


# **Star Hopping Guide**

**to the**

# **Messier Marathon**

**(Text Instructions)**

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## Introduction

This document, along with its companion book of charts, is intended to supplement Don Machholz's *The Messier Marathon Observer's Guide*<sup>ii</sup> and his book *The Observing Guide to the Messier Marathon*<sup>iii</sup>. The object orders and many of the star hops are taken from the former.

A Marathon is great experience that can really help a beginner learn to efficiently use his scope. That was certainly my experience. Yet many beginners quake at the prospect of traversing Virgo. It basically comes down to not having the correct tools. This book will supply all of the charts required for a beginner to complete the evening.

Why produce another guide when there is so much information already available? In 2004 I was getting ready for my first Marathon. I bought Don's book, but after some practice sessions decided that it was not enough information for a beginner to successfully complete the marathon. The finder charts in Don's book are small. It lacked the detailed charts necessary to navigate Virgo. Finally the directions in Don's book are optimized for using a German Equatorial Mount. For example, his directions for locating M37

From M35 go 3.7° preceding W and 8.2° preceding north to M37

are easily translated into actions using a GEM. Using an Alt/Az mounted Dobsonian such directions were less useful. I realized that what I needed was a set of overview and detailed charts that are optimized for star hopping to the objects. Using my Planetarium program SkyMap Pro I created a detailed script for the evening. I could zoom out for overviews, yet when it came to Virgo I had a detailed script that contained finder fields of view (FOV) and specific star hops that I could just execute. This paper converts that work into book form.

This book is set up for the Messier Marathon of March 25, 2006 that is conducted at Henry Coe State Park near San Jose, CA. Aside from the location of the planets it should be useful for other marathons run at different times and different locations.

One important part of my approach to star hopping is that you have a series of charts

- a) Wide angle charts to locate the portion of the sky and point your red dot (See Equipment Suggestions below). These should cover about 90° of sky and show the stars to about visual magnitude. The Bright Star Atlas<sup>iv</sup> is an excellent example of such a chart.
- b) Finder charts to allow you to navigate to the correct star field. These should cover at least 16° of sky and show stars to magnitude

9. The Uranometria<sup>v</sup> can be used for this, but I find the size and weight of the book rather awkward.

c) Detailed charts to fine-tune your position.

Since at least half of the Messier objects are finder visible, detailed charts are not required for many objects. I have included detailed charts for some areas such as Virgo where you will probably star hop at the eyepiece.

The evening is broken into sections based on my own timeline starting on page 30. Each section is for the objects that you would typically look for at some time in the evening (say at 12 AM). Each section has an overview chart (a type A chart), a series of B type finder level charts, and text description of the star hop for each object.

For experienced star hoppers this is all that should be needed to quickly find all of the objects. Less experienced star hoppers may benefit from first reviewing the section “Star Hopping 101”. It will give you a better idea of how to use the book best to your advantage.

### ***Some Things to Keep in Mind During the Marathon***

- ❑ Read the charts with DIM red light. Using a bright red flashlight (or heavens forbid a white light) is a nice way to blow your night vision.
- ❑ Protect the book from the inevitable dew. Otherwise you will have pulp by morning. I suggest putting it in a plastic bag.
- ❑ Make sure you maintain a checklist of objects observed. Otherwise it is too easy to skip one.
- ❑ Don't be too literal with the object order. My changes from Don's order were mainly due to the horizons at Coe.
- ❑ Use low magnification. I suggest a combination that gives you a 1° field of view.

### ***About the TimeLine***

The Messier Marathon is the perfect exercise for those with Type A behavior<sup>1</sup>. It encourages your (my) goal oriented, competitive nature. Keep in mind that this is supposed to be fun! There are some portions of the evening that you will be very busy. These will include the first two hours after sunset, about midnight, and after 3 AM. Note from the suggested timeline there are also wide gaps. If you work efficiently there will be points in the evening when you will run out of objects. When this happens enjoy the company of your fellow marathoners.

Note the actual timelines on page 30 are for two Messier Marathon run in mid March and are in PST. Since Congress messed with DST in 2007, all of the times in this document will be 1 hour early.

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<sup>1</sup> <http://www.msnbc.com/onair/nbc/nightlynews/stress/default.asp?cp1=1>

## Introduction

The object order in this book was a compromise from Don's order based on the realities of the horizon at Henry Coe State Park. When you start on the summer objects (M13 and later) you will need to wait for the earth to turn.

So take the suggested timeline as a guide and don't become anxious if you don't do this as quickly as I did or in a different order.

### **About the Charts**

All of the charts in the companion chart book were generated by SkyMap Pro version 11<sup>vi</sup> using my marathon notations. Some contain DSS images that were shipped with SMP<sup>vii</sup> or downloaded directly from DSS Sources.

Large circles on the charts represent a 5° field of view that corresponds to an Orion 9x50 Finder. Smaller circles represent a 1° field of view, which is the recommended eyepiece field of view for this exercise. All charts have a scale in the lower right corner and a compass in the upper left.

*Note that charts labeled "Eyepiece" are upside down to represent what would be seen from the eyepiece of a Newtonian telescope.*

Brighter stars are represented using larger images on the charts. The dimmest stars displayed are

Visual Charts	5.5
Finder Charts	9
Detail and <i>Eyepiece</i> Charts	13

Visual and Finder charts are displayed zenith up corrected for the time of the chart. Thus the sky will correlate to the charts either visually or using binoculars. Finders and eyepieces will introduce rotation and/or mirroring. If you are not familiar with these then I suggest you read Star Hopping 101.

I give three types of direction.

- ❑ Left, right, up, and down are movements of the telescope and not the finder views.
- ❑ Where I need to be more precise I have used north, south, east, and west. These directions are discussed in Star Hopping 101.
- ❑ Where I say to place the object in the finder in the position remember if you do not have a "correct image" finder you will need to adjust these directions.

## ***Equipment Suggestions***

This book assumes that the user has available both some sort of red dot finder and a magnifying finder with crosshairs. You can do the marathon with just one of these (the 2004 marathon that is the basis of the timeline only used a Rigel), but you will be more efficient with both.

By “red dot” I mean a device that projects a variable intensity red image on this sky.

There are two main kinds of these

- ❑ Calibrated circles such as a Rigel<sup>viii</sup> or TelRad<sup>ix</sup>. These can be handy since you can estimate star hops with them.
- ❑ A simple red dot such as the Stellarvue<sup>x</sup>.

A good magnifying finder also helps. I personally prefer the Orion 9x50 right angle correct image finder<sup>xi</sup>, but you can use a reversing finder. Make sure you understand how the finder rotates/mirrors what you observe.

## **Star Hopping 101**

I teach both a short and long version of how to use charts to locate objects in the sky. Both presentations are available on my website at

<http://www.robhawley.net/bw>

This chapter is a subset of the material from that class.

## ***Finding Your Way in the Skies***

When I first started using a telescope about 8 years ago I got lost every time I looked for something in the sky. This was particularly true if I did so from my light polluted back yard in suburban San Jose. Sure I recognized the bright star patterns I learned as a cub scout like the Big Dipper, but the rest was a mystery. What I needed was a good chart.

The Bright Star Atlas mentioned earlier was the first set of charts I bought. It provides a good starting point for looking up at the sky and orienting yourself. I still use it today, but it has largely been replaced with a laptop running SkyMap Pro and more recently SkyTools V 3<sup>xii</sup>. I used the former to generate the maps in this book.

The trick to Star Hopping is first getting your bearings. Experience has told me that before I get behind the telescope you first have to sit with a visual star chart and acquaint yourself with the stars. In this example we will find M37 (object 18 below) in a March sky. In March M 37 will be in the west.

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Most paper star charts are oriented with Declination as vertical and Right Ascension as horizontal. They also display stars as dots whose size decreases down to a certain magnitude. In the case of the Bright Star Atlas it is magnitude 6 (about what you would see with averted vision from a good dark site) According to such a star chart this is what the skies should look like in the area of M 37. I am purposely not including the constellation figures in the area we'll be looking since your eye will see a different pattern.



