Cloudy Nights Telescope Reviews
Your astronomical community

Small Wonders: Deep Andromeda

Satellite Galaxies, Star Clouds and Globular Clusters of M31

A sky guide for the intermediate to experienced amateur astronomer

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Figure 1. M31 and vicinity (image courtesy Jeff Thrush)

Target List

Object	Type	Size	Mag	RA	Dec
M 31	Galaxy	189.1'x61.7'	3.5	$00^h\ 43^m\ 07.7^s$	+41° 18' 40"
M 32	Galaxy	8.5'x6.5'	8.1	$00^h\ 43^m\ 05.1^s$	+40° 54' 29"
M 110	Galaxy	19.5'x11.5'	7.9	$00^h\ 40^m\ 45.4^s$	+41° 43' 39"
NGC 147	Galaxy	13.2'x7.8'	9.4	$00^h\ 33^m\ 35.0^s$	+48° 33' 00"
NGC 185	Galaxy	8.0'x7.0'	9.3	$00^h\ 39^m\ 21.2^s$	+48° 22' 47"
NGC 206	Star Cloud	4.2'		$00^h\ 40^m\ 55.5^s$	+40° 46' 50"
G1	Globular Cluster	10"	13.7	$00^h\ 33^m\ 09.7^s$	+39° 37' 14"
G119	Globular Cluster	2"	15	$00^h\ 42^m\ 16.3^s$	+40° 49' 43"
G213	Globular Cluster	2"	14.7	$00^h\ 43^m\ 37.8^s$	+41° 09' 52"
G272	Globular Cluster	3"	14.8	$00^h\ 44^m\ 37.9^s$	+41° 21' 52"
G280	Globular Cluster	2"	14.2	$00^h\ 44^m\ 53.2^s$	+41° 24' 08"
G72	Globular Cluster	2"	15	$00^h\ 41^m\ 16.1^s$	+41° 21' 16"
G73	Globular Cluster		15	$00^h\ 41^m\ 18.9^s$	+41° 44' 00"
G76	Globular Cluster	3"	14.2	$00^h\ 41^m\ 22.3^s$	+40° 38' 20"
G78	Globular Cluster	3"	14.3	$00^h\ 41^m\ 24.5^s$	+41° 16' 17"

Introduction: M31 and associated objects

If you're a long time reader of this series you're probably asking yourself - "Andromeda? Didn't we do that already?" The answer is, of course, yes. But not like this. There are certain areas in the sky that deserve special treatment, and M31 is one. From time to time, we'll take an observers "diversion" to cover a few topics that can't be covered in a typical Small Wonders. This article covers Messier 31 and some of its attendant galaxies and DSOs. Of necessity, the article is therefore somewhat slanted towards larger scopes, but a surprising number of these targets can be caught in fairly small apertures

Late fall / early winter is a wonderful time to observe in the northern hemisphere. The skies are clear and crisp with the haze of summer long gone. It's a time that brings its own unique challenges for many of us, but there is something to be said for being able to observe by 7pm. Many is the night I've stepped out and looked up into a velvet black sky. My eye is naturally drawn toward zenith, and I can hardly overlook M31. The Andromeda galaxy is one of the best known deep sky objects in the night sky. Easily visible to the naked eye from a clear, semi-dark site, it's fullest extent is open for debate. Recent, conservative reports (Skiff and Luginbuhl, French) place it close to 3 degrees in width, Walter Scott Houston wrote that he'd once measured it close to 5 (10 full moon diameters!), as did Robert Jonckheere in 1953. Take some time to measure it for yourself and see what you come up with. Could the difference in measured length be due to a decline in sky conditions over the years?

Figure 2: Images Courtesy John Graham - M32 and M110

Many know that Messier 31 is surrounded by its own attendant host. Indeed, M32 and M110 greet us in our low power views. I've always found it ironic that these two galaxies would be spectacular objects in their own right, but are relegated to side-show status when accompanying the king of the local group. Some astronomers don't realize these aren't the only attendants easily visible for the amateur. NGC 147 and NGC 185 lie some seven degrees away are often overlooked. From very dark skies, I've barely spotted NGC 185 as a subtle background brightening in a 70mm scope. I find it a fair amount easier in my 4" refractor, although not bright by any means. From my rural skies, I find NGC 147 is barely visible in 4" of aperture.

