CHAPTER 1
About this book

Beauty is a manifestation of secret natural laws, which otherwise would have been hidden from us forever. Johann Wolfgang von Goethe (1749–1832)

I HAVE BEEN STARGAZING FOR NEARLY half a century. But I have yet to see all the sky's bright telescopic wonders. I don't mind. I'm in no rush. Unlike time and tide, the deep-sky objects we seek seem to hang around and wait for us to care. I suspect we all care. But I also understand that the task of seeking out these wonders without some guidance can be overwhelming. I felt that way recently when I forgot my star atlas on one very clear night. The stars shined down in magnificent splendor, the Milky Way appeared rich and pure, a marvel to behold. But I also felt a sense of loss, in that, without an atlas in hand, I didn't know where to point my telescope to find new wonders. The fact is, when it comes to taking any journey, guidance helps.

That's why I write these books. By sharing with you lists of celestial objects that have inspired me over the years, I hope to chart a course for you through the stars, to help you see its deep-sky splendors and enrich your time under the night sky. Besides, half the fun of any journey is sharing what we've learned along the way. This book is my latest message to you about yet another "romp" through the heavens and the wonders I have seen.

As silent as the sky may appear, it has a voice. It's the inner voice we listen to each time we look through our telescopes. It cheers us on during the excitement of the search, and celebrates with us each time we find a new target. It influences our thoughts and inspires emotion. It adds significance to our nights and makes us

yearn for more. If anything, in the Deep-Sky Companions series, I've tried to use my inner voice, to inspire you to find your own teller of secrets, so that you too can share the joy of astronomy with others. It's how we grow both personally and spiritually.

The Secret Deep objects are a rich assortment of visual and photographic gems that can add depth to your observing experience. They're all relatively bright, some more obvious than others, with a sprinkling of visual challenges. Admittedly, beyond the bright and obvious Messier objects, we have to search for fainter and less conspicuous wonders, but wonders nevertheless. Besides, I'd argue that many of the faint fuzzy objects we like to seek

require half eyesight and half imagination to "see." I'm not talking about the "bad" imagination – the one that leads us to see things that don't exist – but the good imagination that fires up that special background knowledge of what we're actually looking at.

That's why the CCD images that Mario Motta took of these objects are so special. They help add a visual perspective not attainable in that type of detail with the eyes alone. It's like being in an art gallery looking at Van Gogh's *Starry Night* and trying to see beyond the canvas, into the creator's mind. In our quest, we satisfy our visual appetites by not only looking at CCD images, but also reading about the history and physics of each object. Indeed, many of these objects have been studied with large ground-based and space telescopes in all wavelengths of light. So we have a lot to ponder as we look through our telescopes. It's an exciting time to be an amateur astronomer. We have at our fingertips greater insight into the nature of the universe than ever before. This book, like its companions, will help you to see how astronomers have peeled back the onion layers of understanding over the years to give you the best and present knowledge of each wonder.

THE TELESCOPE AND SITE

There has been a change. The Tele Vue 4-inch f/5 Genesis refractor I used to observe all the objects in the three preceding Deep-Sky Companions series of books, as well as my *Herschel 400 Observing Guide*, is no longer in my possession. I loved (and still do love) that scope. It had been my observing partner for 13 years. But in 2007, Tele Vue founder Al Nagler and I had one of those eerie, simultaneous light-bulb moments. I felt it was time for me to graduate to a slightly larger telescope; at the same time, I wanted to somehow pass on my observing "torch" (the Genesis) to another observer. When we talked, Al not only understood, but he had already thought of the solution.

It turned out that he was considering donating his prototype of the 13-mm Nagler ultrawide eyepiece to the Springfield Telescope Makers, the amateur astronomy and telescope-making club that sponsors the annual Stellafane convention on Breezy Hill, Vermont. Al suggested we unite the Genesis refractor (with an autographed tube, and the accessories I used including three eyepieces (22-mm Panoptic eyepiece, and 7- and 4.8-mm Nagler eyepieces), 2-inch star-diagonal (with a 1¼-inch adapter), 1.8× Barlow, Tele Vue Qwik-Point finder, and original carrying case) and his prototype 13-mm Nagler, and jointly auction them off on eBay. The proceeds from the sale, he said, would be donated to the Stellafane convention to help defray the cost of Stellafane's recently completed Flanders Pavilion.

