Herschel 400

Volume 1

NGC 40 through 2419

An Astrophoto Album

By

David B. Viscio

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Introduction

Photo Courtesy of Yerkes Observatory

Friedrich Wilhelm Herschel

For many years, Amateur Astronomers have enjoyed the challenge and excitement provided by the Messier list of deep-sky objects. The 110 or so objects in the Messier Catalog introduced the observer to the importance of careful observing and record keeping. Upon completion of this project, however, the amateur was left somewhat in a void. He or she wanted to further the quest for deep-sky objects, but outside of the vast *New General Catalog*, there was no organized program that would provide that next vital step upward. With this idea in mind, the formation of the Herschel 400 list began.

The William Herschel Catalog of deep-sky objects could be found in the original *New General Catalog* by Johann Dreyer. The *New General Catalog* was a compilation of several deep-sky catalogs circa 1880; it contained almost 8,000 objects, 2,477 of these objects were observed by William Herschel. The Ancient City Astronomy Club (ACAC) members separated his objects, which used a rather unique classification system with eight sub-categories. These subcategories are:

Class I - Bright Nebulae;
Class II - Faint Nebulae;
Class III - Very Faint Nebulae;
Class IV - Planetary Nebulae;
Class V - Very Large Nebulae;
Class VI - Very Compressed and Rich Clusters of Stars;
Class VII - Compressed Clusters of Small and Large Stars;
Class VIII - Coarsely Scattered Clusters of Stars.

It was soon discovered that a vast majority of Herschel's objects were in Class II and III and, with magnitudes fainter than thirteen, were beyond the reach of many amateur telescopes. The ACAC decided the proposed Herschel 400 List would consist of enough objects to present a distinct challenge, yet still be within range of amateurs who possessed only modest equipment and were affected by moderate light-pollution problems. 400 objects were set as the best number of objects.

For the purpose of these astrophoto albums, the Herschel 400 was divided into 4 sub-lists of 100 objects each. This album contains the first 100 objects - NGC 40 through 2419.

My astrophotography efforts began in 1975 but my ability to obtain acceptable images was hampered by the need for lots of equipment and materials to process film and make final prints and lack of time to adequately develop the skills required. That situation changed dramatically in 2004 when I purchased a Canon EOS 20D digital single lens reflex camera. Relatively quickly, the resulting images began to meet the quality standards I had set for myself and I began a concerted program of deep-sky astrophotography. Three books provided some of my inspiration:

- *Atlas of Deep-Sky Splendors*, Hans Vehrenberg, 1971.
- *The Messier Album*, John H. Mallas and Evered Kreimer, 1978.
- *The Cambridge Deep-Sky Album*, Jack Newton and Philip Teece, 1983.

Goals

- Photograph all the Herschel 400 objects from my location in Prescott Valley, Arizona.
- When possible display all the objects with identical image scale for size comparison
- Show that quality images can be obtained with modest-sized high quality equipment

The Cameras

- Canon EOS 20Da, 3504 x 2336 pixel CMOS, 8.2 Mpx
- Canon EOS 60Da, 5184 x 3456 pixel CMOS, 17.9 Mpx

The sizes of the imaging chips in the cameras are the identical APS format. As a result the 60Da has 1.48 times more pixels per inch than the 20Da. When images from the cameras are displayed at the same resolution on a computer screen, the images from the 60Da will be 1.48 times larger. Images obtained with the 60Da have been designated with an asterisk (*).

The Optical Systems

- Canon EF 180mm f3.5L Macro USM
- Canon EF 100-400mm f/4.5-5.6L IS USM set at 400mm f/5.6
- Takahashi Sky 90 with 0.8X focal reducer/field flattener - 405mm f/4.5

The Mounts

- Vixen GPDX equatorial mount with SkySensor 2000 on JMI Wheeley Bars
- Software Bisque Paramount MX equatorial mount on a permanent pier controlled by TheSkyX Pro and an Apple MacBook Pro laptop computer.

Focusing

Initially focusing was done manually while observing a star through a Canon Angle Finder C at 2.5x magnification. The quality of focus was checked by examining a test image on the camera's LCD screen. Unfortunately image focus varied significantly, resulting in refocusing and second or even third images being acquired.

