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SPECIAL REPORT

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A GUIDE TO EARNING A. L. OBSERVING PINS

by Bill Warren

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Introduction. There are several reasons why amateur astronomers might want to earn A. L. observing pins. For some, those pins are visible evidence of their progress as observers, and they appreciate the challenge of seeing how far their observing skills can take them.

For others, the pin programs take them to objects of beauty and wonder that they might never have known about otherwise. Every program teaches them much more than they knew previously about observing and the nature of the universe.

Presently there are 50 A. L. pin programs. Those programs cover everything that can be seen in the sky from earth-orbiting satellites to Messier objects to galaxy clusters. A list arranged by Beginner, Intermediate and Advanced levels appears in Appendix A.

Two other benefits of pursuing observing pins are often overlooked. First, the pin programs provide reasons to get out and observe regularly, and to see what other people see only in photographs. It's the difference between seeing a total solar eclipse yourself or looking at someone else's photo of it. Both are beautiful, but seeing things for yourself is more immediate and personal than seeing them in photos.

Second, the pin programs offer direction to your observing sessions. They give you specific objects to find, observe and appreciate (as opposed to, say, seeing **Andromeda Galaxy** or **Orion Nebula** for the 847th time – which is always fun but hardly challenging -- or wondering what to look for. If you're involved in a pin program, you'll *know* what to look for.)

At any rate, this Special Edition of the *Observer* is dedicated to FRAC's observers past, present and future who have ever wanted (or will want) to venture into the realm of the A. L.'s pin programs. *This* is what the pin process is all about, and this is what you need to know in order to earn those pins with a minimum of difficulty.

Happy hunting!

-Bill

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Part I: How to Earn a Messier Pin

The Messier Program is a good starting point for beginning observers. It familiarizes you with each of the four types of deep-sky objects – galaxies, nebulas, and open & globular clusters – and it teaches you how to navigate the night sky. Your

search for the Messier objects will take you to 35 constellations that contain most of the beautiful and fascinating celestial objects that can be seen from northern latitudes. With practice, you'll learn to recognize and locate those constellations and familiar objects within them quickly and easily.

At writing, 2,276 A. L. members have earned a Messier pin, and 19 FRAC members before you have done it. You can do it, too. As every one of those FRACsters will tell you, earning a Messier pin will teach you more about yourself, your telescope, the night sky and observing than anything else you'll ever do in astronomy.

**Your first step in pursuing a Messier pin is to read the rules & requirements for that program.* For example, you can't use GoTo or PushTo technology to find the Messiers (although you *can* use them in most of the other deep-sky programs involving telescopes).

**Your second step is to find an observing form to log your observations on.* You can download an excellent form for beginners by Googling www.astromax.org and clicking on the form on the left. It's the one I used while working on the Beginner and Intermediate programs.

Basically, logging your observations boils down to describing what you see. Your descriptions don't have to be lengthy, detailed or precise. (They can't be, if you use the observing form I recommend: it gives you only three lines for your observations.)

Your ability to describe what you see will improve through practice. No one expects a beginner's observations to be very good -- and that's fortunate, too, because *my* Messier observations were *terrible!* I'm exaggerating here, but I think I used words like small, faint and fuzzy about a hundred times!

(Note: Technology has come a long way since I began pursuing A. L. pins in the mid-1990s. With computerized programs as abundant nowadays as ants at a picnic, you may not need the print resources I recommend -- but you need to understand the importance of visual resources, whether in computerized or print format.)

**Your third step is to find a suitable star atlas or star charts*. ("Suitable" means the individual charts are large enough to show you broad portions of the sky.) The three best for beginners are *Seasonal Star Charts (SSC)*, *Deep Map 600 (DM600)* and *Cambridge Star Atlas (Cam).* The latter two contain many deep-sky objects besides Messiers.

SSC is water-resistant. It contains 8 thick charts: 2 for each season, one showing the N sky and the other the S sky. It contains all of the Messiers, only a few other deep-sky objects, and stars down to mag. 5.5. Its major shortcoming is that the constellation boundaries are shown in red lines that vanish under a red-beam flashlight's glow. But *SSC* — and *DM600* too, for that matter – connect-the-dots of bright stars that show the constellations' identifiable patterns.

SSC is the best atlas I've ever seen for orienting observers to the night sky: it contains a planisphere on the cover that shows where the visible constellations are at any given hour of any given night, and the individual charts show the months when objects are visible and where to find them.

After 23 years of observing, I still use *SSC* to locate Messier objects, and to identify hard-to-recognize constellations such as *Aries, Camelopardalis, Cepheus, Eridanus, Hydra, Leo Minor, Libra, Lynx, Monoceros, Puppis* and *Vulpecula*. (Of those constellations, only four – Hydra, Monoceros, Puppis & Vulpecula – contain a Messier object.) A used copy of *SSC* sells for $8.79 from amazon.com.

DM600 is water-resistant, too: If you get dew on it, just wipe it off or leave it open to dry out overnight. Moisture won't warp the single large chart, which is sturdier than paper and folds up like a roadmap for easy storage. That chart shows the locations of stars down to 5th mag., 100 variable & double stars and 500 deep-sky objects (including all of the Messiers) with brief descriptions of each. You can get a used copy of *DM600* from amazon.com for $8.79.