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One immediate problem of this type of chart is that is not what the sky looks like. The stars are aligned Zenith up instead of north up. The dimmer stars will not be seen in an urban sky. Here is the same field of view from suburban San Jose



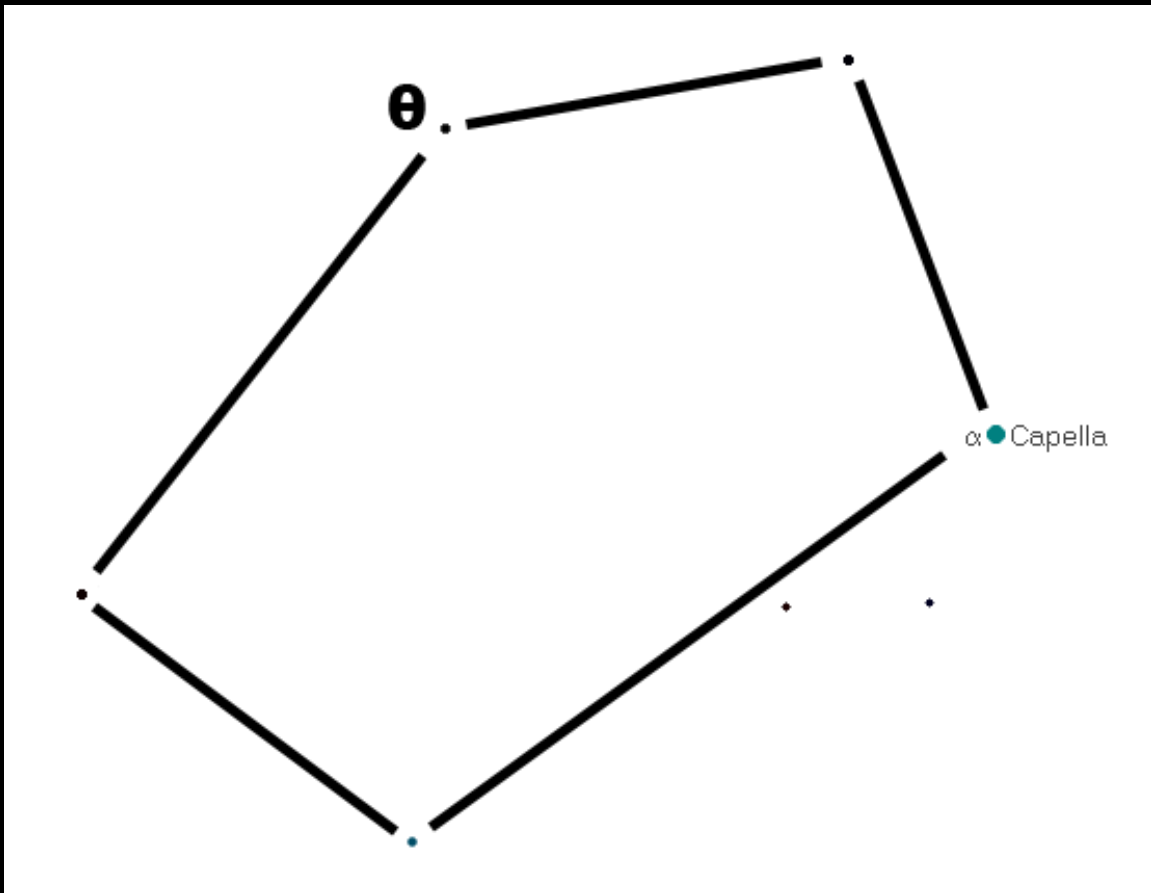
Quite a different view! Yet it is easy to map from one to the other! First start with some obvious points. The constellation of Orion should be easily recognized. . As can be seen the sky is rotated about  $45^\circ$  from the chart. The bright star on the bottom is Aldeberan. In



## Introduction

2006 Mars (right of Orion) and Saturn (near top) will be visible. The two stars in the center about  $\frac{1}{4}$  way from the top are Castor and Pollux. From them you should be able to make out the shape of Gemini. The bright star on the right is Capella. From Capella you should now be able to make out a pentagon shape of Auriga. The figure below is a closeup of Auriga with the stars identified and the pentagon shape outlined.

Note that the initial rotation that was required in this example is the reason that charts in this paper are always aligned with the zenith at the top and specific to the time the object is to be observed. Doing so removes one source of error.



Theta ( $\theta$ ) is the star that we will use in the search for M37. Put your red dot on  $\theta$  and it is time to star using the finder.

### ***Determining Cardinal Directions at the Newtonian Eyepiece***

Every time I have star hopped I have done so using the pattern matching covered in the next section. What occurred to me writing this paper is that Cardinal directions (N E S W) can be easily determined by simply watching the sky move. This may be especially handy for the eyepiece views used in Virgo.

To determine West simply don't move the telescope! The stars will disappear from the field of view to the west and new ones will appear to the East. If you are using a Dob, then you can just rotate the charts so the compass on the charts matches the field of view. You are done!

### ***Star Hopping with the Finder***

A finder shows a fairly wide field of view. In the case of the Orion 9x50 used in this paper the Field of View is 5°. A Finder FOV chart for the area around  $\theta$  is below (this is rotated zenith up). If your finder is a single tube then simply start with the top of the chart pointing down. If your finder has a right angle without a "correct image" adjustment then you will have to perform that rotation in your head.

What you see in the finder may be rotated as it is in this example. It is best to turn the chart as needed until it matches what you see in the finder.

Start by identifying the bright star  $\theta$ . If your red dot is aligned then it should be in the center of the field of view. If not point to an easily identifiable star such as Capella and adjust the knobs on your finder and red dot so they are centered on what you see in the eyepiece. Doing so will save yourself much grief. Ask for help if you don't know how to do this!

Next, note the two bright stars marked A (these may be just outside of the field of view). Bright stars, especially those in patterns, are excellent landmarks.

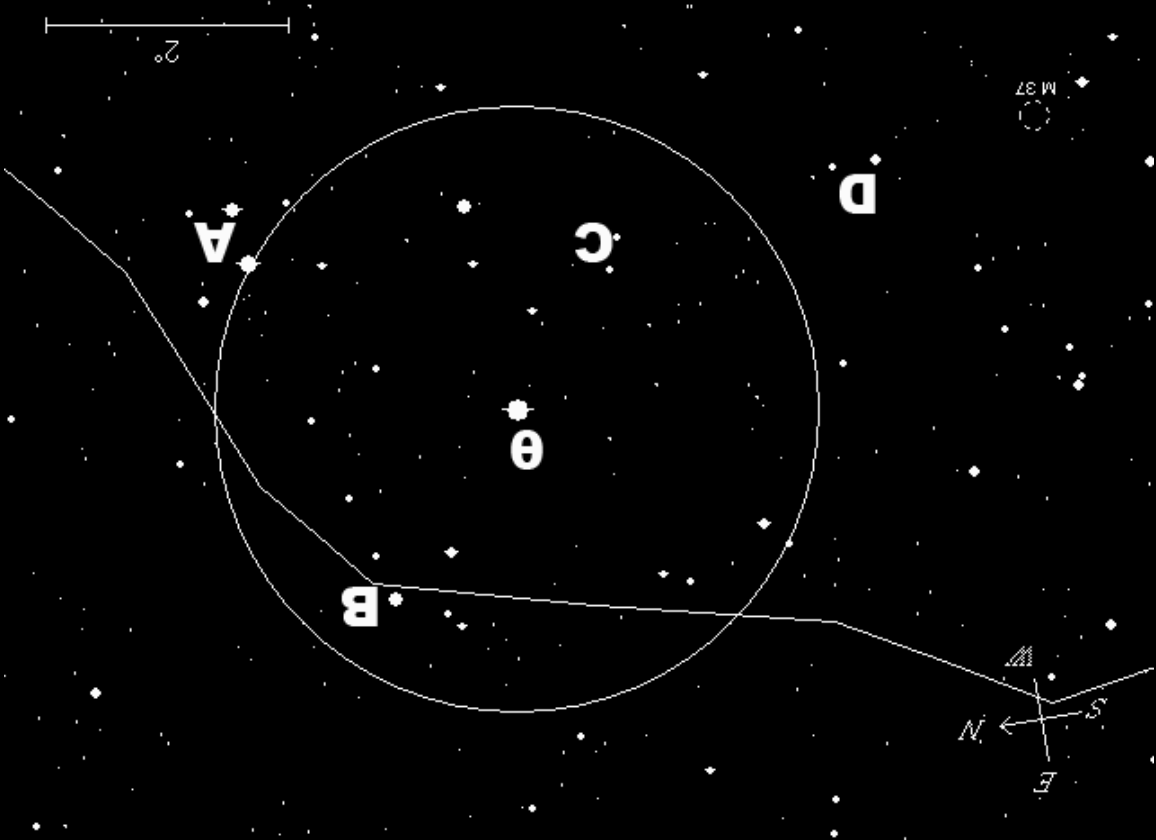
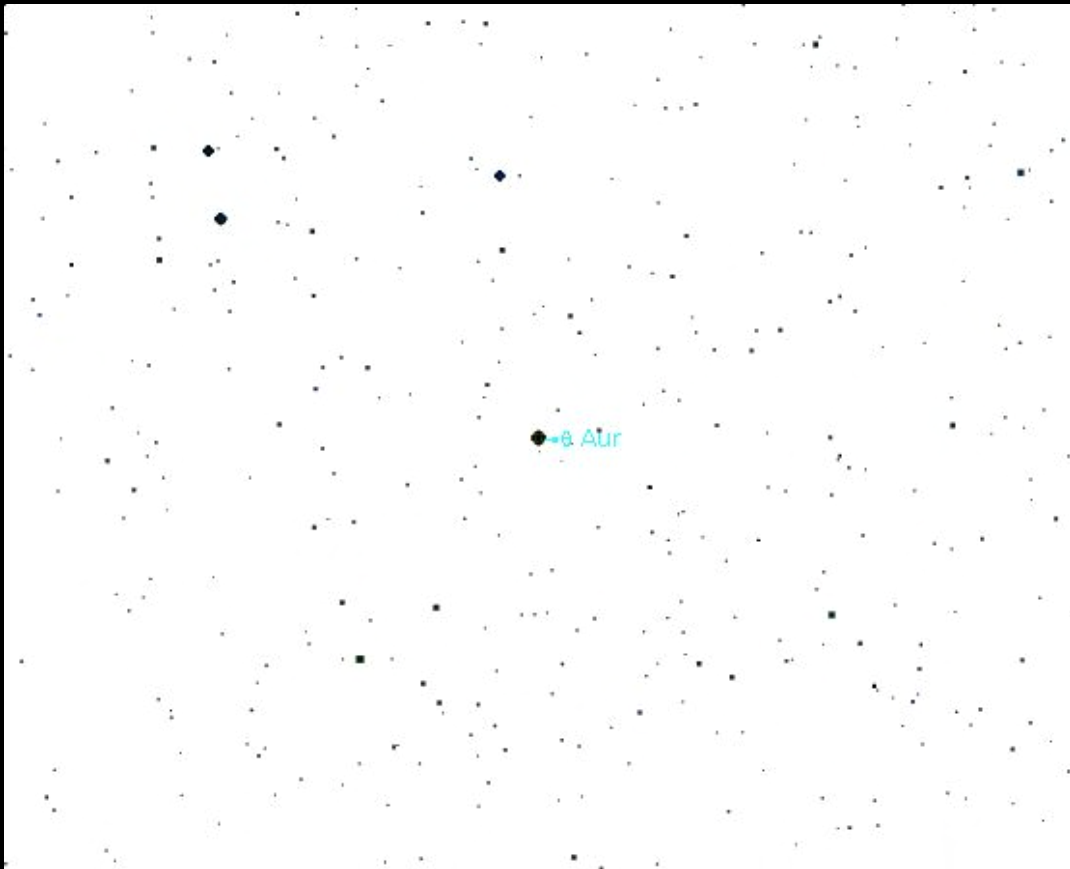
Now note the pattern B. This lies opposite of the path the scope needs to move. You are now ready to start moving the scope toward M 37.

