THE ROYAL ASTRONOMICAL SOCIETY OF CANADA presents:

Explore the Moon

with binoculars

photo by Ian Corbett, Liverpool, Nova Scotia

an RASC observing program with certificate for beginning observers

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Preface

The idea behind *Explore the Moon* (EtM) surfaced in 2011–12 during casual conversations between RASC members Dave Chapman (Halifax Centre), Patrice Scattolin (Centre francophone de Montréal), and Kevin Dunphy (New Brunswick Centre). We were looking for a more elementary introduction to lunar observing than the more daunting *RASC Isabel Williamson Lunar Observing Program* (directed at intermediate-to-advanced observers). We also identified a general need for a beginner's observing program one step up from the novice-level *Explore the Universe*. Such a program would provide an opportunity for observers to gain experience operating their binoculars and small telescopes and hone their observing skills. We combined theses goals and decided to base EtM on the list of lunar features and maps that have been available for some time in the *RASC Observer's Handbook* (most recently updated by Roy Bishop and Michael Gatto in 2014).

An innovation of EtM is the Q-Day method of locating and observing lunar features, which is explained in detail in the text. This method distinguishes the RASC program from other lunar observing programs available to the public. Time will tell if this will catch on, but several testers found it helpful.

We decided to offer two versions: a complete version of 94 features that require a small telescope to complete, and an abbreviated version of 40 features that can be identified in binoculars.

EtM has developed casually over the past few years and field-tested by eager observers. We thank Clara Scattolin, Melody Hamilton, Jim Millar, Greg Dill, Michael Gatto, Paul Evans, and Bruce McCurdy. In 2016, RASC presented *Explore the Moon* as an official Observing Program with certificate—we hope you start observing soon!

Introduction: Why Observe the Moon?

This may seem like a funny question. Many amateur astronomers, however, shun the Moon. It is true that moonlight interferes with the enjoyment of observing and photographing the "faint fuzzies" which are deep-sky objects. A better option is to remain calm and observe the Moon on those nights when it dominates the sky. Here's a list of benefits of lunar observing, particularly for beginning observers:

- It's easy to find!;
- You can observe from home, even in the city—no need to travel to a dark-sky site;
- The Moon is bright, offering plenty of detail, even in small telescopes or binoculars;
- Observing the Moon is ideal for learning how to operate your telescope and binoculars;
- Finding the principal features is not hard, so you can learn *observing skills*;
- It's our nearest celestial neighbour!

Suggested Resources

For the most part, all you will need to complete this program is a pair of binoculars, this document, and a calendar showing the phases of the Moon (to be explained below). It is, however, always good to have a few extra resources at hand to assist or to provide additional details of the features. Here is a brief selection of the wide range of resources available:

- Bruce McCurdy's "Lunar Observing," *Observer's Handbook 2018*, pp. 158–161;
- Peter Grego, *Moon Observer's Guide* (Firefly Books, 2004);
- John A. Read, *50 Things to See on the Moon* (Formac Publishing, 2019);
- Sky & Telescope's *Field Map of the Moon* (illustrated by A. Rükl, 2007);
- Charles Wood and Maurice Collins' *21st Century Atlas of the Moon* (Lunar Publishing, 2012) available at Amazon and Chapters/Indigo;
- *Moon Atlas* (Horsham Online, Ltd. 2011, 2012), software application for MacOS and iOS.

Planning and Observing

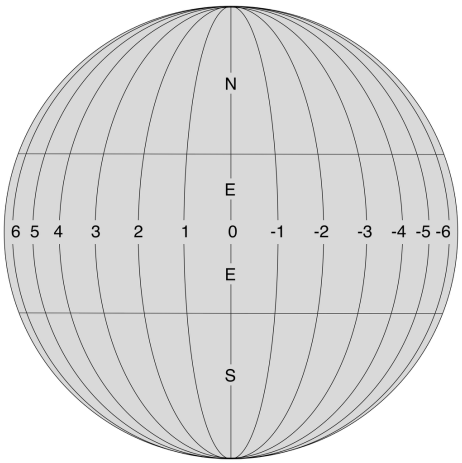
1. To prepare for observing with binoculars, study the map on page 6, which labels all the features included in the binocular version of this program. Depending on the magnification of your binoculars and the steadiness of your arms, hand-holding the binoculars may be sufficient for observing. If not, try mounting (with a suitable adapter) the binoculars on a tripod or monopod, to steady the view. Finally, electronically motion-stabilized binoculars are available, although somewhat expensive.