Cam features 20 large charts containing stars to 6th mag., all of the Messiers and 588 other deep-sky objects. Unlike *SSC* & *DM600*, *Cam* is a hard-back book with pages that are not dew-resistant and the charts do not connect-the-dots. I got around those problems by (a) cutting out the charts, putting them in protective glassine covers and keeping them in a notebook, and (b) connecting the dots myself, using *SSC* as a guide. A used copy of *Cam* sells for $3.79 from amazon.com.

I've used all three of those star atlases and many others over the years. If you're serious about finding deep-sky objects, you need all the resources you can get. Some atlases and charts have DSOs that others don't have.

***Observing Tip #1:** *Don't wait for ideal observing conditions*. If the **Moon** is up, you can work on your Lunar pin – but even under a 2nd- or 3rd-Quarter Moon you can find bright Messiers. You won't see them as well as when the Moon is less intrusive, but there's no rule in any A. L. program saying that you have to see objects under ideal conditions. Just briefly describe what you see under the prevailing conditions.

Observing Tip #2: *Organize your search by listing the Messiers by season in a notebook.* The A. L.'s Messier Program link lists them in six seasons, not four, because the seasons overlap. Those seasons are: Winter (23); Early Spring (20); Late Spring (20); Mid-Summer (16); Late Summer (18); and Fall and Early Winter (13). That list tells you which Messiers to look for at any given time of year. (See Appendix B.)

When observing, look first for Messiers that are farthest west in your view. If you don't get them now, it will be 6-9 months before they rise again high enough in the east to see them clearly.

Second, look for the brightest Messiers before you tackle the fainter ones. Success in finding bright Messiers will give you confidence in searching for the others.

If you don't understand the terms seeing and transparency, read the article about them on our website. Estimating seeing and transparency is a simple but important process: it tells what the sky conditions were when you observed that Messier.

Observing Tip #3: Although some of the individual Messiers can be difficult to find, by far the most challenging task is finding the 16 galaxies located between the stars **Vindemiatrix (Epsilon Virgo)** and **Denebola (Beta Leo),** in an area of sky smaller than your outstretched fist. Six of them are in *Coma Berenices:* **M85, M88, M91, M98, M99 & M100**; and ten of them are in *Virgo:* **M49, M58, M59, M60, M61, M84, M86, M87, M89, & M90**. Scores of other non-Messier galaxies in that same confined area are visible in our telescopes; since you can't use GoTo to find the Messiers, you'll need a detailed star chart of that area of sky to tell you which galaxy is the one you're looking for.

Without exception, the Virgo/Coma Messiers will be the brightest galaxies in their fields of view. Appendix D, "Finding the Virgo-Coma Messiers," tells you how to locate and identify each one, using Vindemiatrix or Denebola as your starting point.

In some cases there's more than one Messier in the same FOV (i.e., **M84**/**M86**, **M59**/**M60** and **M89 & M90**), so it wouldn't hurt to have photos of the Messiers available so you can identify them by their shapes or the locations of nearby stars in the FOV.

During my original search for the Messiers, I bought a photographic chart of the Messier objects to help me identify them. (That same chart sells today at amazon.com for $40.) The photos were small, but that's what I wanted because the Messiers would be small in my telescope, too. I cut out the photos and taped them into a little notebook that I carry around in my equipment box. It's well worn after two decades of use, but you're welcome to refer to it whenever you need to.

A final point regarding your Virgo-Coma Messier search: *It's best to get an early start in the year*. Virgo and Coma Berenices are spring constellations, and spring is the worst time of the year for dew. If you wait until spring to begin your search, you'll be fighting dew the whole time. To avoid the dew, start your search in late February or early March, and plan to stay out late enough for the spring constellations to rise above any sky glow to the east. You can keep the dew off your eyepieces by attaching a hand warmer packet to your eyepiece holder.

***Observing Tip #4:** Actually, there are 109 Messier objects, not 110. Messier's assistant, **Pierre Mechain,** discovered **M101** in 1781 and later admitted in a letter to another astronomer that he mistakenly recorded it again as **M102** and Messier didn't notice the error. Some people (including the A. L.) think he was referring to **NGC 5866**, a nearby galaxy in *Draco*. But that's not what happened, so we give our members the option of finding 109 or 110 Messiers to earn that pin.

***Observing Tip #5:** After 2 yrs. spent looking for Messiers alone in my backyard, I had found just 32. I joined the Atlanta Astronomy Club (AAC),

and in 6 months I found the other 78. The moral? *Ask for help when you need it.* One of the best reasons for joining an astronomy club is to have help available when you need it. I needed help, but none was available until I met **Larry Higgins** and joined the AAC.

Finally, when you finish your Messier project give your observing logs to FRAC's observing chairman or an officer and that person will order your certificate and pin from the A. L. (And by the way, you can earn a partial certificate -- but not a pin -- by requesting it after you record 70 observations. You'll get another certificate for the entire program with your pin.)

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Part II: Beyond the Messier Pin

If you're skilled enough to earn a Messier pin, you're skilled enough to earn other pins. But which one(s) should you work on next? There are three considerations:

**Do the easiest programs before progressing to more advanced ones.* (See Appendix A for a list of the A. L. observing programs by experience level.)