Al's thinking was most appropriate: The Stellafane convention, whose roots date to the 1920s, inspired a revolution in amateur telescope making; Al's 13-mm Nagler inspired a renaissance in deep-sky observing that began in the 1980s and continues to this day; and Tele Vue's Genesis refractor has been referred to as "*the* catalyst for todays growing popular 4-inch APO market." The auction closed on August 17, the Genesis refractor and Al's historic eyepiece have found a new home, and the money earned was donated to Stellafane.

What I now have in my possession is a beautiful Tele Vue NP-127 Nagler-Petzval 5-inch (660-mm) f/5.2 apochromatic refractor with a redesigned four-element optical system that offers me not only crisp wide-fields of view with 2-inch eyepieces, but also high-power capability with 1¼-inch eyepieces. And by high power, I mean, at times, I have pushed the instrument to its extreme: 100× per inch of aperture, especially with planetary nebulae. Note that, throughout Chapter 2, I generally refer to this telescope simply as "the 5-inch."

My arsenal of eyepieces consists of four workhorses: a Tele Vue 20-mm Nagler type 5 (33×), Nagler 11-mm type 6 (60×), Nagler 7-mm type 6 (94×), and Nagler 2–4-mm zoom (330×–165×). I also have a Tele Vue 3× Barlow, which offers me more magnification options up to 990×; as a rule, I generally go no higher than 495×, but I must admit that, on occasion (again with small and bright planetary nebulae), I've gone as high as 990×.

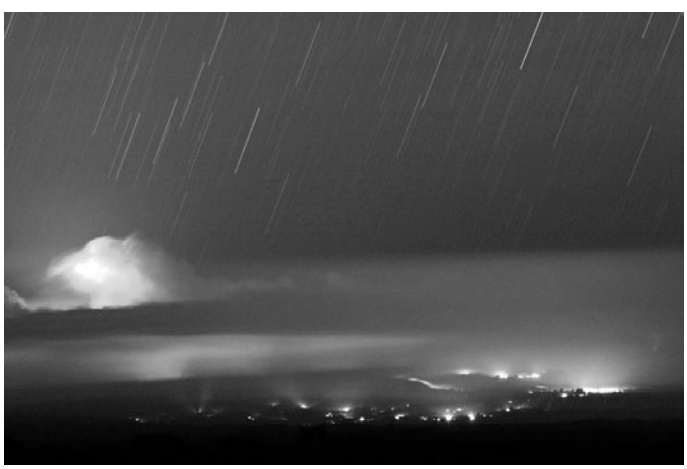
As a finder I use a Tele Vue Starbeam (it's like a laser pointer). The NP-127 offers me a field of view near 2.4° wide when I use the 20-mm Nagler. The telescope sits in the cradle of a sturdy Gibraltar mount, and the entire setup can be broken down in a couple of minutes in case I need to be mobile.

All the observations for this book were from my front yard in Volcano, Hawaii, which is at an altitude of 3,500 feet (1,100 m). I used to observe near the summit of Kilauea volcano in Hawaii's Volcanoes National Park, but something dramatic changed the environment and the landscape: On March 19, 2008, after I had finished my observations for the *Hidden Treasures* and *Herschel 400 Observing Guide*, Kilauea had its first summit explosion since 1924.

Since then, large swaths of the volcanic caldera have been off-limits, and dust and ash remain a problem there to this day; the summit eruption continues to enlargen a new vent inside Halemaumau crater, which also contains a glowing lava lake. So, while viewing the volcano is an awesome sight at night, it can also be less than ideal for looking at the stars on some "bad air" days (see the photo at the opening of this chapter).

Once I began observing at home, I actually found the "journey" very peaceful. I didn't have to drive anywhere, contend with car headlights in the Park, or the issues of volcanic smog (vog) and particle fallout – though now our home sits between two erupting vents and the vog conditions can be a problem here when the winds shift. The photo below shows vog over the town of Volcano at night from the "second" erupting vent, called P'u O'o.