Eventually a JMI Motofocus and a Bahtinov mask were added to the Sky 90 optical system. Focus was achieved by observing the Bahtinov diffraction pattern on the computer screen using Stack Labs' Nebulosity 3. This focusing method is vastly superior to the manual method and the need to repeat image acquisition was eliminated.

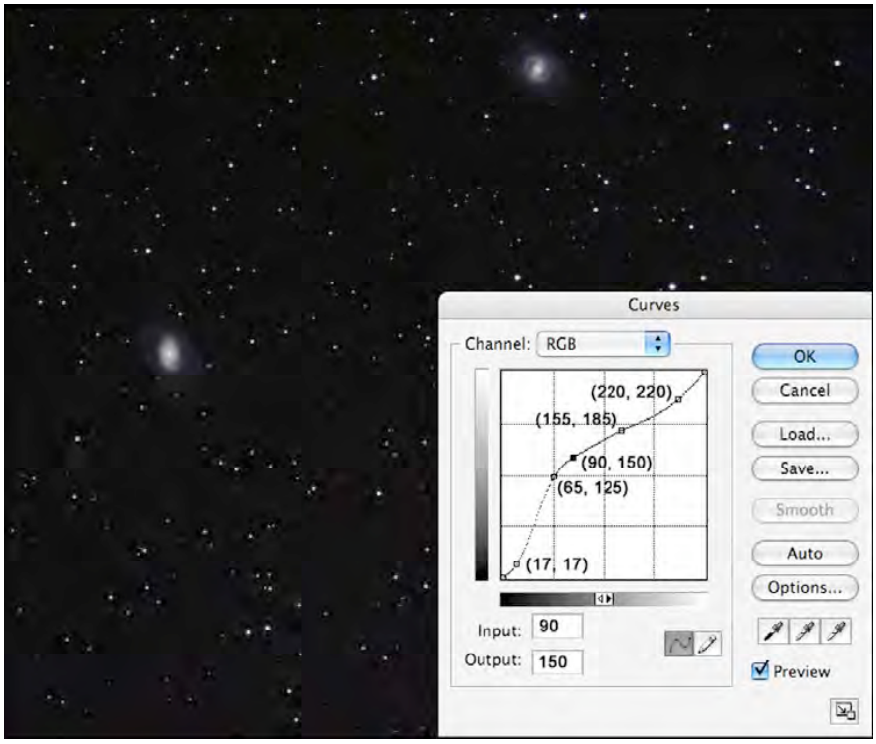
Image Acquisition

The basic image acquisition scheme was to obtain 5 dark-frames, then 30 light-frames and finally 5 more dark-frames, yielding an image set of 10 dark-frames and 30 light-frames for calibrating and stacking. Exposure duration of each frame was 1 minute at ISO 1600 (20Da) or ISO 3200 (60Da) with a 10-second delay between exposures and a 5-second delay from sequence initiation and the first exposure. No bias or flat frames were used. Images were saved as highest quality JPEG files on the cameras' memory cards. Image acquisition was controlled with a Canon Timer Remote Controller TC-80N3.

Basic Image Processing

The 30 light-frames were examined and any with bright satellite or airplane trails were discarded. DeepSkyStacker 3.3.2 was used to calibrate and stack the good frames (usually 27 to 30) from each image set. The final raw stacked image file was saved as a 32-bit TIFF file.

Image enhancement and optimization was performed with Adobe Photoshop CS2. First the image file Mode was changed to 16-bit. While examining the upper right corner of the image, Levels was used to adjust the RGB black point such that R=G=B at a value of 10-15.



Using Curves, the low intensity nebulosity was enhanced while not 'blowing out' bright zones or causing the black background to lighten significantly by setting Curves set points approximately as shown in the figure above.

Any resulting vignetting in background sky intensity was 'neutralized' using techniques similar to those described in "*Fixing Vignetting in Astrophotos*", Sean Walker, Sky & Telescope, September 2001 and the book *Photoshop Astronomy* by R. Scott Ireland. Finally a modest Unsharp Mask (amount:

100%, radius: 1.0 pixel, threshold: 3 levels) was applied.

