecraft imaged them. Amongst his achievements, O'Meara has received the prestigious Lone Stargazer Award, the Omega Centauri Award, and the Caroline Herschel Award. Asteroid 3637 was named O'Meara in his honor by the International Astronomical Union. In his spare time, O'Meara travels the world with his wife, Donna, to document volcanic eruptions. He is a contract videographer for National Geographic Digital Motion, and a contract photographer for National Geographic Image Collection.

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STEPHEN JAMES O'MEARA

with object photos by

Mario Motta

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To Donna,
My love for you is fathomless.

To Daisy Duke, such a joy,
My secret writing companion.

And in memory of Milky Way, Miranda-Pyewacket, and Pele,
My spirits in the sky.

Contents

Preface

The Secret Deep is the fourth title in my Deep-Sky Companions series – the other three books are *Deep-Sky Companions: The Messier Objects*, *Deep-Sky Companions: The Caldwell Objects*, and *Deep-Sky Companions: Hidden Treasures*. Like the third companion, *The Secret Deep* is an important work because it brings to light a new list of 109 deep-sky objects visible in small telescopes under a dark sky. None of the objects in the Secret Deep list appear in the Messier, Caldwell, or Hidden Treasures catalogues; I've included an additional 20 objects in Appendix B. Owners of this series, then, have at their fingertips more than 450 deep-sky objects to explore.

All the Secret Deep objects are visible from mid-northern latitudes, though five or fewer are best seen from more southerly locations in the Northern Hemisphere or further south. Still, the most southerly object in the Secret Deep list – globular cluster NGC 2298 in Puppis – lies at a declination of −36° exactly, so it is only 1¼° further south than open cluster M7 in Scorpius, the most southerly Messier object. From the latitude of New York City, NGC 2298 will be 9° above the southern horizon when highest.

I have taken great care to select objects visible through my new 5-inch Tele Vue f/5 refractor (see Chapter 1) under a clear, dark sky. As with some objects in the Hidden Treasures list, several of the Secret Deep objects are surprisingly bright – including some open star clusters visible in binoculars and to the unaided eyes, a few galaxies more apparent than the dimmest Messier ones, and a couple of planetary nebulae with central stars you can spy through large binoculars. Take, for instance, 10.7-magnitude IC 4593 – the White-Eyed Pea planetary nebula in Hercules. A 2½-inch refractor can easily sweep up this object, but many fail to see it because they are fooled by its starlike form at low and moderate powers. But this striking planetary, consisting of a complex system of asymmetrical shells, is a glorious little gem at high magnifications; I've viewed it with magnifications up to 100× per inch of aperture! Then there's NGC 5846 in Virgo; this fantastic elliptical galaxy not only flanks the celestial equator, but its size and brightness rivals many Messier galaxies in the Coma–Virgo Cluster.

Again (and I never get tired of repeating this), despite popular belief, the famous Messier catalogue is not a list of the "brightest and best" deep-sky objects for small telescopes. It is a catalogue of objects *compiled* by the eighteenth-century French comet hunter Charles Messier (he did not discover many of these objects), who believed they could be confused with comets "just beginning to shine." Like *Hidden Treasures*, the Secret Deep list is an extension of the Messier catalogue – a deep-sky list for the twenty-first-century observer. In fact, two Secret Deep objects could very well be considered true Messier objects: Messier mentions NGC 5195 (Secret Deep 67) in his description of M51 but does not give it an individual listing. And there's an argument that NGC 3953 (Secret Deep 48) is actually M109.

HOW THE 109 SECRET DEEP OBJECTS WERE SELECTED

The purpose of this book is simple. It's designed to help you continue to explore the infinite wonders that populate the

starry heavens and enrich your observing experience. As with my Hidden Treasures list, it would be wrong to call any of the Secret Deep objects "the best," because what's "best" is highly subjective. (What one person claims is "the best" others might not agree.) It would be fair to say that the 109 selections in the Secret Deep are all deep-sky splendors worthy of your attention.

The Secret Deep list is actually an extension of the Hidden Treasures list. Both were created, in part, by the collective "you." While researching *Hidden Treasures*, I came up with more than enough objects to fill the table. The "remainder" then became the foundation of a new list of 109 objects that I decided to call "The Secret Deep." That new list expanded after I completed my *Herschel 400 Observing Guide* (Cambridge University Press, 2007), which alerted me to some fascinating deep-sky objects I hadn't previously encountered. Once I received my new telescope, I began to re-observe all these objects with a fresh eye.