Another benefit of observing from home was that I no longer had to "migrate" to avoid the ins and outs of the island's whimsical clouds or of curious passersby. No. If the clouds rolled in, all I had to do now was sit back in a chair, take a sip of hot chocolate, look up at the sky in the comfort of my home, and wait. Besides, although the telescope I have today is only 1 inch wider in aperture than my Genesis, it's a little bit heavier (perhaps Al thought I needed more exercise). But seriously, the night sky as seen from my house is no different than that up on the volcano's summit, which is just a few miles away. I can see the zodiacal light and band, as well as the gegenschein, from my home. I also get to run inside whenever something wonderful is out, so I can share it with Donna. It's been a wonderful and calming experience, working on this book, and I appreciate the sky I have.



In addition to the Tele Vue 5-inch, I also used 10 × 50 Meade binoculars, and, on occasion, a nineteenth-century brass telescope made by Ross of London, which I simply refer to as "the antique telescope" in Chapter 2. It's the same antique telescope I used to observe some of the Hidden Treasures. The tube measures 17⅛ inches when open, and 7¼ inches when closed. The 1¾-inch objective is in excellent condition.

HOW TO USE THIS BOOK

To find a Secret Deep object, first locate its position on the wide-field finder chart that opens each entry. The chart not only gives you a wide-field view of the constellation it's in, but marks the location of the object relative to bright nearby stars (those with Greek letters or Flamsteed numbers). Next, locate those stars on the detailed finder chart that accompanies the object's photograph and text. Both the wide-field finder charts and the detailed finder charts are oriented with north up and east to the left. Finally, find the part of the text that describes how to locate the object and simply follow the directions.

After the full-page wide-field finder chart, each object's entry in Chapter 2 opens with an image of the object (oriented with north up and east to the left, unless otherwise noted) and a table of essential data: Secret Deep number; common name(s), if any; object type; constellation; equinox 2000.0 coordinates; apparent magnitude; angular size or dimensions; surface brightness in magnitudes per square arcminute (for most objects) and a personal rating of the object's ease of visibility from 1 (difficult) to 5 (easy); distance; and the object's discoverer and discovery date.

Note that you don't have to use the charts in this book. Since I provide the object's equinox 2000.0 coordinates, you can instead employ your favorite detailed sky atlas (such as Wil Tirion's *Sky Atlas 2000.0*) to locate the object. The choice is yours. The charts I created have a simple design. I've tried not to clutter them up with unnecessary details. They are designed to help you make the simplest and fastest sweep to each object, based on my personal experience. You might think otherwise, and I encourage you to pursue whatever venue you find suitable to your needs. Otherwise, my charts should be easy to read and simple to use.

Below the table you'll find William Herschel's original published description of the object, or, if William did not observe the object, his son John's. If neither observer discovered or observed the object, that section is blank. Larry Mitchell, a member

of the Houston Astronomical Society, supplied me with William's original notes, which he drew from his original catalogues as they appeared in the *Philosophical Transactions of the Royal Society of London*.

Most of the John Herschel quotations have been gleaned from those given by the "Deepsky Observer's Companion" (www.fortunecity.com/roswell/borley/49/), which was created by the Astronomical Society of South Africa to promote its Deepsky Observing section. The quotes are from John Herschel's original observations, published in 1847 as "results of Astronomical Observations made during the years 1834, 5, 6, 7 [and] 8, at the Cape of Good Hope; Being the completion of a telescopic survey of the whole surface of the visible heavens, commenced in 1825." During his stay in South Africa, John Herschel often made several observations of each object. The quotes used in this book's tables, however, refer only to his first observation; a date is given only if the junior Herschel discovered the object. At the end of each Herschel description is a code contained in parentheses ("H VIII-88," for instance, or "h 2327"). These codes date to a classification system created and used by the Herschels. "H" stands for the elder Herschel and "h" for his son.