The image scale of the three optical systems was determined using Adobe Photoshop CS2 and Voyager 4 Dynamic Sky Simulator. Then the image scale of the images from the Canon EF 180mm and Canon EF 100-400mm optical systems were up-sampled to match that of the Takahashi Sky 90 optical system for images obtained with the Canon 20Da. Images obtained with the Canon 60Da are displayed with image scale unchanged at 1.48 times that of the 20Da. Images were then appropriately cropped and combined to make the album pages with all the objects at the same image scale for direct comparison.

Final Thoughts

The images in the album were acquired over a period of 5+ years with continuous improvement in equipment, techniques and skills. I am well aware that a number of images could be significantly improved and better photographs will be acquired in the future. In addition, a number of the planetary nebula are essentially 'stellar' in appearance and require significantly greater focal length and image scale yielded by larger OTAs to show detail. But 'perfection' can often be the enemy of 'finishing' so those better images await the future and a second edition of this album.

The Cameras

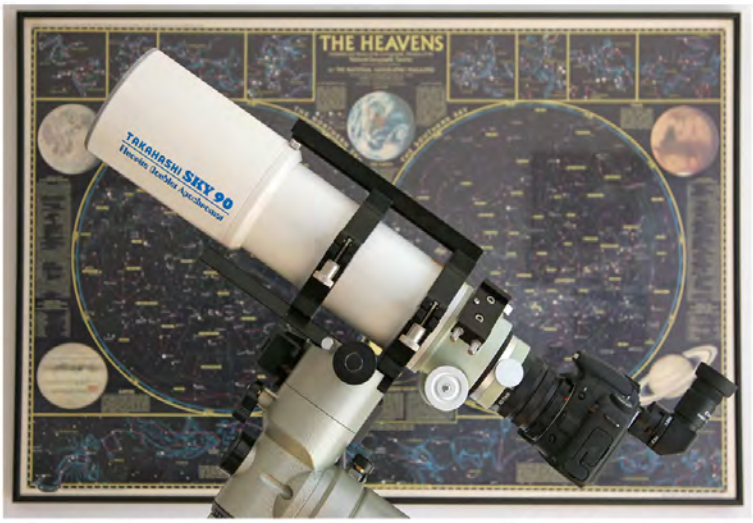
Canon EOS 20Da DSLR

Canon EOS 60Da DSLR

The Optical Systems

Canon EF 180mm f/3.5L Macro

Canon EF 100-400mm L zoom @ 400mm f5.6



Takahashi Sky 90 + 0.8x reducer/flattener 405mm f/4.5

Vixen GPDX Equatorial Mount with SkySensor 2000 on JMI Wheeley Bar

Software Bisque Paramount MX Equatorial Mount on Permanent Pier

Herschel 400 (NGC 40 - 2419)

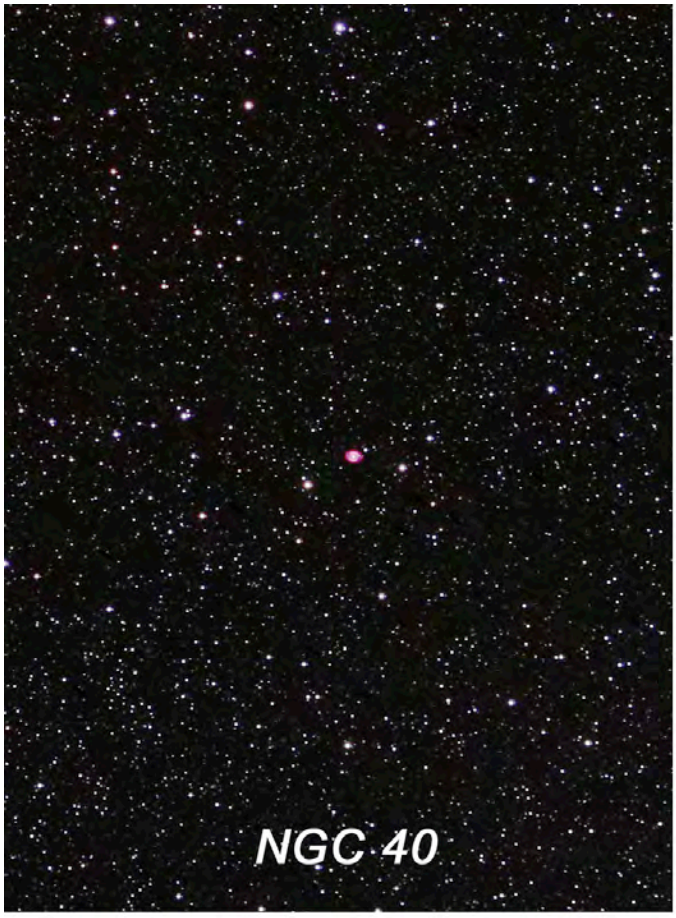
pn:	planetary nebula	sg:	spiral galaxy	ig:	irregular galaxy
bn:	bright nebula	eg:	elliptical galaxy	oc:	open cluster
sr:	supernova remnant			gc:	globular cluster