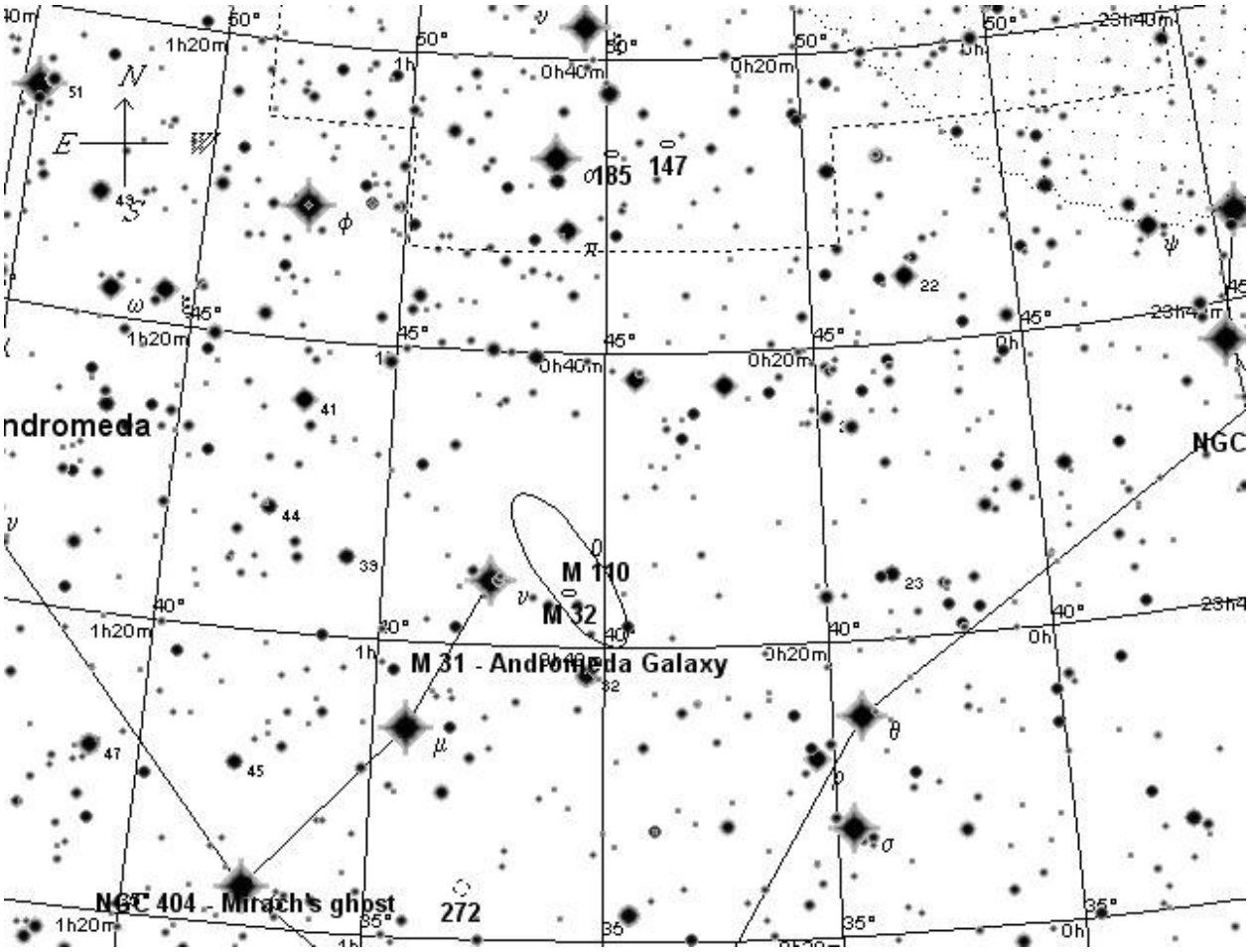

Figure 3: Area map of M31, M32, M110, NGC185 and NGC147

I've viewed M31 in everything from 12x36mm binos to 20+ inch Dobsonians, and I've found that each size has something to offer. I generally prefer smaller apertures so as to take in more than just the central bulge. My favorite views of M31 have typically come through one of my 4" refractors, although I do remember one absolutely spectacular view of the dust lanes though an 18" telescope.

But as beautiful as those objects are though, they aren't the main focus for this article.

It's time to go deep and observe some deep space objects inside Messier 31 itself.

NGC 206 - The Great Star Cloud in Andromeda

You may remember the article I previously wrote on Andromeda. In it I gave G1 (Mayall II) as a challenge object to cap off your observing run. It may surprise some to know that G1 isn't the most visible DSO in M31 – not by a long shot. That honor goes to NGC 206, which is visible in small apertures if you know what you're looking for. NGC 206 is a giant star cloud located in the

southwestern arm, large enough and bright enough for William Herschel to give it a separate catalog number following his observation of it in October of 1786. Some observers have found this stellar association is visible through a 4" scope. To look for it, imagine an isosceles triangle with two corners at M32 and M110. The third corner, lying away from the nucleus of M31, would be NGC 206. If the star cloud isn't immediately obvious try using moderate powers and look for a somewhat sharply defined eastern edge. Reference the image below for assistance.