If you're new to astronomy and observing, you should consider pursuing one or more of the following Beginner Level programs – Binocular Messier; Constellation Hunter; Deep Sky Binocular; Lunar; or Universe Sampler. Each of those programs will improve your observing skills and teach you things you didn't know about astronomy, the universe and observing. But to repeat: *Which one(s) should you do first?*

If you want to use FRAC members' pins as a guide to the popularity of the various programs, here's the breakdown: Outreach (46); Messier (19); Binocular Messier (12); Lunar (10); Double Star (8); Master Outreach (8); Universe Sampler (7); Deep Sky Binocular (6); Caldwell (5); Urban (4); Globular Cluster, Herschel 400 & Master Observer (3 each); Constellation Hunter (2); and Hydrogen Alpha (1).

If you're interested in earning a Master Observer pin, you have to earn five required pins – Messier; Binocular Deep Sky; Lunar; Double Star; and Herschel 400 – and any other five pins. (D.S. is an Intermediate Level program, and H400 Advanced Level.)

Regardless, the obvious starting point beyond the Messiers is the **Lunar** or **Universe Sampler** program. They are by far the easiest of all the A. L. observing programs. The Moon is up all year; you don't have to describe the 100 required features, just check them off your list as you find them. And you can do the U.S. program even if you don't own a telescope or binoculars: They offer a naked-eye option.

Outreach is easy, too: many of our members already have the basic Outreach pin. But to count toward a Master Observer pin, you have to log an additional 150 outreach hrs. beyond the basic pin.)

Binocular Messier involves finding any 50 Messiers in binoculars. Having already earned your Messier pin, you know where to look for them. (Just "look small": they won't as big in binoculars as they appear in telescopes.)

Deep Sky Binocular is easy because, like the B.M. program above, you can see a huge 7^{o} section of the sky -- which makes star hopping easy – and it consists of 60 objects, not 100 or more. (I'll have more to say about the binocular programs later.)

Like the Double Star Program (below), **Constellation Hunter** involves drawing dots to represent the stars. All you need is constellation charts that identify the constellation boundaries.

The easiest Intermediate Level programs are **Double Star** and **Urban**. Double Star is easy because most of them are bright, and all you have to do is draw dots to show how close they are and how they are oriented to each other. It doesn't take the artistic talents of **Van Gogh** to draw dots.

(Note: "Easy" is a relative term. Every observing program – even the easiest ones – contain a few challenging targets or tasks: the A. L. doesn't want to make it *too* easy for us.)

Of the 100 Urbans, 41 are Messiers; you've found them before, so you'll know where to look for them under light-polluted skies. As for the rest -- all of them are bright, so I found them at our club's dark site, then went home, found them again and observed them in Griffin's sky glow.

Light pollution is virtually universal in our area; that's why we travel so far to observe at JKWMA. So if you live near Griffin, Hampton, McDonough, Newnan, Jonesboro, Thomaston or any other city or town, any Urban targets you find at home will count toward that pin.

*Your second consideration in selecting your post-Messier observing project is *interest.* You're going to be spending about a year completing any given program – they are designed that way to keep you coming back for more -- so you need to select an area that you're interested in. For example, I started but never finished the Solar System program because I realized that I just wasn't interested in it. I wasn't having fun, so I abandoned it and went on to other programs.

*Your third consideration is *equipment.* Some of the programs (e.g., Universe Sampler) require that you buy an inexpensive A. L. guidebook for that program. I bought the U.S., Messier, Herschel 400, Herschel 2 and other guidebooks, and all of them were extremely helpful and well worth the money. The U.S. booklet contains several brief chapters covering basic information about observing that every observer should know.

If you're going to do the Lunar Program, you'll need a **Moon** map that shows the locations of all of the targets. The one I recommend is *Sky & Telescope's Moon Map:* It's laminated, folds up in the middle for easy storage, and a used copy sells at amazon.com for $1.82 + s&h. (If you're going to observe the lunar features telescopically, get the one that reverses the features; otherwise, get the regular one.)

You'll need a white-light solar filter to do the Sunspotters program, or an H-alpha filter for that solar program.

Eventually, you'll need an O-III or narrowband light-pollution filter to help you see details in nebulas, etc., but it shouldn't be a high-priority purchase for a beginner. You can do the Messier and Urban programs without it. Later on, you'll know when it's time to buy one.

You don't need a large or expensive pair of binocs to do the Binocular Messiers or Deep Sky Binoculars: the guy who created those programs used a cheap pair of 6x30 binocs from WalMart. The binocular programs will be much easier to do if you purchase an inexpensive tripod to keep your binoculars steady. Otherwise, you can hold your binocs against the side of a building or the top of your car to steady the view. (I used a mop.)

If you're going to do a challenging program like the Herschel 400s, Caldwells or Arp Peculiar Galaxies, you'll probably need an 8- or 10-in. 'scope, and a more advanced star atlas. (See below.)

And that brings us to:

The Herschel 400s. This is a required Master Observer program. But if you're a beginning observer you don't want to start working on it too soon: you won't have the skills necessary to track down all 400 deep-sky objects in that program. About 240 of them are *very* easy and 80 more are relatively easy, but the others can be challenging for a beginner.

On the other hand, you don't want to earn the other nine pins before beginning your H400 odyssey, or your M.O. pin will take an additional year or two to complete. Best advice here is, *Start on the H400s, but do just the brightest ones*. After a year of honing your search skills and becoming familiar with the night sky, you'll be ready to go after the rest of the H400s.

