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EXPLORE SCIENTIFIC MAKSUTOV CASSEGRAIN TELESCOPES

Volume 18 • Issue 6 $6.00 US

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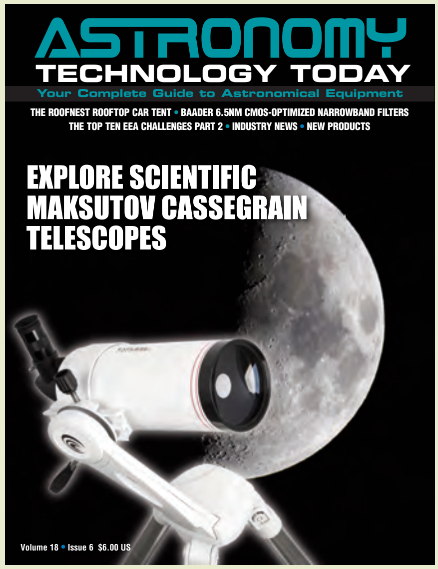
Dr. James Dire has written reviews for ATT for 15 years. His first review was of an Orion 190-mm Mak-Newt in early 2009. And his review in this issue of the Explore Scientific FirstLight 100mm Mak-Cassegrain Telescope is the first Mak-Cass review in the 18 years of our publication which really is hard to believe! The cover astro image is of the first quarter Moon taken with the Mak-Cass and a Canon 650D camera with prime focus with a 1/250s exposure.



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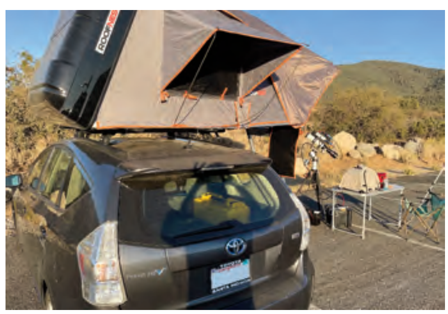

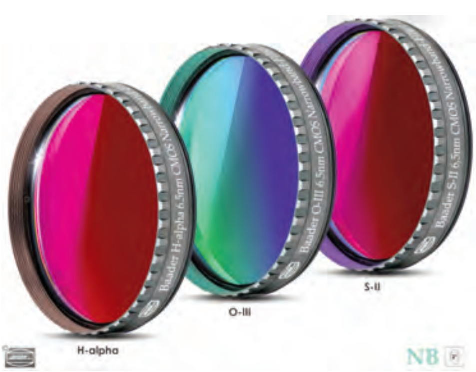

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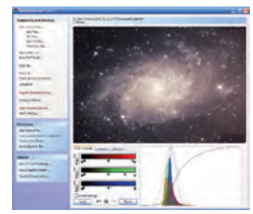

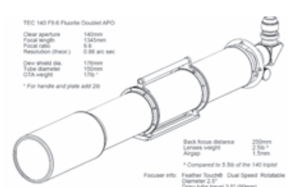

ATT Contributing Writers

Dr. James Dire has a M.S. degree in physics from the University of Central Florida and M.A. and Ph.D. degrees from The Johns Hopkins University, both in planetary science. He has been a professor of chemistry, physics and astronomy and an administrator at several colleges and universities. He has played a key role in several observatory projects including the Powell Observatory in Louisburg, KS, which houses a 30-inch (0.75-m) Newtonian; the Naval Academy observatory with an 8-inch (0.20-m) Alvin Clark refractor; and he built the Coast Guard Academy Astronomical Observatory in Stonington, CT, which houses a 20-inch (0.51-m) Ritchey Chrétien Cassegrain. Dire is a seasoned visual observer and veteran astro-imager.

Matt Harmston his an educational researcher whose appetite for the heavens has been whetted by increasing aperture over the years. More recently, Matt has immersed himself in video astronomy - a means of probing deeper into the night sky while making astronomy accessible to all ages and abilities. With this technology readily available, Matt is considering a career as a sleep-deprivation research subject.