While looking in the finder move the telescope until the cross hairs are on the two stars C. Just pull the scope in the correct direction so the stars move in the direction required by the chart. This is why this process is easier if the chart is rotated to match the sky.

Again looking in the finder move the telescope toward the three stars D. At this point M37 will be in the finder. Adjust and switch to the eyepiece. A small further movement will bring M37 into the field of view.

**It is important you rotate you chart to match what you see.** I have done so in the chart below.

When you look in the finder you may not see as many stars as are charted. City lights will limit what you can see. Start with the brighter stars (larger dots) and verify everything is where it is supposed to be. If you can not match what you see to the chart you are probably in the wrong place!



Confused? A labeled version of the star field is on Page 34.

## ***The Red Dot Shortcut***

The example above is how I learned to star hop. I find it is the best method with most paper charts. The red dot is used to speed finding the first hop, but not to find the actual object.

Using your red dot differently allows you a “cheat” that can make star hopping somewhat faster. The new program SkyTools Version 3 allows you to generate a visual, finder, and eyepiece chart for any object. An example of a Skytools chart is shown on Page 11.

The top left panel shows a visual view of the sky corrected for the sky conditions at your site with your weather (assuming you take the time to set these correctly). The panel is oriented zenith up. Notice that M37 is just to the left of the center of a line between  $\theta$  Aur and  $\beta$  Tau. Place your red dot at this location then look in your finder.

Skytools remembers the properties of your finder. I use a correct view, but for a straight thru finder the chart would be correctly inverted. It may still be rotated since you may viewing the finder from the side. M37 is finder visible in all but the darkest skies, for the moment pretend it is not.

By using the red dot you may not be exactly on the correct location, but you may be close (assuming you have picked your guide stars correctly). Check to see if the view in the finder matches the finder chart. If you are using this on a computer you can zoom the finder chart a bit to give you a better view. Move the scope to match the correct finder view.

The eyepiece chart will help you with the final location of the object. In this case M37 is fairly obvious.

This technique may save you some time in darker skies where you have more guide stars. If you are going to try this it is extremely important that you precisely align your red dot and finder at the start of the observing session.

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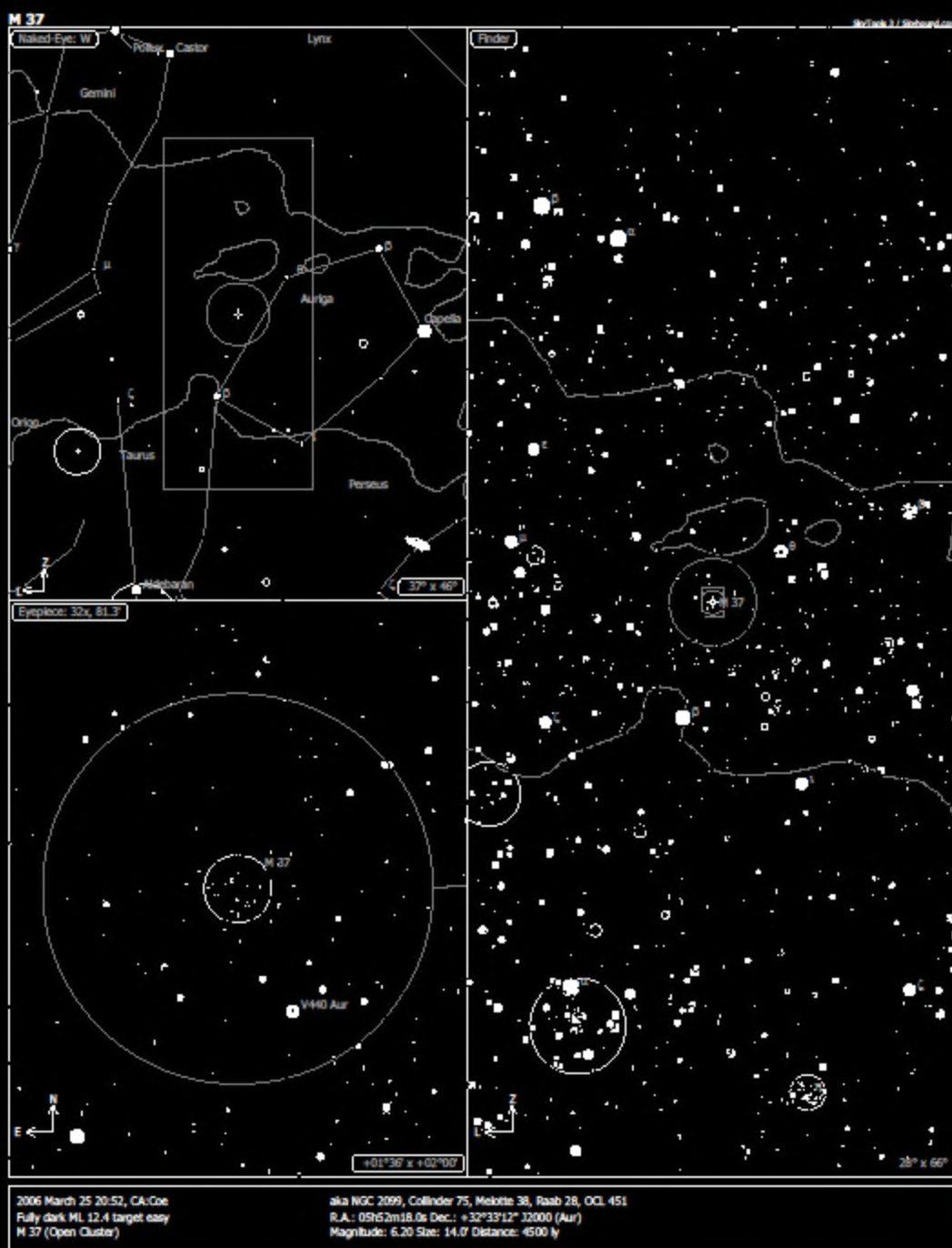


Figure 1 Sample SkyTools Chart

## Sunset Objects (Twilight – 9 PM)

The first group of objects are in many ways the hardest. The Marathon that is closest to me is held at Henry Coe State Park<sup>2</sup> near San Jose. This is an excellent site in many ways due to its dark eastern and low southern horizons. Unfortunately, San Jose and the suburb of Morgan Hill lie to the west. The sunset objects are thus competing with the considerable light pollution from a major city. A skylight filter or light pollution filter<sup>xiii</sup> may help in picking these out from the glare. Refer to **Figure 1** for a Visual overview.