2. The observing strategy we propose is to explore a strip of the Moon's illuminated surface next to the terminator (the boundary between light and dark). For the mathematically inclined, this would span around 20º of lunar longitude. Of course, you can observe any illuminated part of

the Moon you like, but near the terminator the angle of the sunlight most clearly reveals the topography of craters, mountains, and valleys. The best "hunting" is to be had on the several nights surrounding First Quarter phase. One might expect that observing the Full Moon would be recommended, but in fact many of the features appear flat and washed-out by the near-overhead illumination. Observing next to the terminator also limits the number of target objects to a manageable goal for a single night of observing. Plan ahead!

3. You will most likely be observing in the mid-evening, during the 2 weeks between New Moon and Full Moon. Look on a calendar for the date of the nearest First Quarter phase. That is Q-Day 0 (We call them Q-Days to distinguish them from the Moon's age in days from New Moon). From your observing date, figure out how many days there are before First Quarter (negative Q-days) or after First Quarter (positive Q-days). That number will help you select your targets for the night from the table on pages 10–12. (If the number is greater than 7 days, see paragraph 8, below.)

4. The figure to the right shows a globe marked with the *approximate* location of the terminator, based on the number of days before or after the quarter phases. From New Moon to Full Moon, the *sunrise terminator* crosses the Moon's disk from east to west (right to left for northern-hemisphere observers viewing in binoculars), with shadow to the west and sunlight to the east. (Note that lunar east-west is opposite the east-west sky directions.) The north-south lines with **negative numbers** indicate **days before** the quarter phase; the lines with **positive numbers** indicate **days after** the quarter phase. It is important to know where the terminator will be!



5. For planning purposes, the table on page 7 orders the features by the approximate day of appearance in the lunar cycle and from north to south along the terminator, and they are cross-referenced to numbers on the feature charts in the telescope version, which is based on material in the *RASC Observer's Handbook* (see column **OH label**). To find or confirm a feature, the north-south lines are useful in roughly locating the listed lunar features on the maps and in your binoculars, with the addition of the hints: N = north, E = equatorial, and S = south (see column **pos^{n}**). For example, the crater Copernicus (2 E) appears in the equatorial sector of the Moon, almost halfway from the centre to the western limb, and the sunrise terminator crosses this location about 2 days after First Quarter.

   [From one month to the next, the apparent position of the terminator can vary by about half a Q-Day in either direction, relative to the lunar phase. In reality, lunar phase (percent illumination) is not a precise indicator of the visibility of lunar features, due to *longitudinal libration*, which is an apparent east-west rocking of the lunar globe caused by varying orbital speed of the Moon (owing to its elliptical orbit). A more precise means of determining the visibility of lunar features on any given date and time compares the longitude of the feature with the longitude of the terminator. For more information, read the articles "The Sky Month by Month" and "Lunar Observing" in the *RASC Observer's Handbook*.]