Curtis V. Macchioni is a physicist who spent most of his career in Silicon Valley working on magnetic data storage technology. Now retired he enjoys the extra time under the night sky and writing about astronomy equipment and methods on his web site www.californiaskys.com and producing astronomy helpful videos on his YouTube channel "Astronomy Tips and Reviews with Curtis." He hopes to attend many of the major star parties across the country over the coming years.

Stuart Parkerson has been the publisher of Astronomy Technology Today since its inception in 2006. While working primarily in the background of the company's magazine and website business operations, he now has a more active role in contributing content to the magazine. He also is the founding publisher of App Developer Magazine which launched in 2012. He grew the company to become one top software magazines and websites globally and sold his ownership interest in 2016.

Mark Zaslove his a two-time Emmy Award winner and recipient of the coveted Humanitas Prize. Mark is a born-again astro noobie, who once had an Optical Craftsman scope as a kid and is now recapturing his youthful enthusiasm (with a digital twist) and having a lovely time doing it.

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EXPLORE SCIENTIFIC MAKSUTOV CASSEGRAIN TELESCOPES

By Dr. James R. Dire

I have reviewed a lot of telescopes for this magazine in the past 15 years. These include acromatic refractors, apochromatic refractors, Newtonians, classical Cassegrains, Schmidt-Cassegrains, Newtonians, Ritchey–Chrétiens and Maksutov-Newtonians. But I have never reviewed a Maksutov-Cassegrain telescope, until now. I believe this is the first review ever of a Maksutov Cassegrain under this cover in the 18 years the magazine has been in existence.

I'll start with defining what a Maksutov-Cassegrain telescope is. The first telescopes were simple refractors. They date back to the last decade of the 15th century. In the year 1661, James Gregory, a Scottish mathematician designed a telescope that looked like a Cassegrain, but he did not know how to make the mirrors for a prototype. Isaac Newton built the first reflector in the year 1668. Reflectors after his design are still called Newtonians.

Cassegrain telescopes were invented by a French priest, Laurent Cassegrain in 1672. Cassegrian's design incorporated a primary mirror with a hole drilled in the center. The secondary mirror directs the light through the hole in the primary mirror to the eyepiece. Like Gregory, he never built one. Each of their designs used a parabolic primary mirror and an ellipsoidal secondary mirror. Gregory's design used a converging secondary mirror, while Cassegrain's design incorporated a diverging secondary mirror.

The telescopes Newton built used spherical

Image 1

Image 2 - The telescope components were shipped in myriad boxes all contained in a double layer cardboard shipping box

Image 3 - The Explore Scientific 100 mm f/14 Maksutov-Cassegrain telescope attached to a Explore Scientific Twilight Nano mount.

primary mirrors. Today Newtonians use parabolic primary mirrors. English entrepreneur John Hadley built the first telescope with a parabolic mirror in the year 1721. It was a Gregorian design. Soon after, opticians started making Cassegrains. One problem with both Newtonians and Cassegrains is that they suffer from coma. Coma causes off-axis point sources, i.e. stars away from the center of the visual image, to have a distorted shape. Despite this Newtonians along with refractors stayed favorites for several centuries.

Bernard Schmidt invented the Schmidt-Cassegrain telescope in 1935. Schmidt-Cassegrains use spherical primary and secondary mirrors. Spherical mirrors are easier and less expensive to make than any other mirror shape. However, Schmidt Cassegrains require a corrector plate at the open end of the tube to correct for spherical aberration from the mirrors. Since they use a lens and mirrors, they are called catadioptric telescopes. Schmidt-Cassegrain telescopes also suffer from coma. To minimize coma they are typically made with focal ratios around 10.

The Russian optical engineer Dmitry Dmitrievich Maksutov invented the Maksutov-Cassegrain telescope in 1941. Although Dutch optician Albert Bouwers came up with the same design in 1940, the telescope carries Maksutov's name. Unlike Schmidt Cassegrains that have a flat corrector lens, Maksutov-Cassegrain telescopes use a meniscus shaped corrector plate that removes spherical aberrations and magnifies the image more than the diverging secondary mirror does on its own. Maksutov-Cassegrain telescopes are typically made with focal ratios from 13-15 to minimize coma.