Don't spend too much time looking for any sunset object. If you can't find it move on to the next and then come back. I was not able to see two in my 8" scope (I did better the next year with a 15").

### 1. M 74 (19:45)

This is one of the most challenging objects of the evening since it is so low in the west. You want to start looking for this object even before astronomical twilight. Getting in the vicinity of it is fairly easy since there are a number of bright stars nearby. **Figure 2** shows a finder view of the object.

Sheratan (Beta Aries mag 2.64) will be the most easily visible star in the vicinity. Gamma Aries (below and to the left) may be visible near it. Put the red dot on Sheratan, confirm gamma in your finder, and then move down until eta ( $\eta$ ) is visible. M 74 should be east within the finder field of view. Use your eyepiece view to verify the star patterns around M 74.

### 2. M 77 (19:50)

In principle you should be able to easily hop to this using delta Ceti; however, this star (mag 4) will probably not be visible in late March or with light pollution. It is easier to try using Menkar as a visual reference and then move the scope down until delta Ceti is visible. **Figure 3** shows a finder view of the object.

### 3. M 33 (20:05)

M 33 is another challenging object due its low surface brightness. Getting into the vicinity is easy since it is about ½ way between Hamal (Alpha Aries) and Mirach (Beta Andromeda). **Figure 4** gives the finder chart for M 33.

A suggestion. If you cannot find M 33 directly you may be able to see NGC 604 that lies in one of its arms using an O3 filter. See **Figure 5**, which is an *eyepiece view* of M 33.

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<sup>2</sup> <http://www.sjaa.net/coe.html>

#### **4-6. M31, M32, and M110 (20:15)**

This group of three galaxies is relatively easy compared to the previous ones. M31 is a visual object in dark skies and is easily seen in the finder. See **Figure 6**.

The classic hop is to start at Mirach, go to Mu( $\mu$ ) and then on to M31. Note that M110 may be hard to see due to low surface brightness.

The *Eyepiece View* **Figure 7** will give you a better chance of finding M110. The view of view circle is 1°. M31 will not extend as far as the arc.

#### **7. M 52 (20:20)**

M 52 is located using **Figure 8**. Start with Schedar move in the direction of Caph and then continue moving the same distance and direction.

#### **8. M 103 (20:25)**

M 103 is located next to Ruchbah as shown in **Figure 8**. Place your dot on Ruchbah. M103 will be within the finder view.

#### **9. M 76 (20:30)**

Please refer to **Figure 9**. Phi ( $\phi$ ) Perseus (mag about 4) may be a visual star. If so, put the red dot on this and M 76 should be just N.

Otherwise you will have to hop from Schedar. Center on Schedar and locate  $\eta$ .  $\eta$  is NE of Schedar. Move E to  $\theta$ . Now move SE until Phi ( $\phi$ ) Perseus is visible.

#### **10. M 34 (20:35)**

M 34 is most easily hopped to starting from Algol (beta Perseus). See **Figure 10**. Center Algol in the finder. Note rho ( $\rho$ ) Perseus. You will want to move the scope down from the line of Algol to rho until you come to 12 Perseus. M 34 will be just off of the edge of the finder to the north.

#### **11. M 45 The Pleiades (20:45)**

The Pleiades (also known as the seven sisters) is a visual object. Look up, log it, and move on. If you want to take a look at it in the scope do so after you do M 79.

#### **12. M 79 (20:50)**

M 79 is the last of the rushed sunset objects. See **Figure 11**. It will be low in the SW sky. Two bright stars in Lepus point to M 79, Arneb and Nihal. M 79 forms an L with these two stars at the top and epsilon ( $\epsilon$ ).

## Winter Messier Objects (9 PM to 10 PM)

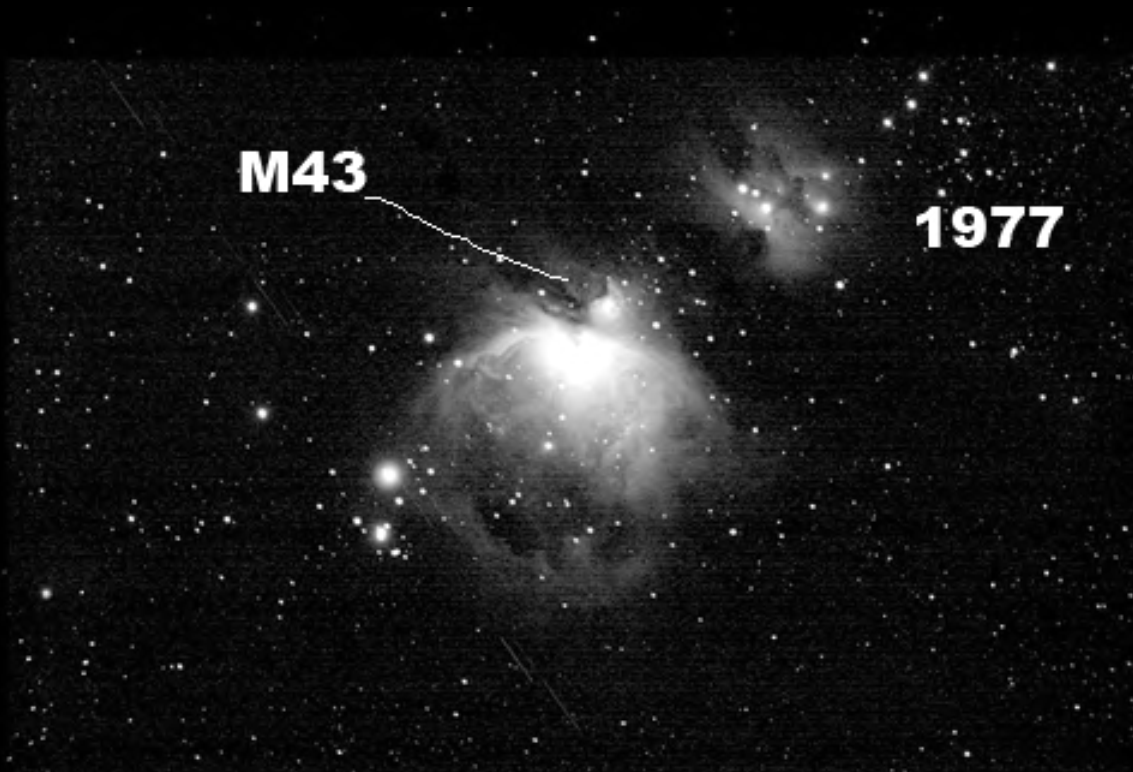
Now that M 79 is finished you have completed the sunset rush. You will have more time on the next group of objects and they will be higher in the sky. The next objects are the Messier Objects most closely associated with the winter skies. See **Figure 13** for an overview of the next objects that will be observed.

### 13. *M 42 (21:00)*

The first winter object to be observed is the Great Orion Nebula. Again this is a visual Object.

### 14. *M 43 (21:01)*

M 43 is a reflection nebula near M 42. There is a lot of stuff near M 42 so be careful you identify the correct object. It is not nearly as bright as M 42 and it will not respond to an O3 filter.



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**15. M 78 (21:10)**

M 78 is tricky because it is a very subtle object. To aid in the search **Figure 14** is a detailed finder chart with stars to Magnitude 12. The large circle is 5°. The small circle is 1°. Note the close pattern of stars to the SE of M78. These should be easy to spot in your finder.

**16. M 1 (Crab Nebula) (21:15)**

M1 is easy if you start with the correct star. This time of the year zeta Tau ( $\zeta$ ) is almost directly above the bright red star Aldebaran. In 2006 Mars will also be near zeta. Make sure you use **Figure 13** to orient yourself.

Put your red dot on zeta (**Figure 15**). M1 will be located SW in a line of mag 6-7 stars.

**17. M 35 (21:20)**

M 35 is located near one of the feet of Gemini. The 3 stars eta ( $\eta$ ) Gemini, mu ( $\mu$ ) Gemini, and 1 Gem are your guides. If you put eta and 1 Gem in your finder as shown in the figure, then M 35 will be within the finder field of view. Caution M 35 is big (note the 1° field of view circle). Don't confuse the smaller NGC 2158 with M 35. This is a good reason to use an eyepiece with a wide field of view.

**18. M 37 (21:25)**

Auriga looks like a pentagon in the sky with the bright star Capella on the north and  $\beta$  Tau on the southwest. Technically Elnath is in Taurus so the constellation figure doesn't match what your eyes see.

M 35 can usually be located by placing your red dot about ½ way between theta ( $\theta$ ) and  $\beta$  Tau. You can try using your red dot to speed you to M37 as described on Page 10.

**19-20. M 36 and M 38 (21:30)**

These two OCs are right next to each other so you really look for them both at the same time. From M 35 move first to the two close stars W of M 37. M 36 will be in one corner of the finder. Once you have seen M 36 continue moving in the same direction. M 38 and M 36 will be within a single finder field of view.