Beyond the Herschel 400. In order to complete the Herschel 400s, Arp Peculiar Galaxies or other advanced deep-sky programs, you'll need a more advanced star atlas than *SSC*, *DM600* or *Cam*.

By far the best advanced atlas and resource is the 2-vol. *Night Sky Observer's Guide* by **Glenn Kepple & George Sanner.** It shows stars to 9th mag., contains 5,500+ deep-sky objects, more than 1,250 photos and drawings of the brightest ones, and descriptions of what you'll see in 'scopes of various sizes. You can buy the volumes separately (used) from amazon.com for less than $50 total.

Sky Atlas 2000.0 is another excellent advanced star atlas. It shows stars to mag. 8.5 and 2,700 DSOs on 29 18"x13" charts. It comes in several formats including: bound or unbound; laminated or unlaminated; and black stars against a white background or white stars against a black background. (White-on-black is better, because that's what you'll see when you look at the sky.) I bought the most expensive version – spiral bound and laminated – but you can get a used unlaminated

(but spiral-bound) version at amazon.com for less than $45.

Sky & Telescope's Pocket Sky Atlas ($5.92 used from amazon.com) shows stars to mag. 7.6 and 1,500 color-coded deep-sky objects on 80 charts that are divided at the center by spiral binding. This can be difficult, because the overlaps are not precisely aligned. (The Jumbo Edition features the same charts enlarged.)

Shortcuts. It took me 2-1/2 yrs. to complete the Messier program – I was just starting out and working by myself without help for most of that time -- and 6-1/2 yrs. to do the other nine programs I chose for a M.O. pin. If you're going to devote that much time to collecting pins, you'll be grateful for any shortcuts along the way. Here's what I recommend:

*If your telescope has GoTo or PushTo capability -- GoTo uses motor drive to move your'scope to an object, whereas PushTo is manually operated but also contains an electronic finder system -- ***by all means use it in any program that doesn't specify that you cannot use it!*** If I'd had GoTo, I could have completed the H400s in a year, rather than taking 2-1/2 yrs. to do it without GoTo. (PushTo phone apps are available now.)

*Many programs accept photographic images of their objects (and some accept drawings) in lieu of written descriptions. If that appeals to you, check the rules for the programs you're interested in. If they don't say you can't do it that way, you can.

*Rather than spending observing time writing down my observation notes at the telescope (and losing the object I was observing in the process), I dictated them into a pocket recorder. (Can you do that with a Smart Phone?) Later at home I transferred them to my observing log.

*Consider working on two or more programs at a time. After completing the Messier program, I worked on six programs simultaneously: Lunar, Deep Sky Binocular, Double Star, Herschel 400, Urban and Arp Peculiar Galaxies. Here's how to do multiple programs:

Use a separate notebook for each program you're working on, and list the objects in that program by season. (Use the A. L.'s 6-season format.) By doing that, you'll always know which objects in each program will be up on a given evening. Mark them off your list as you observe them.

Take all of your notebooks with you when you observe. Select one program, and look for objects in it until you have trouble finding something, then switch to another program. You won't get frustrated that way, your interest will remain high throughout and you'll make progress in all of your programs. Practically every program features a lot of very easy targets and a few difficult ones.

Admittedly, preparing those notebooks entails a lot of work. But even if you're observing on every clear evening, there will be plenty of cloudy nights and time between club observings for you to prepare for your next observing session. The more prepared you are, the more successful you'll be next time you observe.

*As you proceed from one program to another, you'll notice that many objects appear in more than one A. L. program.

If you save your observing notebooks -- and you should – in most cases you can use those same observing notes in other programs, thereby avoiding the necessity of observing them again.

Finding, say, 400 Herschel objects is a daunting task. But the H400 list contains 15 Messiers and 25 Deep Sky Binoculars; after completing the Messier and D.S.B. programs, you can start the H400s with **40** of them already logged. You're already $1/10^{th}$ of the way to a H400 pin before you even begin!

Remember this, too: *100 of the H400s appear in two or more programs.* Every time you observe one of them that you haven't seen before, you can count that observation toward a pin in any other program in which it appears. The more objects you've seen in *any* program, the more duplications you'll be able to use in other programs.

You don't have to do it that way, of course. But if you're going to spend upwards of half a decade collecting pins, which would you consider easier and more time efficient, observing those forty H400s or other duplicated objects once, or twice? (Over your observing lifetime, you'll go back to the bright duplicated objects many times, just to enjoy their beauty.)

Appendix C contains a list of object duplications in the A. L. programs: 230 celestial objects that

appear in two or more programs, including describing in detail how the A. L. rules apply to them.

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Finally, in studying the rules for a given program, notice where you are supposed to turn in your completed observing logs. Some (primarily Advanced) must be submitted to the A. L. coordinator in charge of that program; most of the Beginner and Intermediate logs can be turned in to FRAC's observing chairman or any officer in the club.

If possible, use the latter method. Most of the A. L. coordinators are easy to work with, but a couple of them take their responsibilities too seriously.