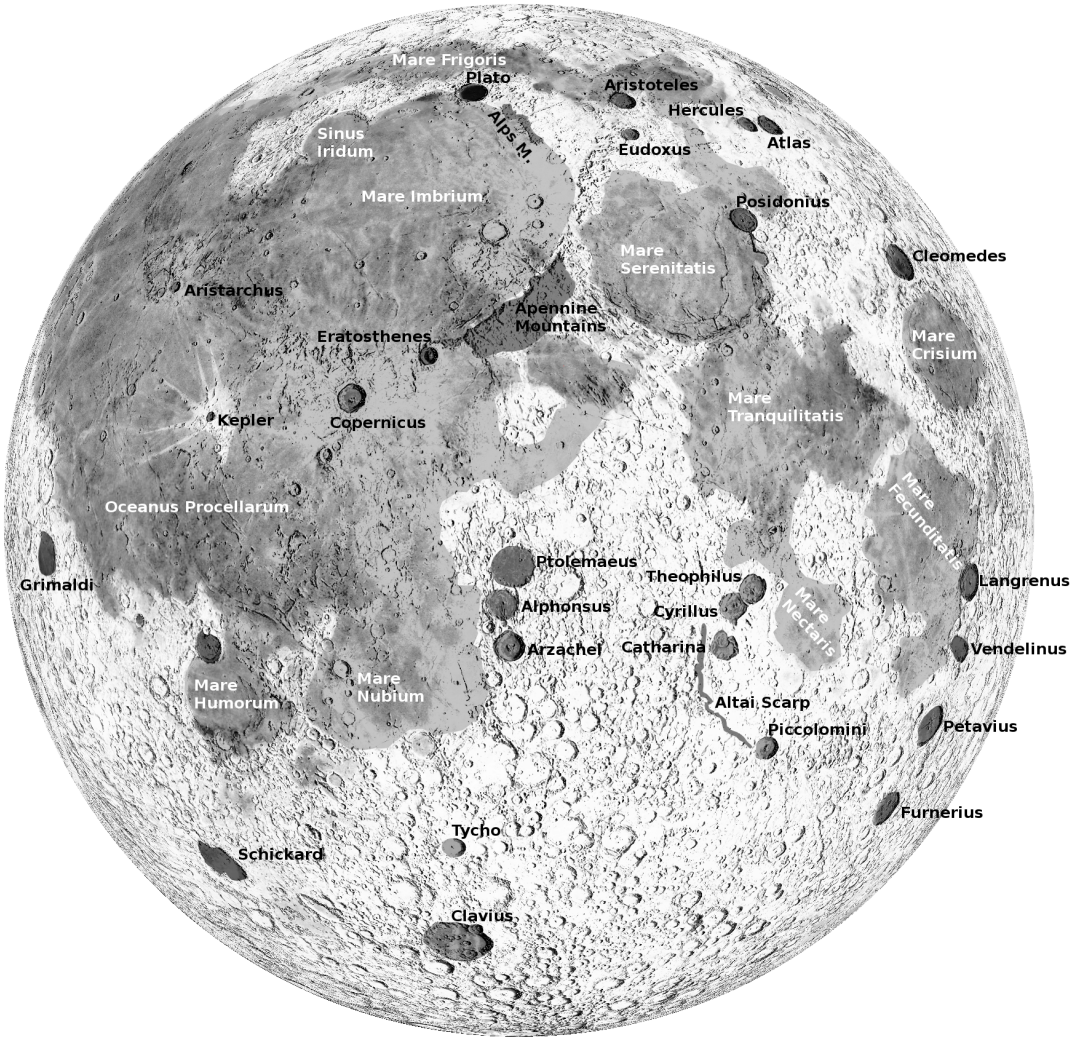
6. Most nights, the strip of lunar terrain just to the east of the sunrise terminator is your main hunting ground. For example, let's say you are observing on April 29, 2017. First Quarter occurs on May 2 (Q-Day 0), so April 29 would be Q-Day –3. Accordingly, try to look for features in the Q-Day range –3 to –4: the Sea of Fertility (–4 E) and the craters Atlas (–3 N), Hercules (–3 N), and Piccolomini (–3 S). Note that some features may lie right on the terminator or even in shadow to the west, in which case you will want to observe these the following night. You could also look for: the Sea of Crises (–5 E) and the craters Cleomedes (–5 N), Langrenus (–5 E), Vendelinus (–5), Furnerius (–5 S), and Petavius (–5 S), although the view of these objects might have been better a day earlier.

7. You can use the same method, with slight adjustment, to plan observing during the two weeks *following* Full Moon, when the *sunset* terminator crosses the Moon. In this case, the Q-Days refer to days before and after the *Last Quarter*, and you will be looking to the *west* of the sunset terminator. You might want to try observing a day earlier than the indicated day number. You will be out very late at night or early in the morning!

Recording Observations and Applying for your Certificate

There is no set recording or reporting format, but if you want to apply for the EtM certificate, you must keep a record of the date and time of observations, the sky conditions, the binocular characteristics, and any observing remarks or details noticed. You are encouraged to include drawings, but it is notmandatory. You could use the table itself as a checklist of completed observations. Consider setting up a separate logbook for EtM, for ease of validation. The application form and directions are online at www.rasc.ca/observing/explore-the-moon-observing-certificate

Explore the Moon (binocular version)



(map by Clara Scattolin, 2014, based on the Virtual Moon Atlas ap-i.net/avl/en/start

Maria or "Seas"

Mare Crisium = Sea of Crises
Mare Fecunditatis = Sea of Fertility
Mare Frigoris = Sea of Cold
Mare of Humorum = Sea of Moisture
Mare Imbrium = Sea of Showers
Sinus Iridum = Bay of Rainbows
Mare Nectaris = Sea of Nectar
Mare Nubium = Sea of Clouds
Oceanus Procellarum = Ocean of Storms
Mare Serenitatis = Sea of Serenity
Mare Tranquilitatis = Sea of Tranquility