With that telescope, I also resurveyed the night sky, constellation by constellation, for other bright or interesting objects that would be visible to amateurs living in the Northern Hemisphere – ones not already listed in the Messier, Caldwell, and Hidden Treasures catalogues. When the list grew to more than 200 objects, I decided to whittle it down. I did so, in part, by comparing my findings against those in the popular deep-sky object lists published by the following astronomical societies:

- "Herschel 400": Ancient City Astronomy Club (St. Augustine, Florida)
- "Additional Objects": Hawaiian Astronomical Society
- "Best Objects in the New General Catalog": A. J. Crayon and Steve Coe, Saguaro Astronomy Club (Phoenix, Arizona)
- "Finest N.G.C. Objects": Alan Dyer, Royal Astronomical Society of Canada
- "TAAS 200": The Albuquerque Astronomical Society (New Mexico)

As you can see in Appendix C, 51 percent of the Secret Deep objects appear in these other lists: this is remarkable given that, unlike the Secret Deep list, many of these lists include objects only in the NGC; they also include objects in the Messier, Caldwell, and Hidden Treasures catalogues! The Secret Deep list contains 97 NGC objects, and fully 75 percent of these appear in the other lists.

The final 109 Secret Deep objects comprise 38 galaxies, 23 open star clusters, 18 planetary nebulae, 15 bright nebulae (some with clusters embedded in them), 11 globular star clusters, 1 supernova remnant, 1 asterism, 1 quasar, and 1 black hole (the visible companion star). The table compares the number and types of deep-sky objects covered in all four catalogues.

Owners of all four titles in the Deep-Sky Companions series will have the most up-to-date astrophysical and visual information on 436 deep-sky objects, with ancillary data on many more. And since the astrophysical, visual, and tabular data in *The Secret Deep* have been gleaned from many of the same sources in the other three volumes, you can compare the data with confidence. No other series of books to my knowledge offers observers such consistent data.

Object comparison table

Object type	Messier Catalogue	Caldwell Catalogue	Hidden Treasures Catalogue	Secret Deep Catalogue
Open star clusters	27	28	38	23
Galaxies	39	35	35	38
Globular star clusters	28	18	8	11
Bright nebulae	7	12	8	15
Planetary nebulae	4	13	14	18
Dark nebulae	0	1	1	0
Supernova remnants	1	2 segments of 1	0	1
Star clouds	1	0	0	0
High-proper-motion stars	0	0	1	0
Double stars	1	0	0	0
Asterisms	1	0	4	1
Quasars	0	0	0	1
Black holes	0	0	0	1

The Secret Deep list has many superlative and fascinating objects. These include a planetary nebula whose last thermal pulse has produced a circumstellar shell similar to the one expected in the final days of our Sun's life, a piece of the only supernova remnant known that's visible to the unaided eye, the flattest galaxy known, the largest edge-on galaxy in the heavens, the brightest quasar, and the companion star to one of the first black hole candidates ever discovered.

And there's much more. Several of the open clusters are not only double but also possible binary clusters, being physically related. Some of the nebulae (vast swaths of dust and vapor) form fanciful shapes (a flying fox, cosmic rosebud, and fossil footprint, for instance). Many of these clouds of nascent matter harbor new stars and those still in the process of formation. There's also an abundance of globular star clusters. These ancient stellar "cities," which populate the outskirts of our Galactic disk and halo, contain tens to hundreds of thousands of suns. Held together by the fantastic bond of gravity, these stellar congregations may be as old as the universe itself.

You'll also find many starburst galaxies (extragalactic systems that can manufacture suns at the phenomenal rate of hundreds of millions per year), cannibalistic galaxies (those consuming their dwarf neighbors), interacting pairs of galaxies, and grand-design spiral systems with supermassive black holes at the center of their active galactic nuclei.

In Chapter 1, "About this book," I discuss the telescopes I used to observe the Secret

Deep objects, my observing site and methods, helpful observing hints, and more. Since the history, astrophysics, and visual descriptions of many of these objects have never been described at length in any other popular work, this chapter also explains my approach to presenting the information.