The Roman numeral in William Herschel's system identifies the class into which the elder Herschel placed each object:

I. Bright nebulae
II. Faint nebulae
III. Very faint nebulae
IV. Planetary nebulae: Stars with burs, with milky chevelure, with short rays, remarkable shapes, etc.
V. Very large nebulae
VI. Very compressed and rich clusters of stars
VII. Pretty much compressed clusters of large or small stars
VIII. Coarsely scattered clusters of stars

The Arabic numeral that follows is simply the order in which that object appears in that class. So H I-156 is the 156th object in Herschel Class I (bright nebulae).

The original 1888 *New General Catalogue* (NGC) description, or a description from the supplemental *Index Catalogues* (IC), follows each Herschel entry (if any). If the object is not from one or the other of these catalogues, it is left blank.

The Herschel and NGC/IC catalogue descriptions are followed by the running text, which may not only enhance the historical entries mentioned above but also bring to light any recent research findings. I then begin to describe the object's appearance in the sky, starting with its location and how best to find it. The directions are followed by my visual impressions as seen through the 5-inch at various magnifications. At times, I record its naked-eye or binocular appearance, or the view through my antique telescope; ocasionally I include descriptions by other observers using larger instruments. There may also be a visual challenge or two, as well as a brief visual impression of any other interesting objects nearby.

A drawing of the object as seen through the 5-inch at various magnifications also accompanies the text, so you can compare your view of any Secret Deep object with my own. The views may be very dissimilar, but that's okay; we all see things differently.

SOURCES OF DATA AND INFORMATION

The data and information in this book were drawn from a variety of modern sources.

Many of these sources were used in *Deep-Sky Companions: The Messier Objects*, *Deep-Sky Companions: The Caldwell Objects*, and *Deep-Sky Companions: Hidden Treasures*, so you can compare the properties of these objects with confidence. Generally speaking, I gleaned recent research findings on the physical nature of each object from the *Astronomical Journal* or the *Astrophysical Journal*, and citations are given. From each object's apparent diameter and distance I calculated its physical dimensions using the formulas that appear on page 35 of *Deep-Sky Companions: The Messier Objects*. Other information, such as constellation lore; properties of stars; and objects' positions, apparent magnitudes, angular sizes, and surface brightnesses, come from the following excellent sources (primary sources are listed first).

Star names, constellations, and mythology

Allen, Richard Hinckley. *Star Names: Their Lore and Meaning*. New York: Dover Publications, 1963.

Ridpath, Ian. *Star Tales*. New York: Universe Books, 1988. See also www.ianridpath.com/startales/contents.htm.

Staal, Julius D. W. *The New Patterns in the Sky: Myths and Legends of the Stars*. Blacksburg, VA: McDonald and Woodward, 1988.

Stellar magnitudes and spectra

Stars, http://stars.astro.illinois.edu/sow/sowlist.html.

Hirshfeld, Alan, Roger W. Sinnott, and Francois Ochsenbein, eds. *Sky Catalogue 2000.0*, Vol. 1, 2nd edn. Cambridge, UK: Cambridge University Press, and Cambridge, MA, USA: Sky Publishing Corp., 1991.

Stellar data

Stars, http://stars.astro.illinois.edu/sow/sowlist.html.

ESA. *The Hipparcos and Tycho Catalogues*. Noordwijk, the Netherlands: European Space Agency, 1997.

Double stars

Luginbuhl, Christian B., and Brian A. Skiff. *Observing Handbook and Catalogue of Deep-Sky Objects*. Cambridge, UK: Cambridge University Press, 1989.

USNO. *The Washington Double Star Catalog*. Washington, DC: Astrometry Department, U.S. Naval Observatory. http://ad.usno.navy.mil/ad/wds/wds.html.

Variable stars

American Association of Variable Star Observers, www.aavso.org.

Open star clusters

Archinal, Brent A., and Steven J. Hynes. *Star Clusters*. Richmond, VA: Willmann-Bell, Inc., 2000.

Open star cluster distances generally were gleaned from the professional literature.

Globular star clusters

Harris, William E. *Catalog of Parameters for Milky Way Globular Clusters*. Hamilton, ON: McMaster University. www.physics.mcmaster.ca/~harris/mwgc.dat.

Skiff, Brian A. "Observational Data for Galactic Globular Clusters." Webb Society *Quarterly Journal* **99**:7 (1995), updated May 2, 1999.