A	Canon 180mm	B	Canon 100-400mm	C	Sky 90

NGC	Type	Mag	RA	Dec	Optics
40	pn	10.2	00h 10.2m	72º 15'	C
129	oc	10.0	00h 27.0m	59º 57'	C
136	oc	11.3	00h 28.7m	61º 15'	C
157	sg	11.2	00h 32.3m	-08º 40'	C
185	eg	11.7	00h 36.1m	48º 04'	C
205	eg	9.4	00h 37.6m	41º 25'	A
225	oc	9.1	00h 40.5m	61º 31'	C
246	pn	8.5	00h 44.6m	-12º 09'	C
247	sg	11.0	00h 44.6m	-21º 01'	C
253	sg	8.9	00h 45.1m	-25º 34'	C
278	eg	11.3	00h 49.2m	47º 18'	C
288	gc	7.2	00h 50.2m	-26º 52'	C
381	oc	9.2	01h 05.2m	61º 18'	C
404	eg	10.7	01h 06.6m	35º 27'	C
436	oc	8.8	01h 12.4m	50º 33'	C
457	oc	7.5	01h 15.9m	58º 04'	C
488	sg	11.1	01h 19.1m	05º 00'	C
524	eg	11.1	01h 22.1m	09º 16'	C
559	oc	7.5	01h 26.1m	63º 02'	C
584	eg	10.8	01h 28.8m	-07º 07'	C
596	eg	11.5	01h 30.3m	-07º 17'	C
598	sg	6.7	01h 31.1m	30º 24'	B
613	sg	10.2	01h 32.0m	-29º 40'	C
615	sg	11.6	01h 32.6m	-07º 35'	C
637	oc	7.5	01h 38.3m	63º 47'	C
651	pn	11.0	01h 38.8m	51º 19'	C
654	oc	9.1	01h 40.5m	61º 39'	C
659	oc	9.8	01h 40.8m	60º 28'	C
663	oc	7.1	01h 42.6m	61º 01'	C
720	eg	10.5	01h 50.6m	-13º 59'	C
752	oc	7.0	01h 54.7m	37º 25'	C
772	sg	10.9	01h 56.6m	18º 46'	C

NGC	Type	Mag	RA	Dec	Optics
779	sg	11.3	01h 57.2m	-06º 12'	C
869	oc	4.4	02h 15.5m	56º 55'	C
884	oc	4.7	02h 18.9m	56º 53'	C
891	sg	11.5	02h 19.3m	42º 07'	C
908	sg	11.0	02h 20.8m	-21º 27'	C
936	sg	10.7	02h 25.1m	-01º 22'	C
1022	sg	11.2	02h 36.1m	-06º 53'	C
1023	eg	10.5	02h 37.2m	38º 52'	C
1027	oc	7.5	02h 38.8m	61º 20'	C
1052	eg	11.2	02h 38.6m	-08º 28'	C
1055	sg	11.5	02h 39.2m	00º 16'	C
1084	sg	11.0	02h 43.5m	-07º 47'	C
1245	oc	6.9	03h 11.2m	47º 03'	C
1342	oc	7.1	03h 28.4m	37º 09'	B
1407	eg	10.6	03h 37.9m	-18º 44'	C
1444	oc	6.4	03h 45.6m	52º 31'	C
1501	pn	13.3	04h 02.6m	60º 47'	C
1502	oc	5.3	04h 03.0m	62º 11'	C
1513	oc	8.8	04h 06.2m	49º 23'	C
1528	oc	6.2	04h 11.4m	51º 07'	C
1535	pn	9.3	04h 12.1m	-12º 52'	C
1545	oc	8.0	04h 17.1m	50º 08'	C
1647	oc	6.0	04h 43.2m	18º 59'	B
1664	oc	7.5	04h 47.4m	43º 37'	C
1788	bn	11.0	05h 04.5m	-04º 24'	C
1817	oc	7.9	05h 09.2m	16º 38'	C
1857	oc	8.5	05h 16.6m	39º 18'	C
1907	oc	9.9	05h 24.7m	35º 17'	C
1931	bn	9.5	05h 28.1m	34º 13'	C
1961	sg	11.7	05h 36.8m	69º 24'	C
1964	sg	11.6	05h 31.2m	-21º 59'	C
1980	bn		05h 33.0m	-05º 56'	C
1999	bn	10.0	05h 34.1m	-06º 45'	C
2022	pn	11.5	05h 39.3m	09º 03'	C
2024	bn	10.7	05h 39.4m	-01º 52'	C
2126	oc	10.0	05h 58.1m	49º 55'	C
2129	oc	7.2	05h 58.1m	23º 18'	B
2158	oc	11.0	06h 04.3m	24º 06'	B