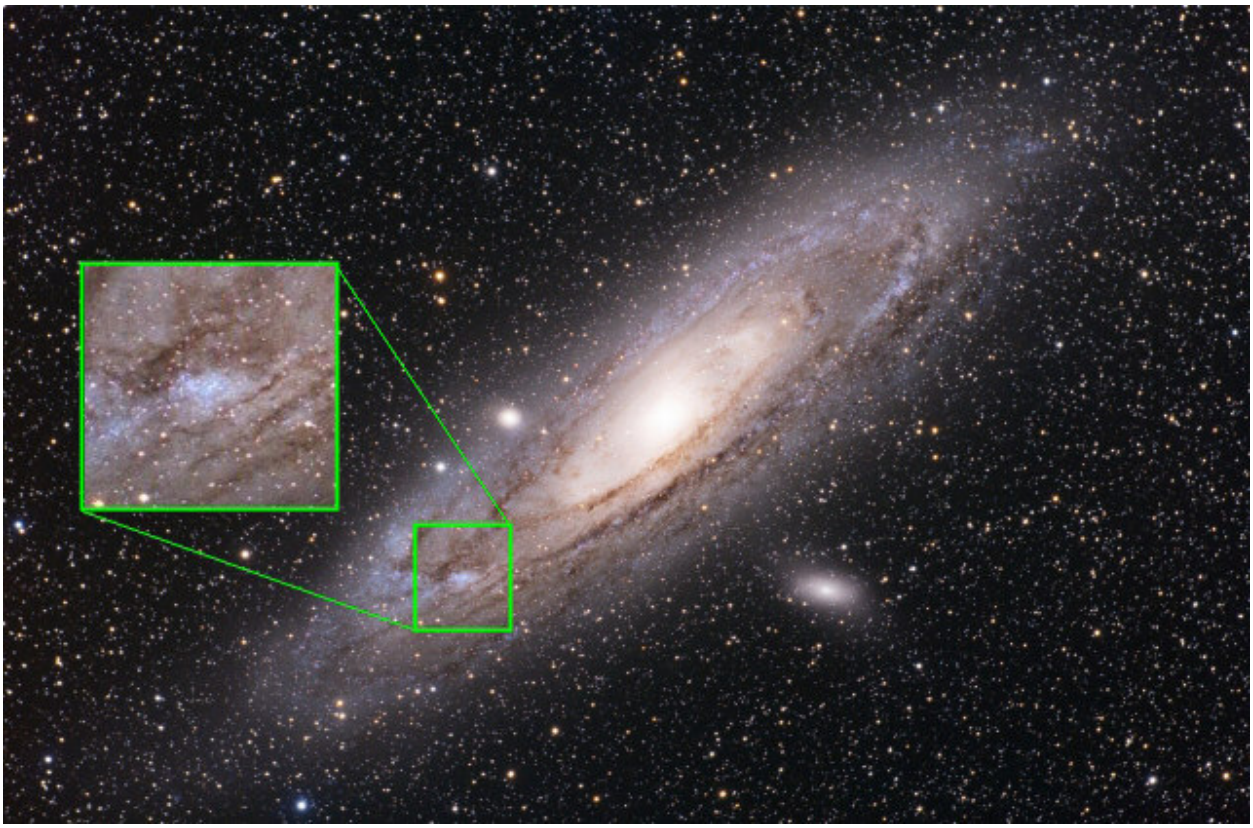

Figure 4: M31 Original Image Courtesy Jurij Stare - NGC 206 is the exploded area

According to a 1997 paper in the publication Astronomy and Astrophysics, authored by Magnier, Prins, Augusteijn, van Paradijs, and Lewin, 206 is probably the largest and most massive region of star formation in the local group. It's actually located at the intersection of two spiral arms, suggesting that the interaction between the arms is what's fueling the star formation. Further, they place the age somewhere between 20 and 30 Myr. For those interested, the full article can be accessed at http://aa.springer.de/papers/7326002/2300442.pdf.

There are several other open clusters and stellar associations visible to the amateur in M31, for an excellent reference, see pg. 17 of Luginbuhl and Skiff's: Observing Handbook and Catalogue of Deep-Sky Objects. Some of the best defined objects however, are the globular clusters. A paper published in late May 2006 (http://arxiv.org/abs/astro-ph/0605718) indicated that there were on the order of 97 currently known (confirmed) clusters in M31, with many more suspected. Of these, probably some 23+ globulars are visually detectable by amateurs (with large enough scopes).