Globular star cluster distances generally were gleaned from the professional literature.

Planetary nebulae

Skiff, Brian A. "Precise Positions for the NGC/IC Planetary Nebulae." Webb Society *Quarterly Journal* **105**:15 (1996). (Positions.)

Luginbuhl, Christian B., and Brian A. Skiff. *Observing Handbook and Catalogue of Deep-Sky Objects*. (Dimensions and central star magnitudes.)

Cragin, Murray, James Lucyk, and Barry Rappaport. *The Deep-Sky Field Guide to Uranometria 2000.0*, 1st edn. Richmond, VA: Willmann-Bell, Inc., 1993.

Planetary-nebula distances generally were gleaned from the professional literature or from the World Wide Web page of the Space Telescope Science Institute (www.stsci.edu).

Diffuse nebulae

Cragin, Murray, James Lucyk, and Barry Rappaport. *The Deep-Sky Field Guide to Uranometria 2000.0*, 1st edn.

Diffuse nebula distances were gleaned from the professional literature.

Galaxies

The Deep-Sky Field Guide to Uranometria 2000.0, 1st edn. (Positions, angular size, apparent magnitude, and surface brightness.)

NASA. *The Extragalactic Database*. Pasadena, CA: Infrared Processing and Analysis Center. http://nedwww.ipac.caltech.edu/. (Types, mean distance, radial velocity, and all detailed descriptions of galaxy structures as seen in photographs have been gleaned from the accompanying notes.)

Tully, R., Brent. *Nearby Galaxies Catalog*. Cambridge, UK: Cambridge University Press, 1988. (Inclination, total mass, and total luminosity.)

Extragalactic supernovae

List of Supernovae. Cambridge, MA: Central Bureau for Astronomical Telegrams. http://cfa-www.harvard.edu/iau/lists/Supernovae.html.

Other details of discovery were gleaned from individual IAU *Circulars*.

Historical objects

Smyth, Captain William Henry. *A Cycle of Celestial Objects*. Richmond, VA: Willmann-Bell, Inc., 1986.

Glyn Jones, Kenneth. *The Search for the Nebulae*. Chalfont St Giles, UK: Alpha Academic, 1975.

Other historical anecdotes in this book were gleaned from various individual and professional papers from the nineteenth and early twentieth centuries.

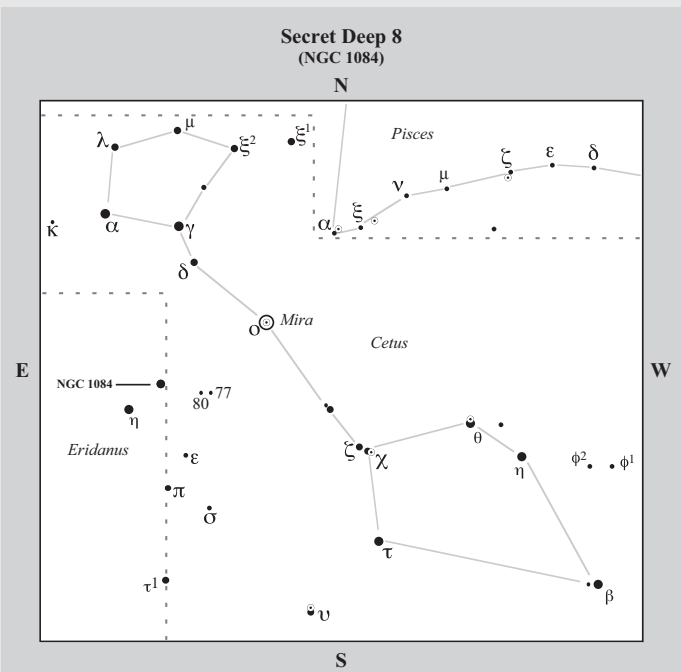
General notes

Note that the World Wide Web Uniform Reference Locators, or URLs, are subject to change. The dimensions, magnitudes, and positions of all other additional deep-sky objects in this book were taken from *The Deep-Sky Field Guide to Uranometria 2000.0*.

As in the other books in the Deep-Sky Companions series, the data in this book differ from those appearing in older but popular references. This book contains the most up-to-date astronomical data and accurate historical and observational information about each object in the Secret Deep catalogue that you'll find in any book in the popular literature.