NGC	Type	Mag	RA	Dec	Optics
2169	oc	6.4	06h 05.7m	13º 58'	C
2185	bn	11.0	06h 08.7m	-06º 12'	C
2186	oc	9.5	06h 09.4m	05º 27'	C
2194	oc	9.2	06h 11.0m	12º 50'	C
2204	oc	9.1	06h 13.5m	-18º 25'	C
2215	oc	8.6	06h 18.4m	-07º 16'	C
2232	oc	4.0	06h 24.1m	-04º 43'	C
2244	oc	6.2	06h 29.7m	04º 54'	C
2251	oc	8.5	06h 32.0m	08º 24'	C
2264	bn	4.7	06h 38.4m	09º 56'	C
2266	oc	9.8	06h 40.5m	27º 02'	C
2281	oc	6.9	06h 45.8m	41º 07'	C
2286	oc	8.0	06h 45.1m	-03º 07'	C
2301	oc	5.8	06h 49.2m	00º 31'	C
2304	oc	10.1	06h 52.3m	18º 05'	C
2311	oc	9.6	06h 52.8m	-04º 31'	C
2324	oc	8.8	07h 00.4m	01º 08'	C
2335	oc	9.1	07h 04.2m	-10º 00'	C
2343	oc	8.0	07h 05.9m	-10º 34'	C
2353	oc	5.3	07h 12.3m	-10º 12'	C
2354	oc	9.0	07h 12.2m	-25º 38'	C
2355	oc	9.5	07h 14.2m	13º 52'	C
2360	oc	9.4	07h 15.4m	-15º 33'	C
2362	oc	10.5	07h 16.6m	-24º 52'	C
2371	pn	11.0	07h 22.4m	29º 35'	C
2372	pn	11.0	07h 22.4m	29º 35'	C
2392	pn	9.5	07h 26.2m	21º 01'	C
2395	oc	9.4	07h 24.3m	13º 41'	C
2403	sg	8.9	07h 32.0m	65º 43'	C
2419	gc	11.5	07h 34.8m	39º 00'	C