Bright Andromedean Globular Suspects				
ID	Mag		ID	Mag
G1	13.7		G302	15.2
G76	14.2		G244	15.4
G280	14.2		G256	15.4
G78	14.3		G279	15.4
G213	14.7		G96	15.5
G272	14.8		G226	15.5
G72	15.0		G87	15.6
G119	15.0		G305	15.6
G64	15.1		G54	15.7
G219	15.1		G2	15.8
G257	15.1		G287	15.8
G172	15.2			

We'll take a look for 9 or so of the brighter and easier to find Andromedan globulars. For most of the targets in the rest of the article, I'd recommend a 10 inch or larger telescope. (G1 is the notable exception here – I've heard reports of it being caught in apertures as small as 5".) Tracking ability helps as well, because we'll be working at moderate to high magnification most of the time.

M31 Globular Resources

Figure 5: Image Courtesy - Pete Kennett

Note: The above image is a resize and crop of an image that labels many of M31's suspected globulars. Full size versions can be found at:

- Color image: *http://www.cloudynights.com/images/SWandromedaglobs/m31globs.jpg*.
- Black and white negative image (for use at the telescope): *http://www.cloudynights.com/images/SWandromedaglobs/m31globs_inverted_bw.jpg*.

Excellent charts are a requirement. Although the charts for this series are usually embedded in the article itself, this isn't really optimum for this approach, therefore I've provided a link to three full scale finder charts for the globulars mentioned in this article. I'd suggest printing them off for reference at the scope:

- Chart 1: Bright Central Andromeda Globulars: http://www.cloudynights.com/images/SWandromedaglobs/pdf/M31%20-%20Bright%20Central%20Globulars.pdf (URL on 1 line)
- Chart 2: G1 Star Hop Chart: http://www.cloudynights.com/images/SWandromedaglobs/pdf/G1%20StarHop%20Chart.pdf (URL on 1 line)
- Chart 3: G1 Eyepiece Chart: http://www.cloudynights.com/images/SWandromedaglobs/pdf/G1%20Eyepiece%20Chart.pdf (URL on 1 line)

I still have charts here so the reader can follow along, and my star hop comments are really addressed to the ones in this article - I expect with the full charts, people can plan their own star hops. Please note that the globular finder charts display stars to around magnitude 15 except as noted. In addition, again, I'd recommend Luginbuhl and Skiff's: Observing Handbook and Catalogue of Deep-Sky Objects as a further reference for those who wish to explore further.

When hunting for the globs in M31, I find I typically use medium powers (150-180x) to star hop, then confirm the field with high power (250-300x).