**21. M 41(21:35)**

The next group of objects will be in the southern sky. M 41 is located in Canis Major near Sirius. See **Figure 13** for a visual view and **Figure 16** for a finder view. M 41 is at one corner of a triangle with Sirius and Mirzam ( $\beta$ ). It should be easily located with a red dot.

**22. M 93 (21:40)**

M 93 is located near  $\xi$  Puppis. See **Figure 13** for a visual view and **Figure 16** for a finder view. Puppis is left of the bright stars in the bottom of Canis Major.

**23-24. M 47 and M 46 (21:45)**

Once again these two objects are found with a single search. See **Figure 17**. The easiest way is to drop down and left from  $\alpha$  Monoceros. As you can see it is about 1 finder view away. M 46 is much dimmer than 47 and is probably best located in the eyepiece

**25. M 50 (21:50)**

Look for  $\theta$  above Sirius. See **Figure 17**. Move about 1 finder width higher and you will be on M 50.

**26. M 48 (21:55)**

M 48 is the last of the Monoceros OCs. See **Figure 18**. It is located a long way from bright stars so averted vision may be required to find the guide stars. Try hopping from nearby  $\zeta$  Monoceros (mag 4.3). If you can't see zeta then you will have to use  $\alpha$  Monoceros.

## **Leo and Cancer (10 PM – 10:30 PM)**

The next set of objects are the Messier's associated with the spring sky. At 22:00 these will be high in the south sky. Consult **Figure 19** for an overview.

### **27. M 44 BeeHive Cluster (22:00)**

The Beehive is a visual object. Use **Figure 19** for reference. In 2006 Saturn will be quite close to it.

### **28. M 67 (22:05)**

M 67 is located next to the dim star Acubens (mag 4.25  $\alpha$  Cancer) which is below and to the left of M 44. Use **Figure 19** for reference.

### **29-31. M 95, M 96, and M 105 (22:10)**

These three galaxies are all searched for as a group. Please refer to **Figure 20**. Note the size of the  $1^\circ$  field relative to the size of the galaxy field.

M 95 is the first galaxy to search for. Start with rho ( $\rho$ ) Leo. Move the finder view left (east). You can look for two triangle patterns using 53 Leo. Either or both may be visible. You will need to do the rest from the *eyepiece view* using **Figure 21**.

### **32 – 33. M 65 and M 66 (22:15)**

Start with Chertan (the right lower hind star on Leo). See **Figure 20** and **Figure 22**. Move down in the finder until you are centered on the triangle. Now switch to your eyepiece. Remember that NGC 3628 is similar in magnitude. All three should fit in a  $1^\circ$  field of view.

## **Ursa Major Objects (10:30 PM – 11:30 PM)**

Now swing your scope to the north. The next set of Objects are in Ursa Major and Canes Venatici. At about 10:30 PM these will be in the northeast sky. The visual chart **Figure 23** includes Alt Az bearings since this is high in the sky.

### **34 – 35. M 81 and M 82 (22:25)**

There are two star hops to M81 and M82. See **Figure 24**. The first is to draw a line from Phecda through Dubhe and then an equal distance beyond. Place your red dot here and M82 should be in the finder.

The second involves jumping from Dubhe to 23 and then to 24. Place 24 as shown in the finder and M81 may be finder visible.

### **36 – 37. M 97 and M 108 (22:30)**

Both of these objects are near Merak (see **Figure 25**). Place Merak as shown in your finder. M 97 should be centered. You may need an O3 filter. M 108 will be about ½ the distance back to Merak.

### **38. M 109 (22:35)**

M 109 is next to Phecda (see **Figure 25**). Place the red dot on Phecda. M 109 is just out of the field of view of a 1° eyepiece.

### **39. M 40 (22:40)**

M40 is just a double star. Messier thought he saw nebulosity in it (like M 78), but modern observers disagree. For historical reasons the object has been left in the catalog. **Figure 26** is an *eyepiece view* of M40. Note Megrez ( $\delta$ ).

### **40. M 106 (22:45)**

Use **Figure 25**. Hop to 106 from M40 by first going to 5 Cvn. 106 is in direct line between Dubhe and Phecda and forms a right triangle with 5 Cvn.

**41. M 94 (22:50)**

M 94 is an easy hop from Cor Caroli (alp Cvn). See **Figure 27**. If you put your red dot on Cor Caroli then M 94 will be just to the left of the finder field of view.

**42. M 63 (22:55)**

Go back to Cor Caroli. Refer to **Figure 27**. Now move the scope about 1 finder field down to the upside down T (20). M 63 will be to the left of the T.

**43. M 51 (23:00)**

M 51 can be quickly found using Alkaid (the star at the end of the dipper). Refer to **Figure 28**. Place your red dot on Alkaid. Note line of stars ending in 24 Cvn. Move your finder in that direction. You will see a triangle of dimmer stars. M51 is on the far side of the triangle with its companion NGC 5195.

**44. M 101 (23:05)**

Go Mizar/Alcor. Follow the chain of stars from Mizar/Alcor. Note this is a rather dim object despite its large magnitude.

**45. M 102 (23:10)**

M 102 is located from Edasich (12 Draco). See **Figure 23** for a visual reference and **Figure 29** for a finder view. M102 is located just up and to the right of Edasich.

**47. M 53 (23:15)**

Refer to **Figure 23** for visual directions and **Figure 30** for finder directions. Start the star hop from Arcturus through Muphrid and then continue to the dim star alpha Com (mag 4.38). Note there is another Glob of similar magnitude near M 53.

**47. M 64 (23:20)**

Move the scope up from M 53 about 1 finder width. Use the mag 5 star 35 com to indicate how far up to move.

**48. M 3 (23:25)**

M3 is a finder visible object even from urban sites. You should be able to find it by putting your red dot about ½ between Cor Caroli and Arcturus. The visual view in **Figure 23** should help put you in the correct location. Otherwise consult the finder chart in **Figure 30a**.

## **Downtown Virgo (11:45 PM – 1 AM)**

This would be a good time to go to the rest room. For the next group of objects you will do a single hop with the finder and then navigate at the eyepiece. Consequently most of the charts in this section will be eyepiece charts.

### ***The 3 Landmarks of Virgo***

**Figure 31** gives a visual view of the Virgo area. **Figure 32** is a finder view that includes the annotations for the search approach.

There are 3 references that you can use for Downtown Virgo

- ❑ Hop From Denebola to a finder visible triangle of stars. The Magnitude 5 star 6 com is at the point of the triangle and should be visual with averted vision.
- ❑ M86 and M84 (once you have found them) are very bright and can be used to re-orient yourself
- ❑ Hop from Vindemiatrix to an inverted Y that is easily finder visible. Rho Virgo (mag 4.9) is at the center of the Y and may be visible with averted vision.

The detailed instructions (**Figures 33 and 34**) will direct you to start at the triangle near 6 Com and move using the eyepiece. Consequently I recommend using the eyepiece charts at the eyepiece and not using the text. Just be sure you check off the objects to make sure you don't miss any.

### **49. M 98 (23:45)**

The next set of objects use **Figure 33**.

M 98 is at the point of the triangle. 6 Com should be at the side of your field of view. Take a moment to familiarize yourself with the rotation of the sky relative to the charts. The extremely large circle is the field of view of the finder. The group of small circles is our 1° fields of views from our eyepieces. You should be able to follow the star hops just from the chart.

### **50. M 99 (23:50)**

Move along the triangle in the SE direction past 6 com to M 99. 6 Com will just be outside of the field of view once M 99 is reached.

### **51. M 100 (23:52)**

Move back to 6 Com and then along the N edge of the triangle to M 100.

**52. M 85 (23:56)**

From M 100 move the field of view N to 11 com. It is about 2 degrees. Note the star pattern that is the ½ waypoint. Once you have reached 11 com move E one field of view to M85.

**53-54. M 84 M86 (00:00)**

From M 85 you can backtrack to M 99 and continue along the direction of the triangle to M 84/86.

The way I have done it is to star hop using the path shown by the group of field of views. M84/86 are in the cluster of galaxies at the top of the page. M 84 and M 86 will form your next landmark. Take a moment to look in your finder and remember the field of view in case you have to come back to it.

**55. M 87(00:05)**

The next group of objects use **Figure 34**.

M 84 and M 86 lie on a roughly E-W path. Move the field of view SE to M 87.

**56. M 89 (00:07)**

From M 87 move E to M 89

**57. M 90 (00:10)**

From M 89 move NE to M 90. Remember this field of view, as we will return here shortly.

**58. M 88 (00:15)**

From M 90 move NW to M 88. It will be about 2 fields of view along a dotted line of stars.

**59. M 91 (00:17)**

From M 88 move E one field of view to M 91. Once you have reached M 91 complete the triangle back to M 90.