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Appendix A: A. L. Observing Programs By Experience Level

Beginner (16): Binocular Double Star; Binocular Messier; Constellation Hunter; Dark Sky Advocate; Deep Sky Binocular; Galileo; Lunar; Messier; Meteor; Outreach (Basic & Master); Sketching; Sky Puppy; Solar System; Southern Skies Binocular; Universe Sampler.

Intermediate (15): Advanced Binocular Double Star; Asteroid; Caldwell; Carbon Star; Comet; Double Star; Earth Orbiting Satellite; Globular Cluster; Lunar II; Open Cluster; Southern Skies Telescope; Stellar Evolution; Sunspotters; Two In the View; Urban.

Advanced (19): Active Galactic Nuclei; Analemma; Arp Peculiar Galaxies; Asterism; Binocular Variable Star; Bright Nebula; Dark Nebula; Flat Galaxies; Galaxy Groups & Clusters; Herschel 400; Herschel II; Hydrogen Alpha; Local Galaxy Group & Neighborhood; Master Observer; Near Earth Objects; Occultation; Planetary Nebula; Radio Astronomy; Variable Star.

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Appendix B: The Messiers By Season

Winter (23): M1; M31; M32; M33; M34; M35; M36; M37; M38; M41; M42; M43; M45; M46; M47; M50; M52; M76; M78; M79; M93; M103; M110.

Early Spring (20): M3; M40; M44; M48; M51; M63; M65; M66; M67; M81; M82; M94; M95; M96; M97; M101; M105; M106; M108; M109.

Late Spring (20): M49; M53; M58; M59; M60; M61; M64; M68; M84; M85; M86; M87; M88; M89; M90; M91; M98; M99; M100; M104. **Mid-Summer (15 or 16):** M4; M5; M6; M7; M9; M10; M12; M13; M14; M19; M62; M80; M83; M92; M102 (optional); M107.

Late Summer (18): M8; M11; M16; M17; M18; M20; M21; M22; M23; M24; M25; M26; M28; M54; M55; M69; M70; M75.

Fall & Early Winter (13): M2; M15; M27; M29; M30; M39; M56; M57; M71; M72; M73; M74; M77.

Appendix C: Object Duplications in the A. L.'s Observing Programs

(Note: This report is limited to the following observing programs: **Arp Peculiar Galaxies; Binocular Messier; Caldwell; Deep Sky Binocular; Galaxy Groups & Clusters; Globular Cluster; Herschel 400; Herschel II; Lunar; Messier; Open Cluster; Planetary Nebula; Two in the View; Universe Sampler;** and **Urban.**)

Considerable duplication exists among the various A. L. observing programs. No less than 230 objects (8 lunar, 14 double stars and 208 deep-sky objects) appear in more than one program. For example, **M42** is on the lists of the Messier, Binocular Messier, Universe Sampler and Urban Program.

Duplication is important because, with certain exceptions noted below, if you observe an object once you can use that same observation in other programs in which that object appears.

Of the 110 Messiers, 102 of them are also on the **Binocular Messier** list (18x50 version). To earn a Binocular Messier pin, find any 50 of them. Of course, they are duplicates only when you observe them in binocs; otherwise, they must be observed separately. (But if you do it the other way – finding them first in binoculars – you can count those B.M.

observations toward your Messier pin and any other programs in which they appear.)

Among its 100 targets, the **Urban Program** contains 41 Messiers, 14 Double Stars and 27 other deep-sky objects that appear on other lists. However, they are duplicates only if they are observed under light-polluted conditions; otherwise, they must be observed separately. (See pp.4-5.)

The same holds true for **Constellation Hunter, Lunar** (naked-eye objects) and **Universe Sampler** (naked-eye version): binocular or telescopic observations do not count. Binocular observations are acceptable for any objects in the following programs: **Arp Peculiar Galaxies, Binocular Messier, Caldwell, Deep Sky Binocular, Galaxy Groups & Clusters, Globular Cluster, Herschel 400, Herschel II, Lunar and Lunar II** (binocular or telescopic), **Messier, Open Cluster, Planetary Nebula, Two in the View, Urban** and **Universe Sampler** (telescopic).

Electronic GoTo and PushTo mechanisms are expressly forbidden with the **Caldwell, Constellation Hunter, Lunar, Messier, Universe Sampler** and binocular programs. In all other programs, the use of mechanical or electronic finders is acceptable. Go to the A. L. web site and read the rules and requirements for any program you wish to pursue.

Here are the A. L. objects that appear on more than one observing program list:

Lunar/Universe Sampler (naked-eye) duplications (4): Mare Crisium, Mare Serenitatis, Mare Imbrium and Mare Humorum.

Lunar/Universe Sampler (binocular or telescopic) duplications (4): the Apennines Mtns. and craters Aristoteles, Copernicus and Grimaldi.

Messiers duplicated in the Arp Peculiar Galaxies Program (11): M32 (Arp 168), M49 (Arp 134), M51 (Arp 85), M60 (Arp 116), M65 (Arp 317), M66 (Arps 16, 317), M77 (Arp 37), M82 (Arp 337), M87 (Arp 152), M90 (Arp 76), and M101 (Arp 26).

Messiers duplicated in the Binocular Messier Program (102): M1-20, M22-42, M44-56, M58-72, M75, M77-90, M92-97 and M99-110.

Messiers duplicated in the Galaxy Groups & Clusters Program (8): M49, M60, M66, M86-87, M100, M105-106.