Finding Andromedan Globular Clusters

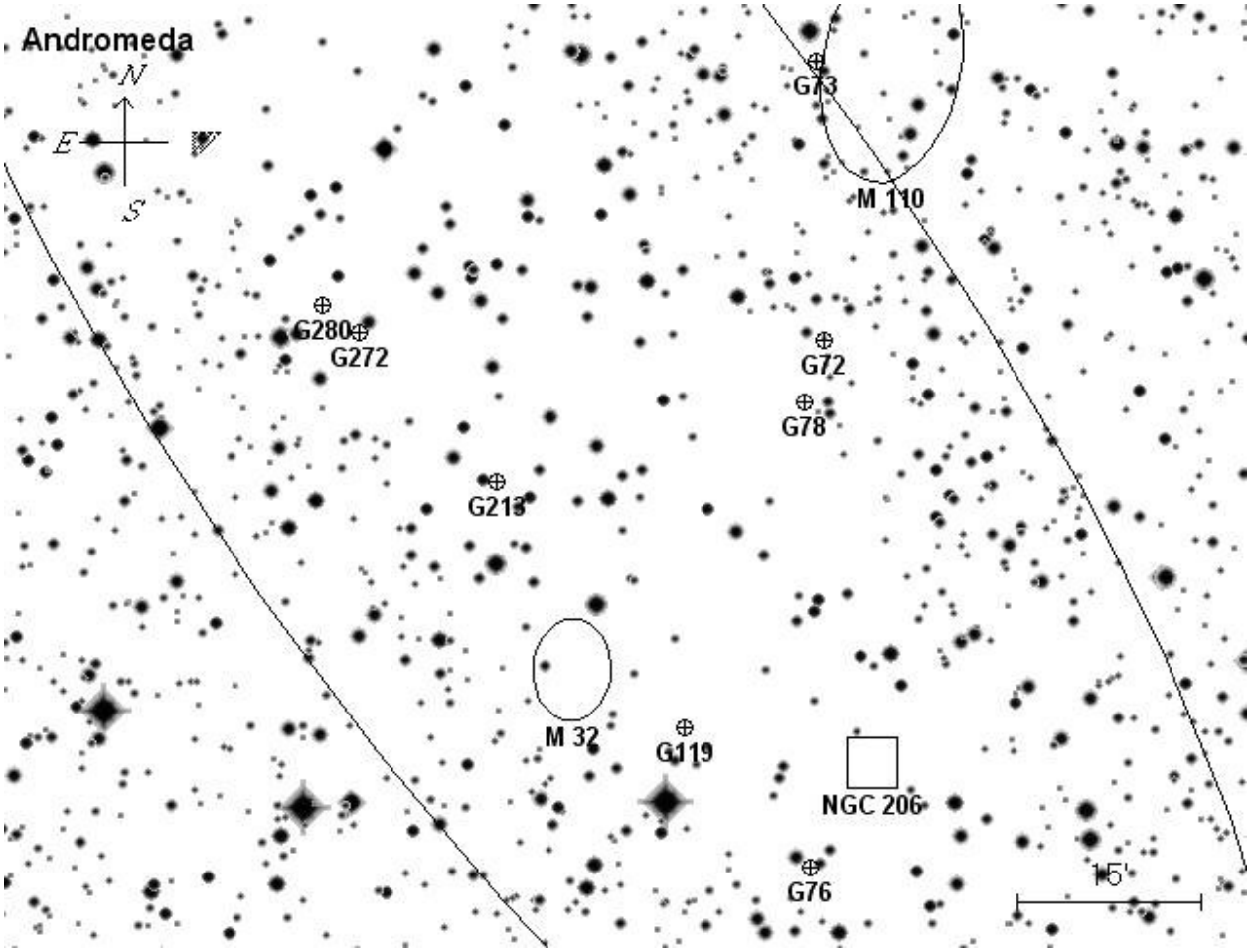

Figure 6: Central Andromedan Globulars and NGC 206

G119

Let's start with G119. First center the core of M32 in your scope, then move SW slightly - about 1/3 of the way to NGC 206, and look for an offset trapezoid (see the attached charts for a better view) that lies to the south of G119 lies in. Switch to higher power and averted vision should bring out a faint point of light in exactly the right place. To all visual appearances this is a simple foreground star, but check your charts to confirm it is one of the remote globulars in the Andromeda galaxy.

G76

Now let's head a bit further southwest in search of G76, one of the brightest globulars in M31. Notes from a session with my 15", indicate I reached a triangle of stars that included GSC 2801-2059, in the general area. In the position indicated by my charts I found not one, but two points of light very similar in magnitude. If you're using a large scope try using high power to determine which one is a foreground star, and which is the globular - I've seen some reports that indicate in larger apertures G76 shows some extent. Personally, I believe the western most one is most likely the globular – what do you think?

G213

Travel back to M32 again in order to begin another star hop along the outskirts of the galaxy. From M32 head NE to G213. In my 15", I found this faintly visible with averted vision. Interestingly, it appeared extended, but I this may have been due to poor seeing (or averted imagination) rather than my detecting any actual extension in the globular itself.

G280 and G272

On to G280 and G272. In my 15", at 168X the field containing G280 and G272 is marked by a curious asterism of 5-6 stars that resembles a mushroom. G280 lies slightly NE of G272, and seems ever so slightly harder to hold in view. Both appear as faint star like points of light. My notes indicate that G272 was somewhat hard to hold at 168x because of the glare off a nearby bright star. Use of a narrow AFOV eyepiece and increasing the power to 315x tightened the field and brought globular out better.

G73

From here, head up across M31 to M110. There on the eastern side of M110 lies our next target: G73. Again, in my 15" scope, I found G73 quite easy to hold and recognize. Look for a chain of stars parallel to M110 on the eastern side.

G78 and G72

Drop south to G78 and G72. I'll confess I know I've hit the general area, but I've yet to confirm G78. There were multiple points of light in the correct general area - all similar magnitude, and none of them exactly where my charts show G78. Can you pick it out? G72 on the other hand was easily visible with direct vision 90% of the time.

From here, it's time to begin the long (yet surprisingly easy) hop down to G1 (Mayall II) the giant globular in the SW suburbs of M31.

G1

According to Wikipedia (http://en.wikipedia.org/wiki/G1_%28astronomy%29), G1 (also known as Mayall II, MII, NGC-224-g1, SKHB 1, GSC-2788:2139, HBK 0-1 and Andromeda's Cluster) is the brightest cluster in the local group, and lies some 170,000 light years from the galactic core. Fans of the spectacular Omega Centauri might be surprised to learn that G1 is suspected to have twice that jewel's mass. There is apparently some debate, due to the apparent indications of multiple star generations inherent in the cluster, it may not be a true galactic cluster at all, but the remains of a dwarf galaxy consumed by Messier 31. Other astronomers postulate that G1 could have been formed during tidal interactions with a dwarf galaxy.