Explore Scientific carries three different size Maksutov-Cassegrain telescopes: a 100 mm f/14, a 127 mm f/15, and a 152 mm f/12.5. The former has a 1400 mm focal length while the latter two have focal lengths equal to 1900 mm. I decided to test the 100 mm model (**Image 1**).

The telescope arrived very quickly after it was ordered. It was shipped in a double-layer cardboard box. Inside of this, each component was packaged inside a smaller box (**Image 2**). Most components were wrapped in plastic or bubble wrap. The box containing the optical tube assembly (OTA) had Styrofoam cutouts protecting the tube.

The telescope can be ordered with an alt-azimuth mount or an equatorial mount. The first mount is called the Twilight Nano mount (**Image 3**). The dovetail plate on the OTA attaches to the arm that contains an altitude bearing (**Image 4**). A screw-in handle allows the telescope to be manually slewed in altitude. The base of the mount rotates 360° in azimuth.

The second mount is an EQ3 German equatorial mount (**Image 5**). The EQ3 mount comes with slow motion knobs on both the right

Image 4 – The Twilight Nano mount has one arm that received the dovetail plate screwed onto the telescope. This is an alt-azimuth mount.

ascension and declination axes along with setting circles on each (**Image 6**). The quick release knob on the declination axis is pictured in Image 6 while the quick release knob for the right ascension axis appear in **Image 7** on the right side just in front of the setting circle

There is a latitude scale on the side of the mount (**Image 8**) along with an easy to turn adjustment knob. The right ascension axis must be pointed toward the north or south celestial pole, depending on which hemisphere the telescope is used. The EQ3 mount does not come with drive motors. However, two-axes motors with a simple hand controller can be purchased separately.

The 100 mm Mak-Cass comes with a red dot finder scope. It is pictured clearly in Images 1 and 7. The red dot finder attaches to the base shown in **Image 9**. I wanted to use the OTA with a 6x30 or 8x50 finderscope. So I replaced the base with one I already had (**Image 10**) and attached the red dot finder to the new base using a 3D printed bracket (**Image 11**). The telescope also comes with a 1.25-inch diagonal and 25mm (56x) Plössl eyepiece, both visible in Image 11.

Image 12 shows my 8x50 right angle finderscope attached to the telescope. Unfortunately, the counterweight that comes with the CG-3 mount for this OTA is not large enough to balance the system with anything heavier than the red dot finder. Fortunately, I have many extra counterweights on hand and was able to add a second one to achieve balance.

The telescopes optics are pictured in **Image 13**. The secondary mirror presents a 30% obstruction by diameter, but only 9% by surface area. So this 100 mm telescope has the same light gathering power of a 95 mm refractor.

Image 5 - Here the 100 mm f/14 Maksutov-Cassegrain telescope is attached to an Explore Scientific EQ3 German equatorial mount.

Image 6 - A close-up view of the EQ3 mount that arrived with the telescope. Note the setting circles on each axis as well as the slow motion hand knobs.

I also picked up an Explore Scientific solar filter to test with the telescope. The solar filter uses Thousand Oaks Optical SolarLite film housed in a cardboard cell (**Image 14**). This solar filter is designed to use with practically any size Explore Scientific telescope up to 6 inches in aperture. Four foam wedged have to be cut down in size to fit the outer tube diameter of the telescope. A template for this in provide with the filter (Image 14). The foam wedges are then placed in the cell using very strong two-sided tape supplied with the kit. If the wedges are not cut to the correct size for the telescope, a snug fit on the OTA will not be achieved.

Image 15 and Image 16 show the filter attached to the 100 mm Mak-Cass. I achieved a very tight fit to prevent any breeze from blowing the filter off which would be disastrous if this occurred while viewing the Sun.

On the first clear day after receiving the telescope, I set it up in my backyard to view the Sun. The views were superb. The supplied 25mm eyepiece has a 50° field of view. The Sun filled up every bit of the field of view. The detail in the myriad sunspot visible was impressive. I then popped in a 30mm 53° eyepiece to make it easier to see the entire Sun in the field of view. Next I used a 15 mm (93x) Plössl eyepiece to zoom in on sunspots. The telescope held the power quite well.