Messiers duplicated in the Globular Cluster Program (29): M2-5, M9-10, M12-15, M19, M22, M28, M30, M53-56, M62, M68-72, M75, M79-80, M92 and M107. (In order to count them – and four other non-Messiers as well – as duplicates, you must estimate the compactness of resolved stars toward their centers. It's not difficult to do, but otherwise you'll have to find them again, although you can still use your original observations.)

Messiers duplicated in the Herschel 400 Program (15): M20, M33, M47, M48, M61, M76, M82, M91, M102, and M104-M109.

Messiers duplicated in the Open Cluster Program (9): M7, M11, M26, M38, M44, M47-M48, M67 and M103.

Messiers duplicated in the Planetary Nebula Program (4): M27, M57, M76 and M97.

Messiers duplicated in the Two in the View Program (32): M4, M6-8, M13, M17, M20, M21, M31-32, M35, M38, M42-3, M46, M49, M51-53, M58-60, M65-66, M71, M77, M95-96, M101, M105-106, M110.

Messiers duplicated in the Urban Program (41): M2-8, M10-13, M15, M17, M22, M27, M30-31, M35-39, M41-42, M44-45, M48, M50, M57, M62, M64, M67, M77, M81-82, M84, M86-87, M92, M94 and M104.

Messiers duplicated in the Universe Sampler Program (naked-eye) (11): M4-8, M11, M22, M31, M41-42 and M44.

Messiers duplicated in the Universe Sampler Program (telescopic) (4): M1, M27, M51 and M57.

Double Stars Program stars duplicated in the Urban Program (9): Eta Cassiopeia; Gamma Aries; Beta Monoceros; Theta Orion (the Trapezium); Gamma Leo; Beta Scorpius; Epsilon Lyra (the Double-Double); Gamma Delphinus; and Delta Cepheus.

Double Stars Program stars duplicated in the Universe Sampler Program (2): Theta Taurus and Alpha Capricornus.

Double Stars Program stars duplicated in all three of those programs (3): Gamma Andromeda; Zeta Ursa Major (Mizar and Alcor); and Beta Cygnus.

Deep-Sky Objects (other than Messiers) duplicated in two or more programs (106):

(PN=planetary nebula; SG=spiral galaxy; EG=elliptical galaxy; EN=emission nebula; IG=irregular galaxy; GC= globular cluster; OC=open cluster; and SNR=supernova remnant. Three-letter abbreviations (e.g., *Cas* for *Cassiopeia*) are used to identify the constellations.

Regarding observing programs: A=Arp Peculiar Galaxies; C=Caldwell; DSB=Deep Sky Binocular; GG&C= Galaxy Groups & Clusters; GC=Globular Cluster; H400=Herschel 400; H2=Herschel 2; OC=Open Cluster; PN=Planetary Nebula; TV=Two in the View; U= Urban; and US=Universe Sampler. Caldwell and Arp numbers are given.

NGC 40 (PN, Cep): C2, H400, PN
NGC 129 (OC, Cas): DSB, H400
NGC 185 (EG, Cas): C18, H400, TV
NGC 246 (PN, Cet): C56, H400, PN
NGC 247 (SG, Cet): C62, H400
NGC 253, Sculptor Galaxy (SG, Scl): C65, DSB, H400
NGC 457, Owl Cluster (OC, Cas): C13, DSB, H400, TV, US
NGC 559 (OC, Cas): C8, H400
NGC 663 (OC, Cas): C10, DSB, H400, U
NGC 752 (OC, And): C28, DSB, H400, U
NGC 772 (SG, Ari): A78, H400

NGCs 869/884, the Double Cluster (OC/OC, Per): C14, DSB, H400, TV, U, US
NGC 891 (SG, And): C23, H400, TV

NGC 1023 (SG, Per): A135, H400, TV
NGC 1097 (SG, For): A77, C67
NGC 1342 (OC, Per): DSB, H400, OC, U
NGC 1528 (OC, Per): DSB, H400, US
NGC 1647 (OC, Tau): DSB, H400, U
NGC 1662 (OC, Ori): DSB, H2, OC
NGC 1817 (OC, Tau): DSB, H400, TV, U
NGC 1907 (OC, And): DSB, H400, TV
NGC 1961 (SG, Cam): A184, H400

NGC 2169, "37" asterism (OC, Ori): DSB, OC, UC, US
NGC 2232 (OC, Mon): DSB, H400, OC, U, US
NGC 2244 (OC, Mon): C50, DSB, H400, OC, TV, U
NGC 2251 (OC, Mon): DSB, H400, TV
NGC 2261, Hubble's Variable Nebula (EN, Mon): C46, H2
NGC 2264, the Christmas Tree Cluster (OC, Mon): DSB, H400, U
NGC 2281 (OC, Aur): DSB, H400, U
NGC 2343 (OC, Mon): DSB, H400, TV
NGC 2360 (OC, CMa): C58, DSB, H400
NGC 2362, Tau Canis Major Cluster (OC, CMa): C64, H400
NGC 2392, Eskimo or Clown Face Nebula (PN, Gem): C39, H400, PN, U
NGC 2403 (SG, Cam): C7, DSB, H400
NGC 2419 (GC, Lyn): C25, GC, H400
NGC 2506 (OC, Mon): C54, H400
NGC 2527 (OC, Pup): DSB, H400
NGC 2539 (OC, Pup): DSB, H400, U
NGC 2571 (OC, Pup): DSB, H400
NGC 2655 (SG, Cam): A225, H400, TV
NGC 2775 (SG, Cnc): C48, H400
NGC 2782 (SG, Lyn): A215, H400