What's truly amazing is that you can easily make out some extent to G1 through a moderately sized back yard telescope. It's not just a point source like most of the other globulars we visited this evening. While one is a long long way from resolving individual stars, you can clearly see that there is something there - especially when you compare it to the two foreground stars (mag 14.3 and 13.6 respectively) that flank it. At mag 13.7, it's a somewhat dim target though, so the more aperture you can throw at this, the better your chances of finding it. It's certainly doable in a 10"

scope from a decent site, and more than likely is cacheable in an 8" scope from a very dark site. I've even heard rumors of folks grabbing it in a 5" scope.

While it's not a toughie to see - if you have sufficient aperture - it can be a real pistol to find. Conceptually, this is a spectacular target.

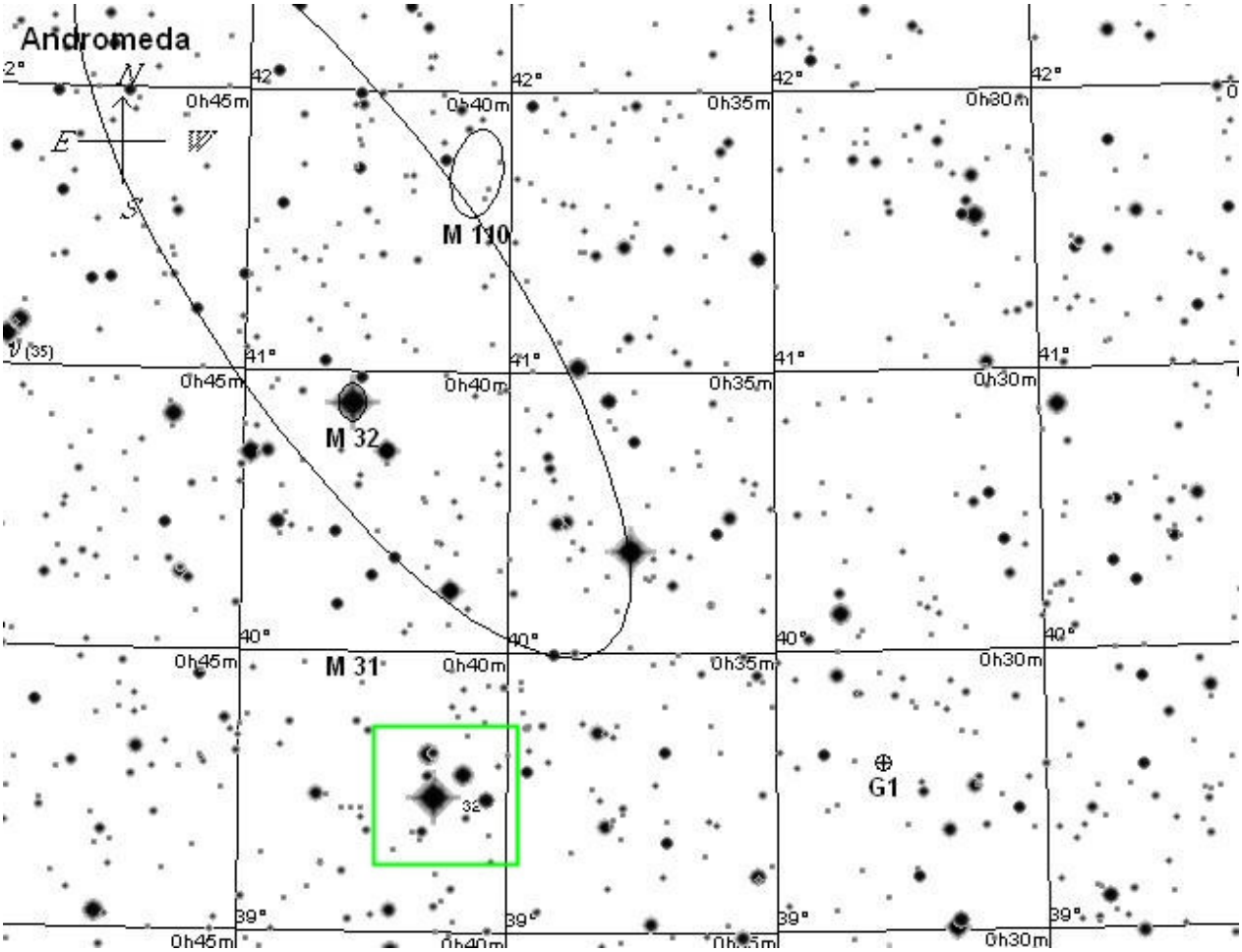

Figure 7: G1 Star Hop Chart

Start your star hop at the nucleus of M32 and work down to the asterism indicated in the chart - keep in mind the area indicated is ½ to 1/3 of a degree wide. Once you've found it, then star hop over towards G1.