After I had my fill of visual solar viewing, I attached a Canon 650 DSLR camera to the telescope to image the Sun through the SolarLite filter. I used a cable release to activate the shutter and used the cameras setting to lock up the camera's viewfinder mirror so t hat I would not induce any vibrations in the camera during the exposure. **Image 17** is a 0.01 s exposure at ISO800.

That night I used the same setup to take a picture of the Moon (**Image 18**). The seeing was not that great during the afternoon and evening. While I had no trouble focusing the telescope while viewing through the eyepiece, focusing using the camera in live view mode was very difficult. That night I measured the seeing to be between 5 and 6 arcseconds, downright lousy. I took a series on Moon images with 1/60 s to 1/80 s exposures at ISO800 without much success. Then I took at few at ISO1600 at 1/250 s. One of those attempts caught the Moon at an instance of calm seeing. This is Image 18. I am really happy with the quality of that image.

On another evening without the Moon out, I used the telescope to view various star clusters and nebulae. The telescope performs as well as any 90 to 100 mm refractor I have ever used.

Saturn was near opposition, so I waited up until 11:00 pm to view Saturn. At 56x and 93x, views of Saturn were quite good. There is a rule of thumb that the maximum usable magnification of a telescope is the aperture size in millimeters times two. So for this telescope that would mean 200x. I tried to view Saturn with a 6.7mm eyepiece (209x) and determined it would not hold that high power.

At f/14, one would not want to use this telescope for deep space imaging. The optical system is way too slow and would require very long exposures. However I decided to try it anyway. I put the telescope on a Celestron CGEM II mount atop my 132 mm Apo. I attached an SBIG STF-8300C CCD camera to the 100 mm telescope and a guide camera on the Apo. Again getting a good focus using the CCD camera was difficult due to the small size of the focusing knob and the long focal length of the telescope. I did the best I could and pointed the telescope towards some of my favorite targets.

Image 19 is of globular cluster M13. This composition was created with a stack of twelve 5-min exposures. This image is equivalent to what I can obtain in 10 minutes with my 132 mm Apo. The second object is the Ring Nebula, M57 (**Image 20**). To capture this image, I used twenty 5-min exposures.

In conclusion, the 100mm Maksutov-Cassegrain telescope is a great scope for the price. Both the alt-az version and equatorial version cost under $400. The equatorial mount version cost $20 more than the alt-az version. It is well worth the extra $20. With the long focal length it was easier finding and tracking objects with the equatorial mount. The telescope is superb for exploring the Moon and viewing the Sun through the SolarLite filter. Planets will appear much larger than in an equal aperture Newtonian or refractor. With nearly four inches of aperture, the telescope does a great job capturing the brighter deep space objects found in the Messier and NGC catalogs. The quick cool down time after setup makes in a great scope for splitting double stars. ATT

Image 7 – The red-dot finder atop the telescope came with the telescope. The focusing knob is on the back right side of the optical tube assembly.

Image 8 – The hand-turn bolt on right is used to adjust the mount for the user's latitude. A latitude gauge appears on the side of the mount. There is a hand knob that must be loosened to adjust the latitude and tightened to hold it in place.

Image 9 – This is the shoe that holds the red dot finder.

Image 10 – The author replaced the red-dot shoe with one that would hold a 6x30 or 8x50 finder scope.

Image 11 – The author purchased a 3D printed bracket to hold the red-dot using the same shoe for his optical finder scopes.

Image 12 – The 100 mm Mak-Cass shown with the author's 8x50 finder scope. A 1.25-inch diagonal with a 1.25-inch 25mm Plossl eyepiece are also shown attached to the telescope.

Image 13 – The telescopes optics are shown here. The corrector lens covering the tube opening holds the secondary mirror in place. The lens is so clean it is practically invisible in the image.

Image 16 – This view shows how the foam wedges glued onto the solar filter housing securely hold the filter onto the telescope.

Image 14 – The Explore Scientific Sun Catcher Solar Filter can fit various diameter optical tube assembles. A template is provided to cut out foam wedges to hold the filter on the various-diameter tubes.

Image 15 – The author explored the Sun with the solar filter attached to the telescope and another home-made solar filter over the finder scope.