**60. M 58 (00:20)**

Having returned to M 90 in the previous step continue on in the same direction along a line of stars. This direction is marked by a mag 8 star just SE of M 90 at the beginning of the line of stars. M 89 will probably flash through one side of the eyepiece.

## Downtown Virgo

### **61-62. M 59 M 60(0:24)**

A mag 8 star lies just W of M 58. Move E about 1 field of view. M 59 will be the first object seen. M 60 the second. Once you are done look in the finder. Align the finder to  $\rho$  the middle star of the Y. You have just completed Downtown Virgo! Time to stretch.

### **63 M 49 (0:35)**

Now that Downtown Virgo is complete it is time for the Virgo suburbs. Refer to **Figure 32**. Using your finder reacquire the upside down Y. Now move your scope down and to the right to M49.

### **64 M 61 (0:40)**

Continue moving in the same direction M61 is one finder field of view further.

### **65. M 104 (0:45)**

The next set of objects are located below and to the right of Leo. Use **Figure 35** for visual reference. They are best located using the red dot

M104 is a quick hop from the top of Corvus (**Figure 36**). It will be on a line from the bottom right star through Algorab and about the same altitude as Spica.

### **66. M 68 (00:50)**

Refer to **Figure 37**. M68 is about 1 ½ finder views down from the bottom left star of Corvus (beta)

### **67. M 83 (00:55)**

Put your red dot in the middle of Hydra star pattern as shown in **Figure 38**.



## **Early Summer Objects (1:15 AM – 3:30 AM)**

If you have been following the timeline it is now about 1AM. The problem now is that the eastern horizon of Coe is about to dictate the object order. Thus from this point onward there are some differences between the object order in this paper and Machholz's order {marked with braces}. Similarly for marathons held at other sites the order will have to be varied based on what the horizon looks like. The rule from this point forward is

### **“If you can see it, bag it”**

The visual chart (**Figure 39**) will attempt to mark the eastern horizon line with a heavy black line.

#### **68. M 5 (01:15)**

M 5 will be fairly high in the sky so it is logical to complete it. Refer to **Figure 40**. Start with Unukalhai (alp Serpens). Move the scope right about 2 finder fields of view. M5 should be detectable in the finder.

#### **69. M 13 (01:20)**

Refer to **Figure 41**. M 13 is easily finder visible and will be 1/3 of the way between the top two stars in the Hercules keystone.

#### **70. M 92 (01:25)**

M 92 is located about ½ way between the bottom star in the Hercules keystone and Rastaban.

#### **71 {77.} M 107 (1:30)**

Refer to **Figure 42**. From Coe the next object in Machholz's sequence is too low. We will pick up several objects while Lyra rises higher.. M107 is half way between zeta and Phi Ophiuchus.

#### **72{78}. M 12 (01:35)**

Start your hop from the two similar magnitude stars Yed Prior and Yed Posterior. Hop to 12 Oph and then continue to M 12. M 12 should be finder visible.

#### **73{78}. M 10 (01:36)**

Move the scope down about ½ finder field. 30 Oph and 23 Oph should be visible. M 10 will be slightly above the line between these.

**74{79}. M 14 (01:37)**

You can probably move directly from M 10 to M 14 by following the star field. If you are unsure I have marked out a path to follow.

**75{71}. M 57 (02:00)**

Now that Lyra has risen we can do the two objects there. M57 is between Sheliak and Sulafat in Lyra. Use **Figure 39** for visual reference and **Figure 43** for your Finder.

**76{72}. M 56 (02:05)**

M56 is about ½ way between Sulafat and Alberio.

**77{81}. M 9 (02:15)**

Refer to **Figure 44**. M 9 is about the same elevation as Antares. You should try to get it as soon as it has risen enough. M 9 is directly below Sabik in the same finder field of view.

**78{82}. M 4 (2:20)**

M 4 is in the same finder field of view as Antares.

**79{83}. M 80 (2:21)**

M 80 is above M 4. Follow  $\sigma$  to the correct field of view.

**80 {73} M29 (02:30)**

Refer to **Figure 45**. M29 is near Sadir. M 29 is really small in a field rich with stars. The following will help you identify it. The circle is 1°.



**81{74.} M39 (02:35)**

M39 may still be too low. If so, continue with M 71 and M 27 and then come back to it.

M 39 is a long star hop from Deneb. Move the finder to the field of stars left of Deneb. From there proceed in the direction of the arrows. This is a hop that I have to visit each star pattern.

**82{76} M 71 (02:40)**

Refer to **Figure 46**. M 71 is in the constellation Sagitta that is populated by fairly dim stars. If necessary, locate it using Altair and Tarazed as a visual reference. M 71 is located between  $\gamma$  and  $\delta$ . The latter will be in the same field of view as  $\alpha$  and  $\beta$ .

**83{77} M27 (02:42)**

From M 71 continue to the last star in Sagitta ( $\eta$ ). Move NW (at right angle to  $\gamma$ ). Note the arrow asterism. M27 may be finder visible, but don't count on it.

**86. M 19 (02:50)**

Refer to **Figure 47**. This Glob is about 2/3 way between Antares and  $\theta$  Oph.

**87. M 62 (02:52)**

From M 19 move the scope down and to the right. There is an asterism that forms a cup with M 62 in the center.

Unfortunately you will probably have to wait for the sky to rotate, before you can continue this hop with M 6 and M 7. The Horizon line is an estimate. Proceed as quickly as you can. At least M 7 is a visual object when it is higher.

This would be a good point for a break. From 3:30 on you will be busy until twilight.

**86. M 6 (03:15)**

Refer to **Figure 48**. As soon as you can after bagging M 62 move onto this object. It is about to get very busy.

M 7 should be visual. M 6 will be about a finder view above it. You can star hop from the two stinger stars in the scorpion.

**87. M 7 (03:20)**

M 7 is below M 6 and about the same height as the stinger stars.

## **Summer Milky Way (3:30 AM – 4 AM)**

The time between Downtown Virgo and now has been pretty well filled with picking off objects here and there. Now a whole pile of objects is about to rise followed closely by twilight. You will have to operate efficiently here or you will not complete the list.

At this point it is about 3:30 AM in the morning. You should recheck your list to make sure you have not missed any objects.

Note the pace in the timeline is going to pick up considerably. While earlier the timeline allowed 5-10 minutes per object, it will now be down to 1 or 2.

Like in Virgo you will probably not have time to read my prose. Thus this section contains detailed finder charts that document each movement of the scope. I suggest you work from these plus a checklist to insure you don't miss anything.

Take a moment to study **Figure 49**. It is especially important to visually find the dim arc of stars near M 11 at the edge of Aquila. These show up better on the more detailed chart **Figure 50**. Once you locate M11 you will traverse down to the upper Sagittarius objects using the finder.

Let the fun begin.

### **88. M 11 (03:30)**

Refer to **Figure 50**. The band of stars from  $\lambda$  to  $\eta$  to  $\beta$  is the visual reference. Use these as a guide to find M 11. M 11 may be finder visible as a hazy patch.

### **89. M 26 (03:35)**

From M 11 move right to  $\epsilon$  and  $\delta$ . M 26 will be slightly down.

### **90. M 16 (03:40)**

From M 26 move right. An unlabeled mag 5 star will pass through the field of view. A group of stars containing  $\gamma$  will pass through the bottom of the finder. That field needs to be just out of the field of view for M16.

### **91. M 17 Swan Nebula (03:41)**

The Swan Nebula is about  $\frac{1}{2}$  finder field of view below M 16.

### **92. M 18 (03:42)**

Another  $\frac{1}{2}$  finder field of view down is the smallish OC M 18.

**93. M 24 (03:43)**

Continue down and a little right to the Sagittarius Star Cloud M 24. Note the field in your finder if you have been hopping at the eyepiece.

**94. M 25 (03:44)**

Refer to **Figure 51**. Move the scope down and to the left (E) about 1 finder view to M 25. Return back to M24.

**95. M 23 (03:45)**

Move right (west) about 1 finder view to M 23. As an alternative move down to  $\mu$  and then follow the group of stars.

**96-97. M20 (Trifid Nebula) M21(03:46)**

Move the telescope down about 1 field of view to the finder visible M 20. Verify in the eyepiece. M 21 is just NE of M 20.

**98. M 8 Lagoon Nebula (3:48)**

The Lagoon Nebula is in the same finder field of view as M 20. Verify in the eyepiece. The Lagoon has an OC NGC 6530 within it.

**99. M 28 (3:49)**

Put the red dot on Kaus Borealis the star at the top of the teapot. M 28 is within the finder field of view.

**100. M 22 (3:50)**

M 22 is the opposite direction from Kaus Borealis and is finder visible.

**101. M 69 (3:54)**

The next group of objects are along the bottom of the teapot. Refer to **Figure 52**. Moving left from Kaus Australis the first OC you encounter is M 69.

**102. M 70 (3:55)**

Continue past NGC 6652 to M 70.