I've flipped the image in the following chart to aid star hopping at the eyepiece.

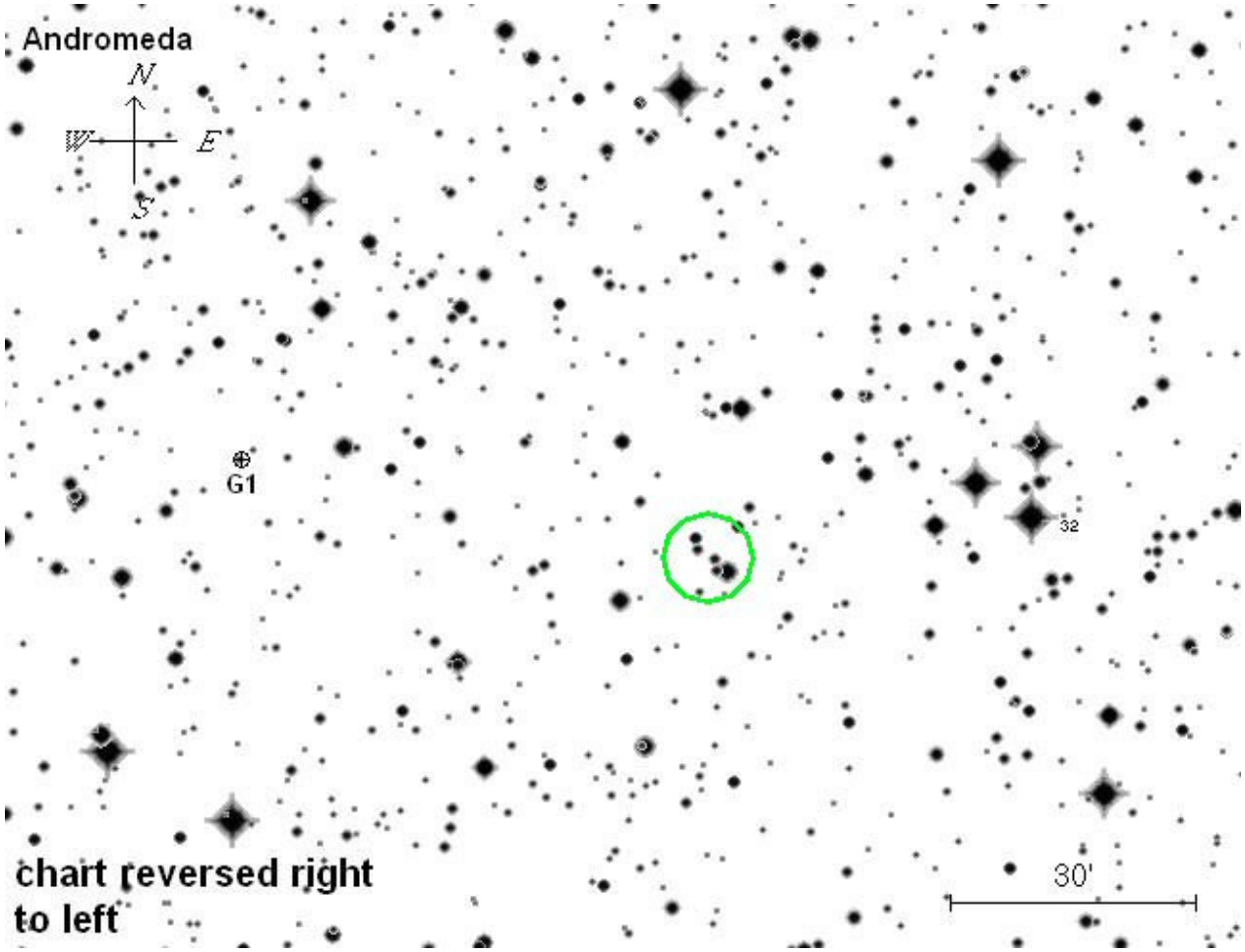

Figure 8: G1 Eyepiece Finder Chart

Note the circled grouping of stars in the chart above - in a moderately sized scope, this grouping bears a strong resemblance to Cassiopeia. Once you're in the right area crank up the power and begin inspecting multiple stars in the area. G1 lies almost in the middle of two similar magnitude foreground stars, and that's a big help when it comes to fishing it out. At moderate powers I've found it can look like a triple star. Under high magnification, it will resemble Mickey Mouse - the two foreground stars are the ears, and Mickey's head - somewhat extended is G1.