Image 17 – The author took this image of the Sun using a Canon 650D camera prime focus with the 100 mm Mak-Cass. The exposure was 1/100 s at ISo800.

Image 18 – Image of the First Quarter Moon taken with the a Canon 650D camera prime focus at ISO1600 with a 1/250s exposure.

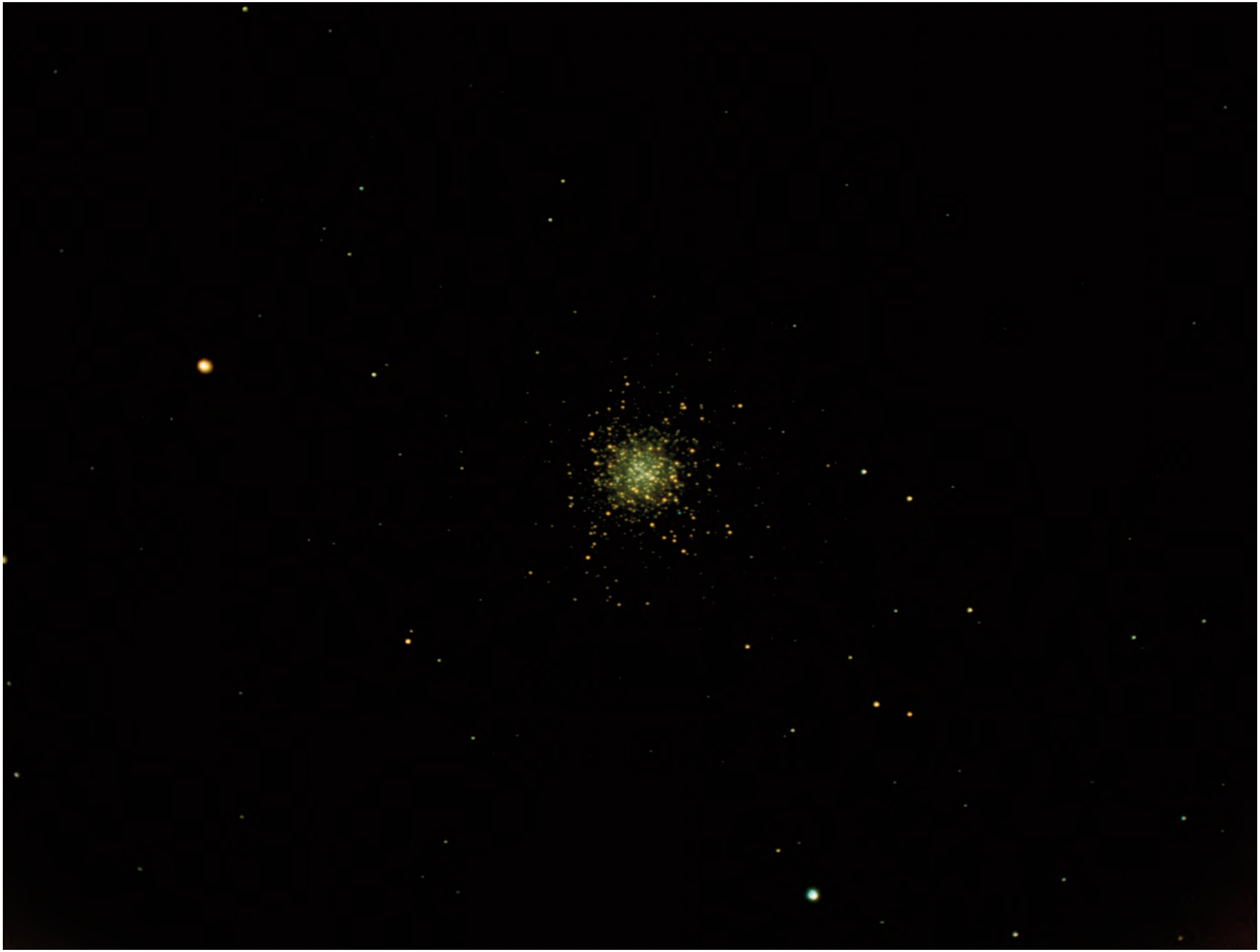

Image 19 – Globular Star Cluster M13 in Hercules taken with the 100 mm Mak-Cass.