**103. M 54 (3:56)**

Continue to M 54. Ascella is in the same finder view of view.

## Sunrise Objects (4 AM – Twilight)

The next batch of objects are going to be challenging since you are trying to beat twilight. You should do these in any order. **Figure 53** will orient you. Note the altitude grid. At least part of the horizon will be lost to the hills east of Coe.

### **104. M 55 (04:00)**

Refer to **Figure 54**. Start with the kite shaped asterism labeled  $\omega$  above. The heavy line is about  $12^\circ$  above the horizon. Note that the kite shape may be difficult to see visually. Move right to M 55.

### **105. M 75 (04:10)**

Return to the kite asterism. Move left and up a little over one-finder field to M 75.

### **106. M 15 (04:15)**

Refer to **Figure 55**. Start with Enif. Enif is at the end of Pegasus, but the familiar square does not rise until after twilight. Notice the two small stars above Enif. These point to M 15. M 15 is normally finder visible, but don't count on it this low.

### **107. M 2 (04:17)**

M 2 is a short hop from Sadalsuud, but if Sadalsuud is not visible yet you will need to come down from Kitalpha.

### **108-109. M 72 and M73 (4:30)**

Refer to **Figure 56**. Try to locate this using Albal. Otherwise you will need to do the longer hop from Dabih.

## Twilight

### **110. M30 (after 4:50)**

M30 will rise at 4:44 in 2006, which is after twilight. At 4:50 it will be  $1^\circ$  high. Try to find it in the increasing light using **Figures 57 and 58**. M 30 is mag 6.9. The star at 2 o'clock in **Figure 58** is mag 5.25.

## Actual Observed Object Timeline

The following table is based on my logs of my first Marathon on March 11-12, 2004 and second Marathon on March 11-12, 2005. While the 2004 marathon was my first marathon, I had extensively practiced before the actual event as can be seen in how quickly Virgo was traversed.

The 2004 marathon was performed with an 8" f/6 manual Dobson. The charts on which this book is based were developed for this marathon. The 2005 marathon used a 15" Plettstone Dobson. Note that my logging in 2005 was not as precise.

Finder Visible means you should be able to detect at least these objects in a 9x50 Finder.

Rob #	Recommended Timeline <sup>3</sup>	Time 2004	Time 2005	Object	Finder Visible	Mag	Type	Machholz Order
1	19:50	19:17	19:38	M 77		8.9	Galaxy	1
2	19:45		19:38	M 74		9.5	Galaxy	2
3	20:05	19:01	19:58	M 33		5.5	Galaxy	3
4	20:15	19:48	20:18	M 31	<input checked="" type="checkbox"/>	3.5	Galaxy	4
5	20:16	19:49	20:18	M 32		8.1	Galaxy	5
6	20:15		20:13	M 110		8.7	Galaxy	6
7	20:20	20:11	20:28	M 52	<input checked="" type="checkbox"/>	6.9	Open Cluster	7
8	20:25	20:15		M 103	<input checked="" type="checkbox"/>	7.4	Open Cluster	8
9	20:30	20:20	20:45	M 76		10.1	Planetary Nebula	9
10	20:35	20:35	20:50	M 34	<input checked="" type="checkbox"/>	5.2	Open Cluster	10
11	20:45	20:42	20:57	M 45	<input checked="" type="checkbox"/>	1.2	Bright Nebula	11
12	20:50	20:47	21:11	M 79		7.7	Globular Cluster	12
13	21:00	20:52	21:11	M 42	<input checked="" type="checkbox"/>	4	Bright Nebula	13
14	21:01	20:53	21:12	M 43		9	Bright Nebula	14
15	21:10	20:54	21:12	M 78		8	Bright Nebula	15
16	21:15	20:56	21:23	M 1		8.4	Supernova Remnant	16
17	21:20	20:58	21:27	M 35	<input checked="" type="checkbox"/>	5.1	Open Cluster	17
18	21:25	20:59	21:27	M 37	<input checked="" type="checkbox"/>	5.6	Open Cluster	18
19	21:30	21:04	21:32	M 36	<input checked="" type="checkbox"/>	6	Open Cluster	19
20	21:31	21:05		M 38	<input checked="" type="checkbox"/>	6.4	Open Cluster	20
21	21:35	21:09		M 41	<input checked="" type="checkbox"/>	4.5	Open Cluster	21
22	21:40	21:11	21:37	M 93	<input checked="" type="checkbox"/>	6.2	Open Cluster	22
23	21:45	21:14		M 47	<input checked="" type="checkbox"/>	4.4	Open Cluster	23
24	21:46	21:15		M 46	<input checked="" type="checkbox"/>	6.1	Open Cluster	24
25	21:50	21:16		M 50	<input checked="" type="checkbox"/>	5.9	Open Cluster	25

<sup>3</sup> Time in PST. Advance 1 hour for PDT



# Actual Observed Timeline

Rob #	Recom- mended Timeline <sup>3</sup>	Time 2004	Time 2005	Object	Finder Visible	Mag	Type	Machholz Order
26	21:55	21:19		M 48	<input checked="" type="checkbox"/>	5.8	Open Cluster	26
27	22:00	21:20		M 44	<input checked="" type="checkbox"/>	3.1	Open Cluster	27
28	22:05	21:27		M 67	<input checked="" type="checkbox"/>	6.9	Open Cluster	28
29	22:10	21:49		M 95		9.8	Galaxy	29
30	22:11	21:50		M 96		9.3	Galaxy	30
31	22:12	21:51		M 105		9.5	Galaxy	31
32	22:15	21:52		M 65	<input checked="" type="checkbox"/>	9.2	Galaxy	32
33	22:16	21:53		M 66		8.9	Galaxy	33
34	22:25	21:58		M 81	<input checked="" type="checkbox"/>	7	Galaxy	34
35	22:26	21:59		M 82		8.6	Galaxy	35
36	22:30	22:04	22:28	M 97		9.9	Planetary Nebula	36
37	22:30	22:05		M 108		9.9	Galaxy	37
38	22:35	22:10		M 109		9.8	Galaxy	38
39	22:40	22:12		M 40		9	Unknown	39
40	22:45	22:15		M 106		8.3	Galaxy	40
41	22:50	22:18		M 94	<input checked="" type="checkbox"/>	8.1	Galaxy	41
42	22:55	22:21		M 63		8.5	Galaxy	42
43	23:00	22:25		M 51	<input checked="" type="checkbox"/>	8.1	Galaxy	43
44	23:05	22:43		M 101		7.5	Galaxy	44
45	23:10	22:48		M 102		9.9	Galaxy	45
46	23:15	22:52		M 53	<input checked="" type="checkbox"/>	7.7	Globular Cluster	46
47	23:20	22:58	0:25	M 64		8.5	Galaxy	47
48	23:25	23:00	0:30	M 3	<input checked="" type="checkbox"/>	6.3	Globular Cluster	48
49	23:45	23:41		M 98		10.1	Galaxy	49
50	23:50	23:42		M 99		9.7	Galaxy	50
51	23:52	23:43		M 100		9.3	Galaxy	51
52	23:56	23:44		M 85		9.1	Galaxy	52
53	0:00	23:47		M 84		9.2	Galaxy	53
54	0:00	23:48		M 86		8.9	Galaxy	54
55	0:05	23:53		M 87		8.6	Galaxy	55
56	0:07	23:54		M 89		9.9	Galaxy	56
57	0:10	23:55		M 90		9.4	Galaxy	57
58	0:15	23:56		M 88		9.4	Galaxy	58
59	0:17	23:57		M 91		10.1	Galaxy	59
60	0:20	23:58		M 58		9.6	Galaxy	60
61	0:24	23:59		M 59		9.7	Galaxy	61
62	0:24	0:00		M 60		8.8	Galaxy	62
63	0:35	0:02		M 49		8.3	Galaxy	63
64	0:40	0:04		M 61		9.3	Galaxy	64