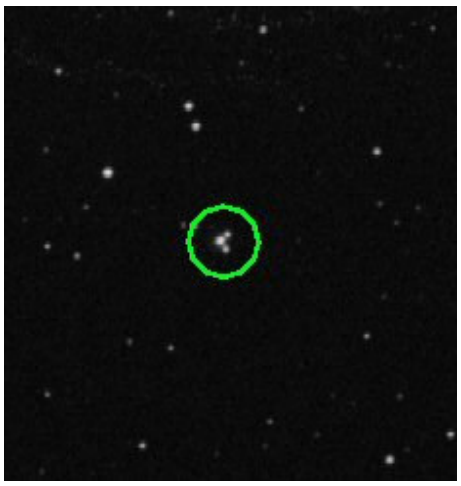

Figure 9: DSS image of G1

The DSS image should resemble what you see. Be sure to pump up the magnification, and you can see that it's not quite a stellar point.

While I've caught it in my 10" and noted extent in my 15" and 18" scopes, the best view I've ever had was when I was observing with Gary Gibbs in his 20" with a Collins I3 image intensified eyepiece. The barest glance showed that it wasn't a star - it presented a star like core with a dimmer coma around the outside and reminded me of tiny dim Milky Way globulars I've caught in one of my small scopes.

Figure 10: Hubble Space Telescope image of G1

This view through the Hubble Space Telescope should help give you a better idea of what you're actually seeing.

Finally, I'd like to take a moment to thank all the readers who submitted observations and photos this month. The included ones are just the tip of the iceberg. Unfortunately, respect for others bandwidth limitations require me to restrict the photos to just a small sample.

As always, I'm gratified that folks find this column useful.

Till next time –

Tom T.

Addendum 11/26/06

Bob Abraham, an astronomer with the University of Toronto contributed the following:

> *"...in the section on G1, it is noted that this object is more massive than Omega Cen, and that G1 might be the core of a stripped dwarf galaxy, and not a "true" globular cluster as a result. Interestingly, Omega Cen itself also shows multiple stellar populations, and many people have recently argued that it also is a good bet that Omega Cen is the core of a dwarf galaxy that has suffered multiple collisions with the Milky Way. At this point, it's probably premature to suggest that either object is not a "true" globular cluster, because we don't yet know much about the rate of dwarf galaxy destruction, and some popular models for galaxy formation actually require the rate of dwarf galaxy destruction to be very very high, so quite a few similar objects might be out there. (That said, most globular clusters have very uniform old stellar populations, so its unlikely that most formed via dwarf galaxy accretion unless this happened a very long time ago)."*
>
> *".... there is quite a bit of controversy about the subset of supposedly "young" globulars in M31 (where "young" in this context means "less than 5 billion years old"). As noted above, most M31 globulars are rather older than this, but a few years ago some astronomers claimed to have discovered a population of young globulars in M31. Last year some observations with Keck's new adaptive optics system were able to resolve these objects and showed quite convincingly that most of these objects were open clusters or asterisms, and not globulars at all. Here's a link to a PDF version of the article: http://arxiv.org/pdf/astro-ph/0510631*
>
> *Comparing Figure 1 of this paper to the HST image of G1 shows that adaptive optics is really beginning to deliver the goods."*

Note: Figure 1 can be found at the end of the paper.

Additional Resources / References

- **Island Universe**: Sue French, *Sky and Telescope*, December 2005
- **Observing Handbook and Catalog of Deep Sky Objects**: Luginbuhl and Skiff
- **Online Papers / Abstracts**:
  - G1 in M31 - Giant Globular Cluster or Core of a Dwarf Elliptical Galaxy? http://arxiv.org/PS_cache/astro-ph/pdf/0105/0105013.pdf
  - Cepheids as tracers of star formation in M 31. II. NGC 206: evidence for spiral arm interactions. http://adsabs.harvard.edu/cgi-bin/nph-bib_query?bibcode=1997A%26A...326..442M& (URL on 1 line)
  - Formation of giant globular cluster G1 and the origin of the M 31 stellar halo http://adsabs.harvard.edu/cgi-bin/nph-bib_query?bibcode=2004A%26A...417..437B&db_key=AST&data_type=HTML&format=&high=450c77306207076 (URL on 1 line)

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I'd love to hear of your experiences under the night sky — please feel free to e-mail me or send any observing reports to: tomt@cloudynights.com
Please indicate if I can cite your observations in future columns.

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