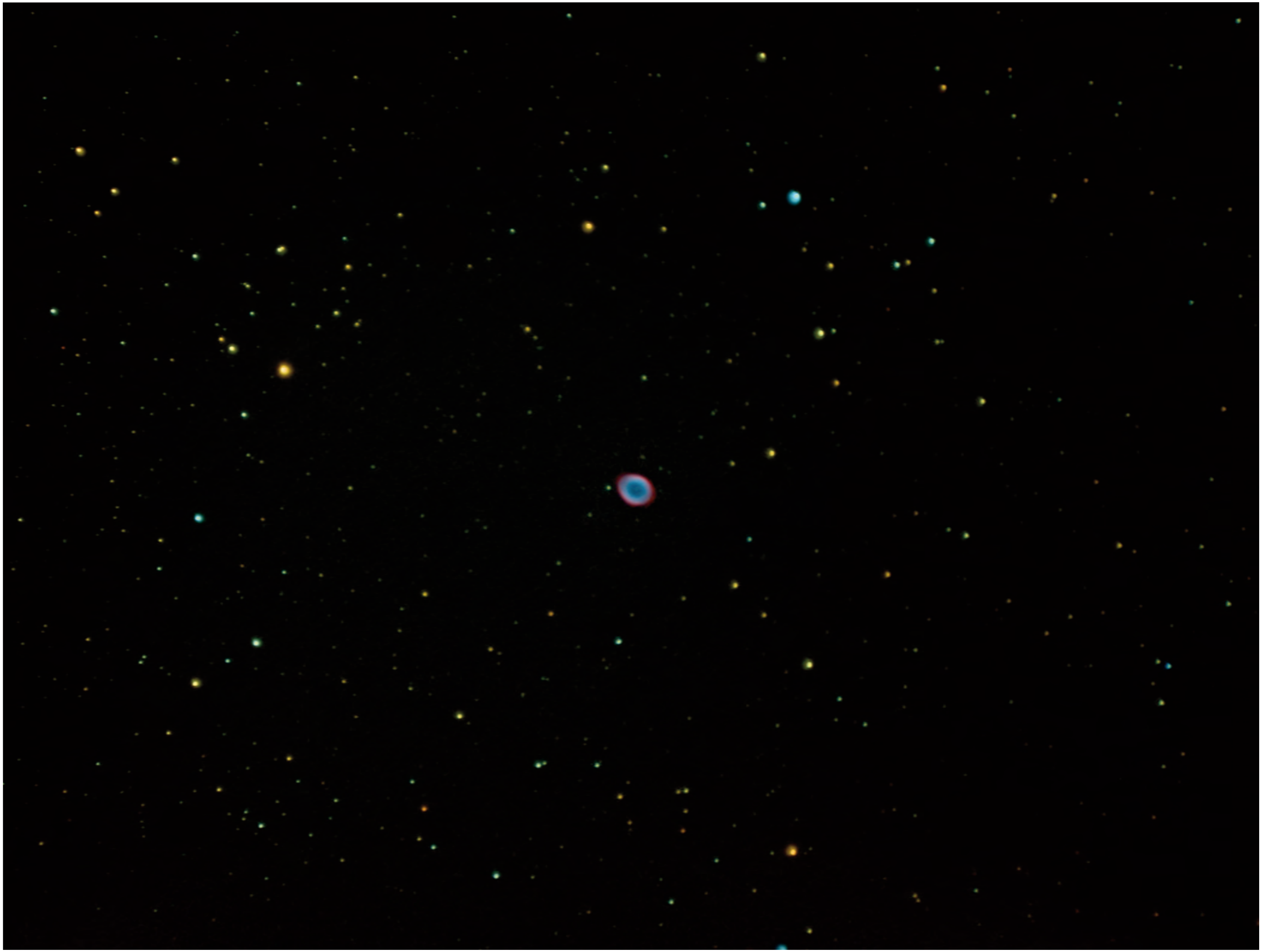

Image 20 – The Ring Nebula, M57, taken with the 100 mm Mak-Cass.