NGC 3115, Spindle Galaxy (EG, Sex): C53, H400
NGC 3193 (EG, Leo): A316, H400, TV
NGC 3201 (OC, Mon): DSB, H400
NGCs 3226/3227 (EG/SG, Leo): A94, H400, TV
NGC 3242, the Ghost of Jupiter (PN, Hya): C59, H400, PN, U
NGC 3310 (SG, UMa): A217, H400
NGCs 3395/3396 (SG/IG, LMi): A270, H400, TV
NGC 3414 (SG, LMi): A162, H400
NGC 3432 (SG, LMi): A206, H400
NGC 3626 (SG, Leo): C40, H400
NGC 3628 (SG, Leo): A16, H400, TV
NGC 3631 (SG, UMa): A27, H400

NGC 4027 (SG, Cru): A22, H400
NGCs 4038/4039, the Antennae or Ring-Tailed Galaxy (SG/SG, Crv): C60/61, H400, H2, TV
NGC 4088 (SG, UMa): A18, H400, TV
NGC 4236 (SG, Dra): C3, H2
NGC 4244 (SG, CVn): C26, H400
NGCs 4435/4438 (SG/SG, Vir): A120, H400, TV
NGC 4449 (IG, CVn): C21, H400
NGCs 4485/4490 (IG/SG, CVn): A269, H400, TV
NGC 4559 (SG, Com): C36, H400
NGC 4565 (SG, Com): C38, H400
NGC 4618 (SG, CVn): A23, H400

NGCs 4627/4631 (EG/SG, CVn): A281, C32, H400, TV
NGC 4697 (EG, Vir): C52, H400

NGC 5005 (SG, CVn): C29, H400
NGC 5128, Centaurus A (EG, Cen): A153, C77
NGC 5195/M51 (EG/SG, CVn): A85, TV, US
NGC 5248 (SG, Boo): C45, H400
NGCs 5560/5566/5569 (SG/SG/SG/, Vir): A286, H400, TV
NGC 5694 (GC, Hya): C66, GC, H400

NGC 6217 (SG, UMi): A185, H400
NGC 6302 (PN, Sco): C69, PN
NGC 6520 (OC, Sgr): DSB, H400, OC, U
NGC 6543, Cat's Eye Nebula (PN, Dra): C6, H400, PN
NGC 6633 (OC, Oph): DSB, H400, U
NGC 6823 (OC, Vul): DSB, H400, OC
NGC 6826, the Blinking Planetary (PN, CYG): C15, DSB, H400, PN, U
NGC 6885 (OC, Vul): C37, H400, OC, TV
NGC 6888, Crescent Nebula (EN, Cyg): C27, H2
NGC 6910 (OC, Cyg): DSB, H400, OC, U
NGC 6934 (GC, Del): C47, DSB, GC, H400, U
NGC 6940 (OC, Vul): DSB, H400, U
NGC 6946 (SG, Cyg): A29, C12, H400, TV
NGC 6960, Veil Nebula (W), (SNR, Cyg): C34, H2, TV
NGCs 6992/6995, Veil Nebula (E), (SNR, Cyg): C33, H2

NGC 7000, North American Nebula (EN, Cyg): C20, H400
NGC 7009, Saturn Nebula (PN, Aqr): C55, H400, PN, U
NGC 7023 (EN, Cep): C4, H2
NGC 7160 (OC, Cep): DSB, H400, U
NGC 7209 (OC, Lac): DSB, H400, OC, U
NGC 7243 (OC, LAC): C16, DSB, H400, U
NGC 7293, Helix Nebula (PN, Aqr): C63, PN, US
NGC 7331 (SG, Peg): C30, GG&C, H400
NGC 7448 (SG, Peg): A13, H400, TV
NGC 7479 (SG, Peg): C44, H400
NGC 7606 (GC, Del): C42, H400
NGC 7635, Bubble Nebula (EN, Cas): C11, H2, TV
NGC 7662, the Blue Snowball (PN, And): C22, H400, PN, U
NGC 7727 (SG, Aqr): A222, H400
NGC 7789 (OC, Cas): DSB, H400, U
NGC 7814 (SG, Peg): C43, H2

Melotte 25, the Hyades (OC, Tau): C41, DSB, U

Collinder 399, The Coathanger (OC, Vul): DSB, TV

*In all, there are 684 object duplications in the A. L. observing programs: 107 Messiers and 102 Binocular Messiers appear on more than one observing list. So do 100 Herschel 400s, 66 Urbans, 59 Two in the Views, 58 Caldwells, 37 Arp Peculiar Galaxies, 37 Deep Sky Binoculars, 32 Globular Clusters, 22 Universe Samplers, 19 Open Clusters, 14 Double Stars, 10 Herschel 2s, 9 Galaxy Groups & Clusters, 8 Lunars and 4 Planetary Nebulas.