I detail the 109 Secret Deep objects in Chapter 2. In many cases the essays describe recent observations from the Hubble Space Telescope, the world's largest ground-based telescopes, and a fleet of spacecraft that now peer (or have peered) into the universe with X-ray and infrared-sensitive "eyes." The essays are also flush with historical anecdotes and some have a dash of mystery (such as whether NGC 3953 is the real M109, and whether NGC 5195 should become the mysterious M102). Those interested in the history of astronomy will not be disappointed. The Secret Deep list includes objects discovered by many great astronomers from the eighteenth, nineteenth, and twentieth centuries, including William and John Herschel, but also Per Collinder, James Dunlop, Williamina Paton Fleming, Beverly T. Lynds, Albert Marth, Lord Rosse, Édouard Jean-Marie Stephan, Jürgen Stock, Wilhelm Tempel, and others.

Since some of the objects will present a visual challenge, especially to novice observers, I try to help as much as possible in the related essays by offering tips on how best to succeed in your search. It's also important to note that some of the nebulae in the list may appear quite small to visual observers, but they transform into magnificent cloudscapes in CCD images. In fact, this is the first book in the Deep-Sky Companions series that considers the astro-imager, whose efforts in the field I appreciate just as much as I do those employing the eye alone. Just take a moment to scan the gorgeous images of each Deep Sky object as captured by Mario Motta, whose work is featured in the book (see also Chapter 1). The details are stunning, the framing, exquisite.

Several appendices complete the work. Appendix A tabulates each Secret Deep object's position, constellation, type, apparent magnitude, and angular size. Appendix B does the same for the 20 additional Secret Deep objects. Appendix C is a table that lists each Secret Deep object and shows which astronomical societies considered it be one of the finest in the night sky. Appendix D is a list of photo credits, and at the end of the book is a Secret Deep checklist – a place for you to make personal notations on each object you find; it includes spaces for you to write down important information, such as the date observed, your location, the telescope and magnification used, atmospheric seeing and transparency, and any other special notes you want to record. It is a personal log that you can return to weeks, months, or years, later to see how you are progressing as an observer.

Deep-Sky Companions: The Secret Deep is not only a valuable resource or companion volume; it is *your* companion to take with you under the stars. I want the words to speak to you as you search, as if I were there to help guide you. It's difficult in our hobby sometimes to be alone under the stars. I want you to know that you are not; I am there with you in spirit. We all share a common bond – a love for the night. Not only do I want to encourage you to observe, to push yourself to new

limits, but to enjoy a shared camaraderie. As I often tell my wife, Donna, when we are apart traveling, "No matter how many miles separate us, we can still share the sky."

I've written each essay so that you can not only enjoy your time with it under the stars, but also in the daytime, or on those cloudy nights. I hope you enjoy reading the histories and science of these glorious objects. We have come so far in our knowledge of the night and the things we seek out with our "star ships." I want to share with you that realized wonder.

I would like to thank Vince Higgs, Lindsay Barnes, Caroline Brown, and the editorial staff at Cambridge University Press for their encouragement, help, and support in this book and the Deep-Sky Companions series. I applaud Al and David Nagler of Tele Vue Optics in Chester, New York, for making such superb refracting telescopes that help me to dive deep into the visible universe.

I give special thanks to my longtime friend Mario Motta for taking the time to create the wonderful images of the Secret Deep objects he imaged with his 32-inch reflector – a part of his home! I thank Harvard astronomer and historian Owen Gingerich for looking over the interesting histories of some of the deep-sky objects whose discoveries have ties to Harvard College Observatory.

I thank my friend and colleague Larry Mitchell of Houston, Texas, for supplying me with William Herschel's original notes, which he drew from his original catalogues as they appeared in the *Philosophical Transactions of the Royal Society of London*; your kindness has been invaluable. Thank you to Terry Moseley, John M. Farland, and Wolfgang Steinicke for their help with Lord Rosse's discovery of NGC 3165. And a big bow goes out to the large pool of professional astronomers (many of whom are listed as the authors or principal investigators of professional papers on the objects being discussed) who took the time to look over the science presented in this book; you've enriched the text so much with your words and wisdom. Of course, if any errors have crept their way into this book, I'm responsible.

Finally, I would like to express my love for my beautiful wife, Donna, and Daisy Duke, our loving papillon, for standing beside me on this long journey; I thank you for your love, support, and understanding.

Well, it's time for you to go forth under the stars, pick away at the Secret Deep, and savor each galactic and extragalactic treat. Good luck.