THE FINDER CHARTS

As I previously mentioned, the wide-field and detailed star charts in Chapter 2 are of my own design. The Secret Deep number



and proper name of each object appears at the top of the chart. The maps appear with north up and east to the left.

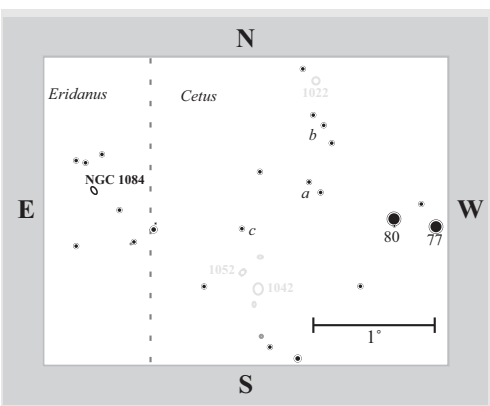
The purpose of the wide-field finder charts is simply to show you the brightest constellations or star fields around the Secret Deep object. Each shows stars roughly to magnitude 4 or 5, and sometimes 6 (but generally only in the region near the Secret Deep object, and only if I feel they will help in the naked-eye or binocular search. Faint stars are more prevalent if the constellation is dim, like Sculptor.

In creating these charts my philosophy was to simplify the view, to help you focus on your target by removing peripheral noise. The purpose of these charts is to help you hone in on one object and one object only, and I've done the field work to help you get there in the fastest and most efficient way possible. Why clutter the view, I reasoned, with lots of dim stars and other objects when all you want to do is see the target you're after. As the old saying goes, "Obstacles are what you see when you take your eye from the goal."

To help you in your search, I've traced out the "stick figure" form of the main constellations in the view. I've also labeled them and their brightest stars, using the traditional Bayer (Greek) letters or Flamsteed numbers. Sometimes I've included a popular star name, such as Mira, the well-known winking star in Cetus the Whale. But in special cases, you may find a non-traditional, italicized, lower-case letter, such as an *a* or *b*; these are additional

unnamed or numbered guide stars, which you'll find in the text described as Star *a* or Star *b*, etc. One symbol, a circle, is used to mark the location of each Secret Deep object on these wide charts.

The detailed finder charts have the same orientation as the wide-field charts, but they show a much smaller area of sky in more detail. The constellation name is given as are any boundary lines. A scale bar appears at the bottom of each chart. Stars are shown to magnitude 11 near the target; sometimes, fainter stars are shown, if I feel they'll help you to identify it. In the detailed charts, I've labeled each Secret Deep target with its full proper name (such as NGC 1084) in black. A faint gray symbol is used to mark the location of other interesting deep-sky objects nearby, which are labeled (also in gray) with the NGC prefix omited. Note too that, in these charts, the italicized letters may also refer to an asterism (a triangle, arc, pair of stars, or line), as described in the text.



I use the traditional symbols below to represent the different classes of deep-sky objects. In the case of galaxies, I also show their apparent orientations.

Thus, to find a Secret Deep object, first locate the object's position on the wide-field finder chart. Next, note the brightest star near the object and locate it on the detailed finder chart. Now, read the accompanying text on how to locate the object and simply follow the directions.

THE IMAGES

All the object images in this book are reproduced in black and white, with north up and east to the left. Unless otherwise noted, all were taken by my longtime friend and colleague Mario Motta with an STL 1001E SBIG camera on his homemade 32-inch telescope. It has a field measuring 17′ × 17′. Photos of objects larger than 17 arcminutes were taken with Motta's 6-inch F/9 Ritchey–Chrétien astrograph, which has a 1° field. (Detailed credits for these and additional photos appear in Appendix D.) I took some of the wider shots, such as Orion's Belt and other large deep-sky objects. I've also reproduced images from the Hubble Space Telescope and other large telescopes. These images were used for the sole purpose of inspiring you to use your imagination. You certainly will not see anything like these images when you look through your telescope, but how else can you fully appreciate what it is you are seeing? So do not be discouraged, be enlightened.