The "Gang of Four" Craters

(north to south)

Langrenus
Vendelinus
Petavius
Furnerius

Explore the Moon (binocular version)

feature name	pos[n]		description	OH label
Cleomedes	–5	N	*Prominent eroded crater to the north of Mare Crisium*	37
Mare Crisium (Sea of Crises)	–5	E	*Spectacular, large lava–filled basin with impressive wall structures. Try viewing at various illumination angles.*	M C
Langrenus (*Gang of Four*)	–5	E	*Crater with twin peaks and pronounced ejecta field*	58
Vendelinus (*Gang of Four*)	–5	E	*Large, heavily eroded crater (not numbered in OH or BOG)*	87
Petavius (*Gang of Four*)	–5	S	*Crater with a massive, complex central peak and floor uplift.*	69
Furnerius (*Gang of Four*)	–5	S	*Old eroded crater with ejecta on its floor*	47
Mare Fecunditatis (Sea of Fertility)	–4	E	*A mare consisting of two contiguous, nearly round areas of dark basaltic lavas*	M Fe
Atlas	–3	N	*Prominent crater, to east of Hercules (below)*	29
Hercules	–3	N	*Prominent crater on the eastern edge of Mare Frigoris*	52
Piccolomini	–3	S	*Midsized crater at the southern tip of the Altai Scarp*	71
Posidonius	–2	N	*Flooded crater with very irregular terrain*	74
Mare Tranquillitatis (Sea of Tranquility)	–2	E	*Large sea on the eastern side, first lunar landing site*	M T
Theophilus	–2	E	*Bordering the edge of Mare Nectaris. Part of trio formed with Cyrillus and Catharina*	84
Cyrillus	–2	E	*Older and more eroded than Theophilus, which overlaps its eastern wall.*	41
Catharina	–2	E	*Old crater with multiple features superposed upon it*	35
Mare Nectaris (Sea of Nectar)	–2	S	*Smallest of the major circular maria, at 350 km across*	M Ne
Altai Scarp	–2	S	*Incredible scarp is the continuous southwestern outer rim of the Nectaris Basin. Spectacular at low Sun angles.*	E
Mare Serenitatis (Sea of Serenity)	–1	N	*Impact basin predating Mare Imbrium, filled with Imbrium Era mare material*	M S
Aristoteles	–1	N	*Crater located at the southern edge of Mare Frigoris*	27
Eudoxus	–1	N	*Neighbor of Aristoteles*	45
Mare Frigoris (Sea of Cold)	0	N	*Large linear sea at the northern limb of the Moon*	M Fr
Alps Mountains	0	N	*Spectacular northeast boundary of the Mare Imbrium basin*	B
Apennine Mountains	0	E	*Spectacular southeast boundary of the Mare Imbrium basin*	F
Ptolemaeus	0	E	*Near the centre of the Moon's disk, younger than Alphonsus*	75
Alphonsus	0	E	*Large crater with central peak, south of Ptolemaeus*	22
Arzachel	0	E	*Crater with sharply–defined, deep–terraced walls*	28
Plato	1	N	*Dark–floored crater on the margin of Mare Imbrium.*	72
Eratosthenes	1	E	*Large crater at the southern tip of the Apennine Mountains*	44
Mare Nubium (Sea of Clouds)	1	S	*Southernmost sea directly west of Alphonsus*	M Nu
Tycho	1	S	*Recent crater best seen at Full Moon when its rays can be traced over much of the lunar surface.*	86
Clavius	1	S	*Large crater in the southern part of the Moon*	36
Mare Imbrium (Sea of Rains)	2	N	*Large sea south of Mare Frigori*	M I
Copernicus	2	E	*Spectacular crater with central peaks, surrounded by a prominent ejecta blanket and numerous secondary craters.*	39
Sinus Iridum (Bay of Rainbows)	3	N	*Dark flooded crater on the edge of Mare Imbrium*	S I
Kepler	3	E	*Recent impact crater, uneven floor, bright ray system*	57
Aristarchus	4	N	*Bright, complex crater near the edge of O. Procellarum.*	25
Oceanus Procellarum (Ocean of Storms)	4	E	*Large lava covered area west of Mare Imbrium*	O P
Mare Humorum (Sea of Moisture)	4	S	*Small sea below Oceanus Procellarum*	M H
Schickard	5	S	*Very large crater containing bright spots in the SW quadrant.*	78
Grimaldi	6	E	*Large round basin with dark floor on the W edge of the Moon.*	49