NGC 40


NGC 129*


NGC 136*


NGC 157*


NGC 185


NGC 205


NGC 225


NGC 246


NGC 247


NGC 253


NGC 278*


NGC 288


NGC 381*


NGC 404

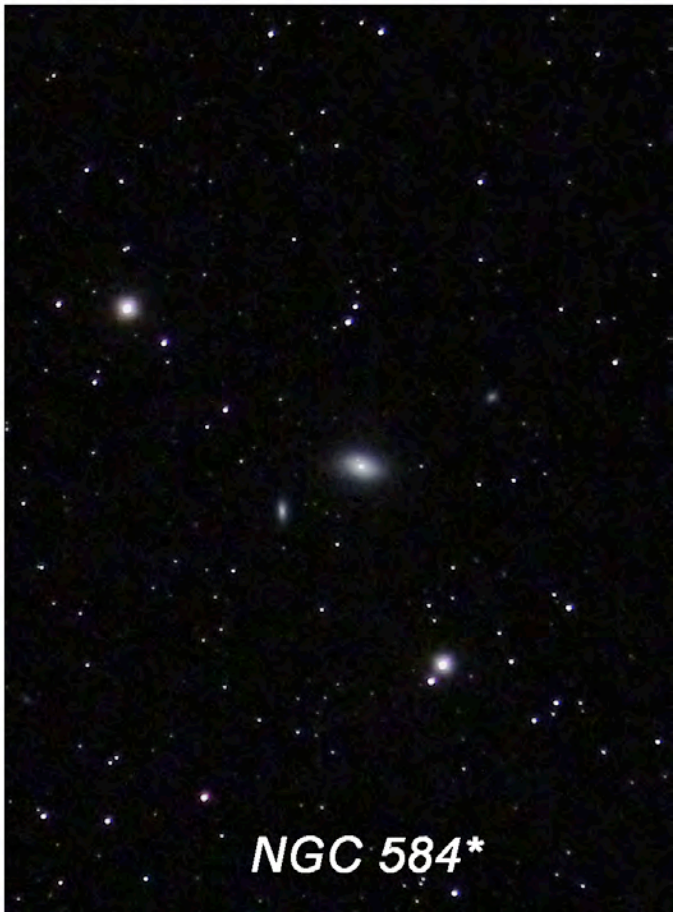

NGC 436*


NGC 457


NGC 488*


NGC 524*


NGC 559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NGC 615*


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NGC 1022*


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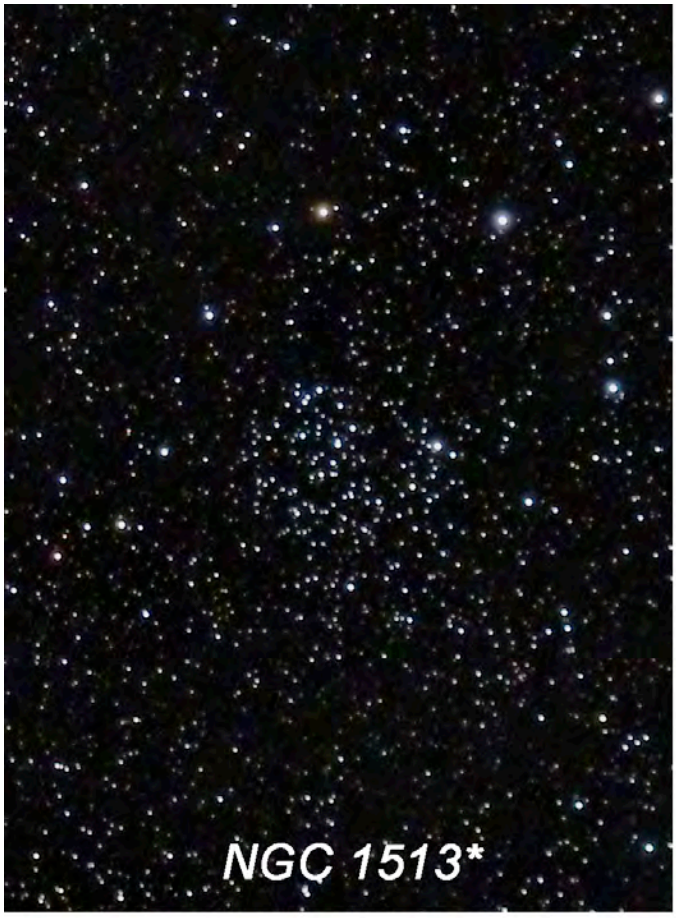
NGC 1342