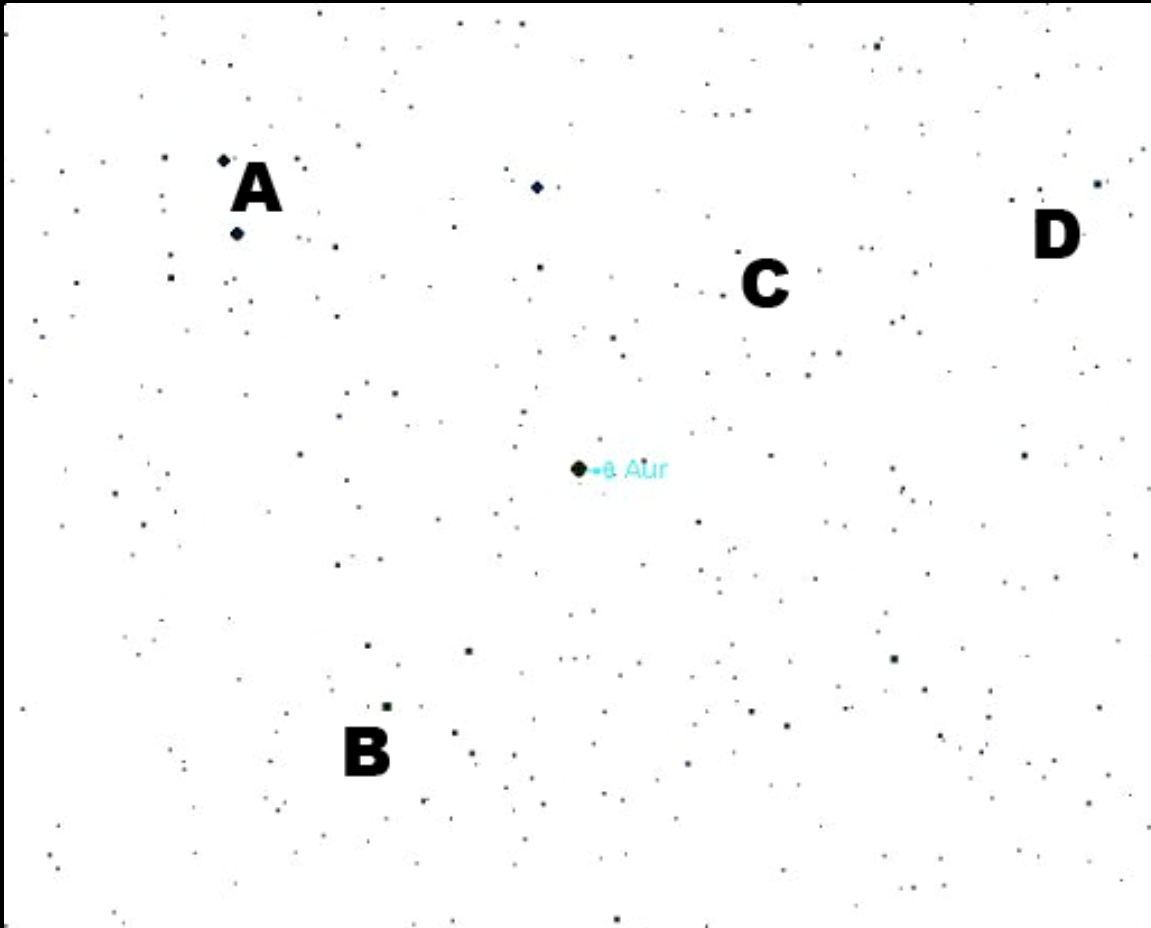
# Actual Observed Timeline

Rob #	Recom- mended Timeline <sup>3</sup>	Time 2004	Time 2005	Object	Finder Visible	Mag	Type	Machholz Order
65	0:45	0:13		M 104	<input checked="" type="checkbox"/>	8.3	Galaxy	65
66	0:50	23:36	1:10	M 68		7.3	Globular Cluster	66
67	0:55	23:34		M 83		7.5	Galaxy	67
68	1:15	0:20	1:56	M 5	<input checked="" type="checkbox"/>	5.7	Globular Cluster	68
69	1:20	1:20	2:01	M 13	<input checked="" type="checkbox"/>	5.8	Globular Cluster	69
70	1:25	1:30	2:01	M 92	<input checked="" type="checkbox"/>	6.5	Globular Cluster	70
71	1:30	1:42		M 107		7.8	Globular Cluster	77
72	1:35	1:54	2:58	M 12	<input checked="" type="checkbox"/>	6.1	Globular Cluster	78
73	1:36	1:55	2:58	M 10	<input checked="" type="checkbox"/>	6.6	Globular Cluster	79
74	1:37	2:01	2:58	M 14	<input checked="" type="checkbox"/>	7.6	Globular Cluster	80
75	2:00	1:33		M 57		8.8	Planetary Nebula	71
76	2:05	2:09		M 56		8.4	Globular Cluster	72
77	2:15	2:13	3:09	M 9		7.8	Globular Cluster	81
78	2:20	2:14	3:21	M 4	<input checked="" type="checkbox"/>	5.4	Globular Cluster	82
79	2:21	3:01	3:26	M 80	<input checked="" type="checkbox"/>	7.3	Globular Cluster	83
80	2:30	2:31	2:46	M 29		6.6	Open Cluster	73
81	2:35	3:07	3:15	M 39	<input checked="" type="checkbox"/>	4.6	Open Cluster	74
82	2:40	2:42		M 71		8.4	Globular Cluster	76
83	2:42	2:51	2:52	M 27	<input checked="" type="checkbox"/>	7.4	Planetary Nebula	75
84	2:50	3:10	3:31	M 19	<input checked="" type="checkbox"/>	6.8	Globular Cluster	84
85	2:52	3:14	3:31	M 62	<input checked="" type="checkbox"/>	6.4	Globular Cluster	85
86	3:15	3:20		M 6	<input checked="" type="checkbox"/>	4.2	Open Cluster	86
87	3:20	3:21		M 7	<input checked="" type="checkbox"/>	3.3	Open Cluster	87
88	3:30	3:27		M 11	<input checked="" type="checkbox"/>	5.8	Open Cluster	88
89	3:35	3:35		M 26		8	Open Cluster	89
90	3:40	3:40	3:46	M 16	<input checked="" type="checkbox"/>	6	Open Cluster	90
91	3:41	3:41	3:46	M 17	<input checked="" type="checkbox"/>	6	Bright Nebula	91
92	3:42	3:42	3:46	M 18	<input checked="" type="checkbox"/>	6.9	Open Cluster	92
93	3:43	3:43	3:51	M 24	<input checked="" type="checkbox"/>	3.1	Open Cluster	93
94	3:44	3:44	3:51	M 25	<input checked="" type="checkbox"/>	4.6	Open Cluster	94
95	3:45	3:45	3:51	M 23	<input checked="" type="checkbox"/>	5.5	Open Cluster	95
96	3:46	3:46	3:56	M 21		5.9	Open Cluster	96
97	3:47	3:47	3:56	M 20	<input checked="" type="checkbox"/>	6.3	Bright Nebula	97
98	3:48	3:48	3:56	M 8	<input checked="" type="checkbox"/>	5	Bright Nebula	98
99	3:49	3:49	4:01	M 28	<input checked="" type="checkbox"/>	6.9	Globular Cluster	99
100	3:50	3:50	4:01	M 22	<input checked="" type="checkbox"/>	5.2	Globular Cluster	100
101	3:54	3:54	4:01	M 69		7.6	Globular Cluster	101
102	3:55	3:55	4:06	M 70		7.8	Globular Cluster	102
103	3:56	3:56	4:06	M 54		7.7	Globular Cluster	103

# Actual Observed Timeline

Rob #	Recommended Timeline <sup>3</sup>	Time 2004	Time 2005	Object	Finder Visible	Mag	Type	Machholz Order
104	4:00	4:47	4:36	M 55		6.3	Globular Cluster	104
105	4:10	4:12	4:51	M 75		8.6	Globular Cluster	105
106	4:15	4:15	4:31	M 15	<input checked="" type="checkbox"/>	6.3	Globular Cluster	106
107	4:17	4:17	4:46	M 2	<input checked="" type="checkbox"/>	6.6	Globular Cluster	107
108	4:30	4:49	4:51	M 72		9.2	Globular Cluster	108
109	4:30	4:52	4:51	M 73		8.9	Open Cluster	109
110	5:01			M 30		8.4	Globular Cluster	110

## Annotated Star Hop Example



This is the example from Star Hopping with the Finder with labels on all of the stars and patterns referred to in the text.

# Endnotes

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<sup>ii</sup> <http://www.seds.org/messier/m-ref.html#machholz>

<sup>iii</sup> <http://www.seds.org/messier/m-ref.html#machholz2>

<sup>iv</sup> [www.willbell.com/atlas/atlas1.htm](http://www.willbell.com/atlas/atlas1.htm)

<sup>v</sup> [www.willbell.com/u2k/index.htm](http://www.willbell.com/u2k/index.htm)

<sup>vi</sup> <http://www.skymap.com/>

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<sup>viii</sup> Rigel <http://www.optcorp.com/product.aspx?pid=105-166-167-757>

<sup>ix</sup> TelRad <http://www.optcorp.com/product.aspx?pid=105-166-167-1084>

<sup>x</sup> Stellarvue Red dot <http://www.optcorp.com/product.aspx?pid=105-166-167-6550>

<sup>xi</sup> Orion Finder  
<http://www.telescope.com/shopping/product/detailmain.jsp?itemID=158&itemType=PRODUCT&iMainCat=6&iSubCat=27&iProductID=158>

<sup>xii</sup> <http://www.skyhound.com/cs.html>

<sup>xiii</sup> <http://www.optcorp.com/ProductList.aspx?uid=105-156-840-850>