Herschel 400

Volume 1

NGC 40 through 2419

An Astrophoto Album

By

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Introduction

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 subcategories. 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:


**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:
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)

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January 25, 2015