NGC 1407*


NGC 1444*


NGC 1501


NGC 1502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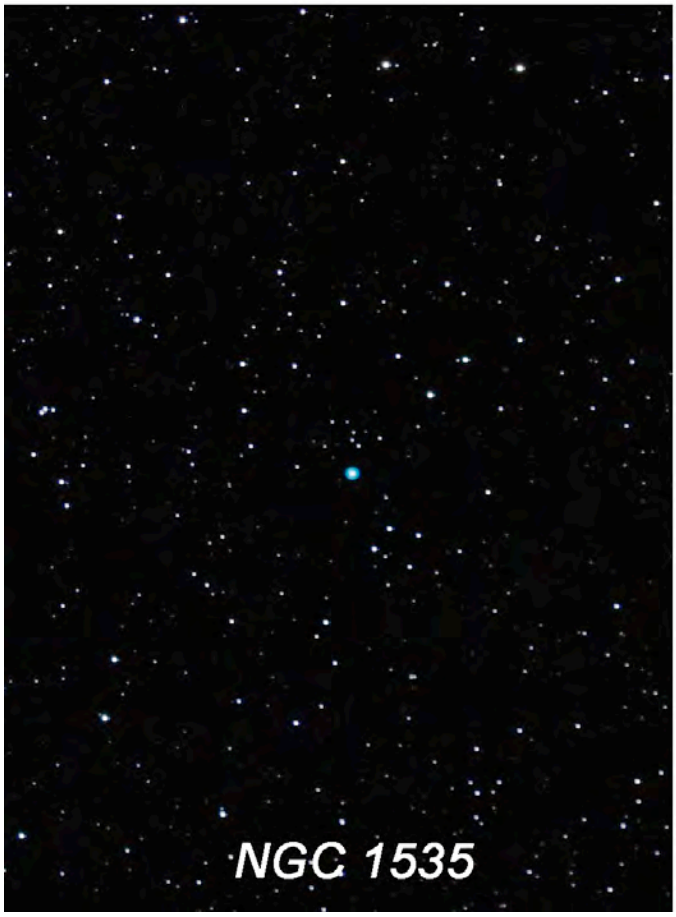
NGC 1528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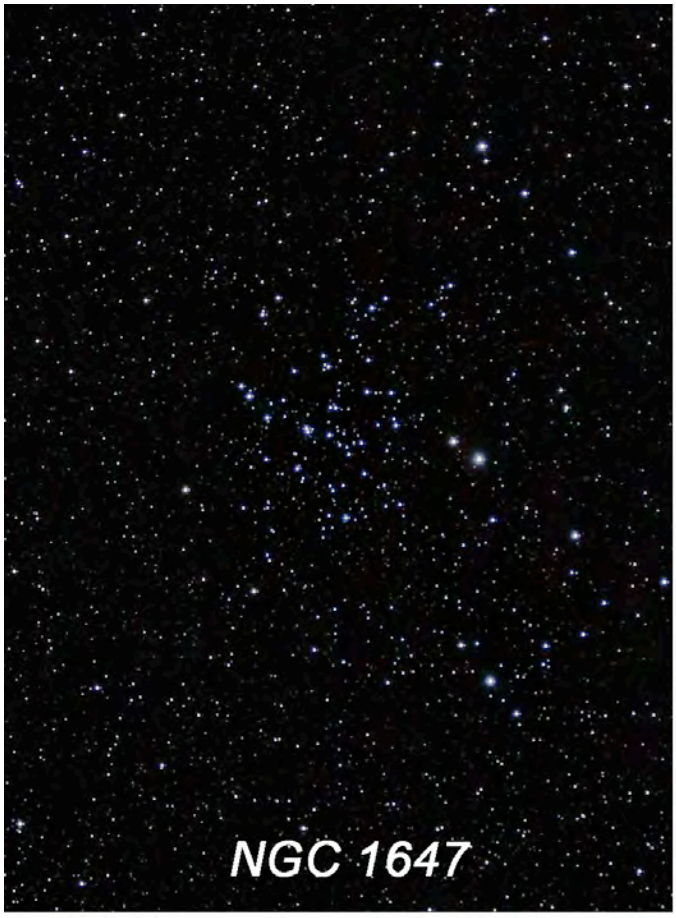
NGC 1545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NGC 1664*