The Double Cluster (NGCs 869/884) and NGC 2244 are listed in the most observing programs – six — and NGCs 457, 2232, 6826 and 6934 appear on five lists. Sixteen other non-Messier objects are on four lists: NGCs 663, 752, 1342, 1817, 2169, 2392, 3242, 4038/4039, 4627/31, 6885, 6910, 6946, 7009, 7209, 7243 and 7662. The remaining 84 non-Messier deep-sky duplications appear in two or three programs.

Eight Messiers – M4-5, M7, M11, M22, M27, M44 and M48 – appear on five lists, and fifteen others – M2-3, M9-10, M12-13, M15, M30, M38, M42, M57, M62, M67, M92 and M107 – appear on four lists.

Eighty-four Messiers appear on two or three lists. Only three Messier objects do not appear in more than one program: M73, M74 and M98.

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Appendix D: Finding the Virgo-Coma Messiers

By the time you work your way through the Virgo-Coma Messiers, you'll be intimately familiar with two stars: 3rd –mag. **Epsilon Virgo (Vindemiatrix,** pronounced: vinn dih MEE uh tricks) and 2nd -mag. **Beta Leo (Denebola,** pronounced: dih NEBB uh luh). One or the other of those stars (or both, in some cases) is directly involved in star-hopping to 18 of the 19 Messiers on this list.

All of the Virgo-Coma Messiers appear on Charts 45 or 47 of *Sky & Telescope's Pocket Sky Atlas* (which also features a separate close-up chart of the 15 Messiers located between Vindemiatrix and Denebola).

Group I. (All three are on Chart 45; M85 is also on the close-up chart.)

***M53** (*Com*). To find this globular cluster, go N one length from 2nd -mag. **Delta Vir** through and beyond Vindemiatrix to the 4th -mag. star **Alpha Com**. M53 is one degree NE of Alpha Com. It is bright, with a large, densely packed center that fades rapidly at the edges. It has a bright double star near it.

All of the other Virgo-Coma Messiers are galaxies.

***M64** (Black Eye Galaxy, *Com*). Go from Vindemiatrix through and beyond 5th -mag. **36 Com** for about 2/3 of the distance between them. M64 has a bright star near it. Look for the dust lane that gives the oval-shaped galaxy a black eye.

***M85** (*Com*). Find M64. M85 lies about 40% of the way from M64 to Denebola. M85 is fainter than M64, and small, with a small, starlike core and a halo. A smaller, fainter – but still bright – galaxy, NGC 4394, lies just 8.5' away to the E.

Group II. All of these galaxies are on Chart 45 and the close-up chart.)

***M98, M99, M100** (*Com*). These three galaxies are located around the 5th -mag. star **6 Leo**, near Denebola. Elongated M98 is in the same field of view as 6 Leo, 1/2° to the W. Cloudlike M99 is about twice as far away from 6 Leo as M98 is, in the opposite direction. Globular-appearing galaxy M100 forms the E apex of an isosceles triangle with 6 Leo and a 5th -mag. double star, **11 Leo**.

***M91, M88** (*Com*). M88 forms a flat isosceles triangle with Denebola and M53 or Alpha Com, both of which lie N of Vindemiatrix. Small, hazy and starlike, M88 lies W of M91, is larger than M91 and has a double star on one side and a single star on the other side. If you find M88 first, wait and M91 will drift into view, a small galaxy that brightens toward the center.

***M84/M86** (*Vir*). This pair is the easiest of all the Virgo galaxies to find: just point your 'scope halfway between Vindemiatrix and Denebola. M86 has the "Smiley Face's" eyebrow above it. M84/M86 are elliptical, with bright cores and little else. (M84 is the one on the right. The Smiley Face's nose and smiley little grin are below M86 and M84.)

***M60/M59, M58, M87** (*Vir*) M59 and M60 lie halfway between M84/M86 and Vindemiatrix, or ¼ of the way from Vindemiatrix to Denebola. Center M84/M86 telescopically, then look in the Telrad or finderscope and go halfway to Vindemiatrix. M60 and M59 are in the same field of view, M60 being larger and brighter. M58 – small and slightly oval, with a bright core -- is slightly W of M59/M60 along the Vindemiatrix-Denebola line. M87 lies still farther W along that line. M87 has a bright core and looks like an unresolved globular cluster.

***M89/M90** (*Vir*). These two galaxies are located N of M58, or about 40% of the way from Vindemiatrix to Denebola and slightly N of that line. M89 and M90 are in the same low-power field of view. M90 has a large, bright, oval core, and M89 appears as a faint star embedded in a hazy glow.

Group III. M49 and M64 are on Chart 45 and the close-up chart; M104 is on Chart 47.

***M49** (*Vir*). This small, circular gray blob lies between two bright stars and forms a slightly-more-than equilateral triangle with Vindemiatrix and **Delta Vir** to the S.

***M61** (*Vir*). A round, faint, globular-appearing galaxy, M61 forms a slightly-more-than right triangle with Vindemiatrix and Delta Vir.

***M104** (Sombrero Galaxy, *Vir*). On edge to us, M104 is small, thin and bright, with a thick central bulge like a fried egg. A dust lane that transects it and gives it its nickname can sometimes be seen. Find it by going almost halfway from 3rd -mag. **Gamma Corvus (Gienah)** to 4th -mag. **Theta Vir**. (Or find the 5th-mag. double star **Struve 1669**: the Sombrero is about 2° NNW of that star.)

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