NGC 1788


NGC 1817*


NGC 1857*


NGC1907


NGC 1931


NGC 1961*


NGC 1964*


NGC 1980


NGC 1999


NGC 2022


NGC 2024


NGC 2126*


NGC 2129


NGC 2158


NGC 2169


NGC 2185*


NGC 2186*


NGC 2194


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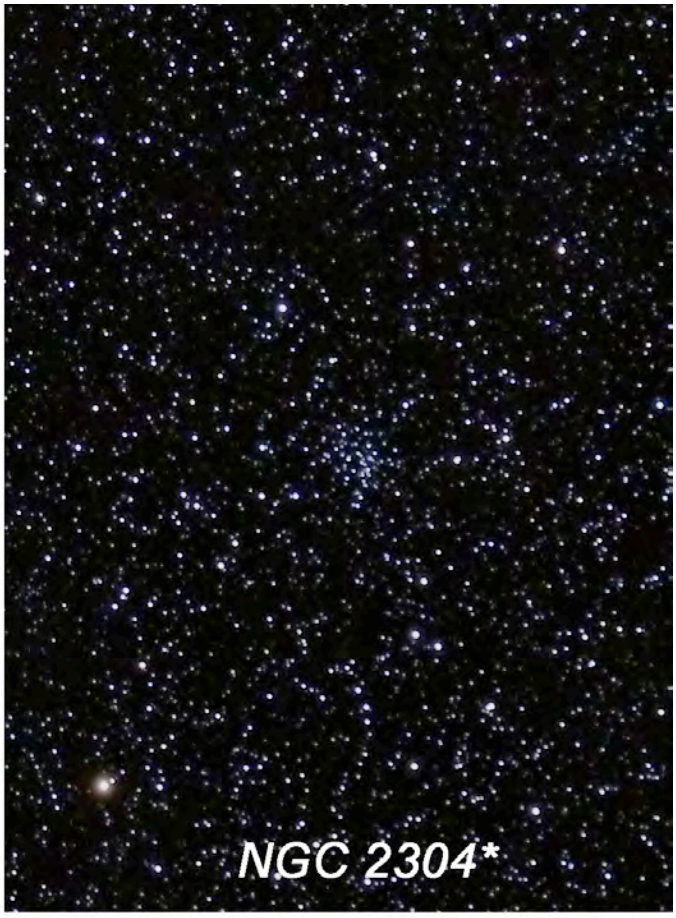
NGC 2264


NGC 2266*


NGC 2281*


NGC 2286*


NGC 2301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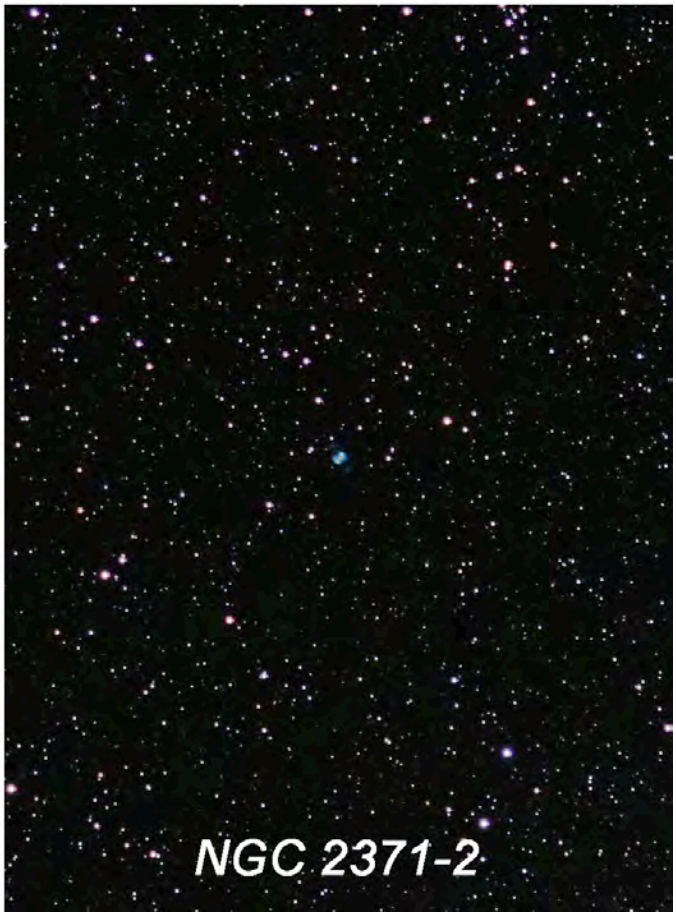
NGC 2353


NGC 2354*


NGC 2355*


NGC 2360


NGC 2362


NGC 2371-2


NGC 2392


NGC 2395*


NGC 2403


NGC 2419

David B. Visicio

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