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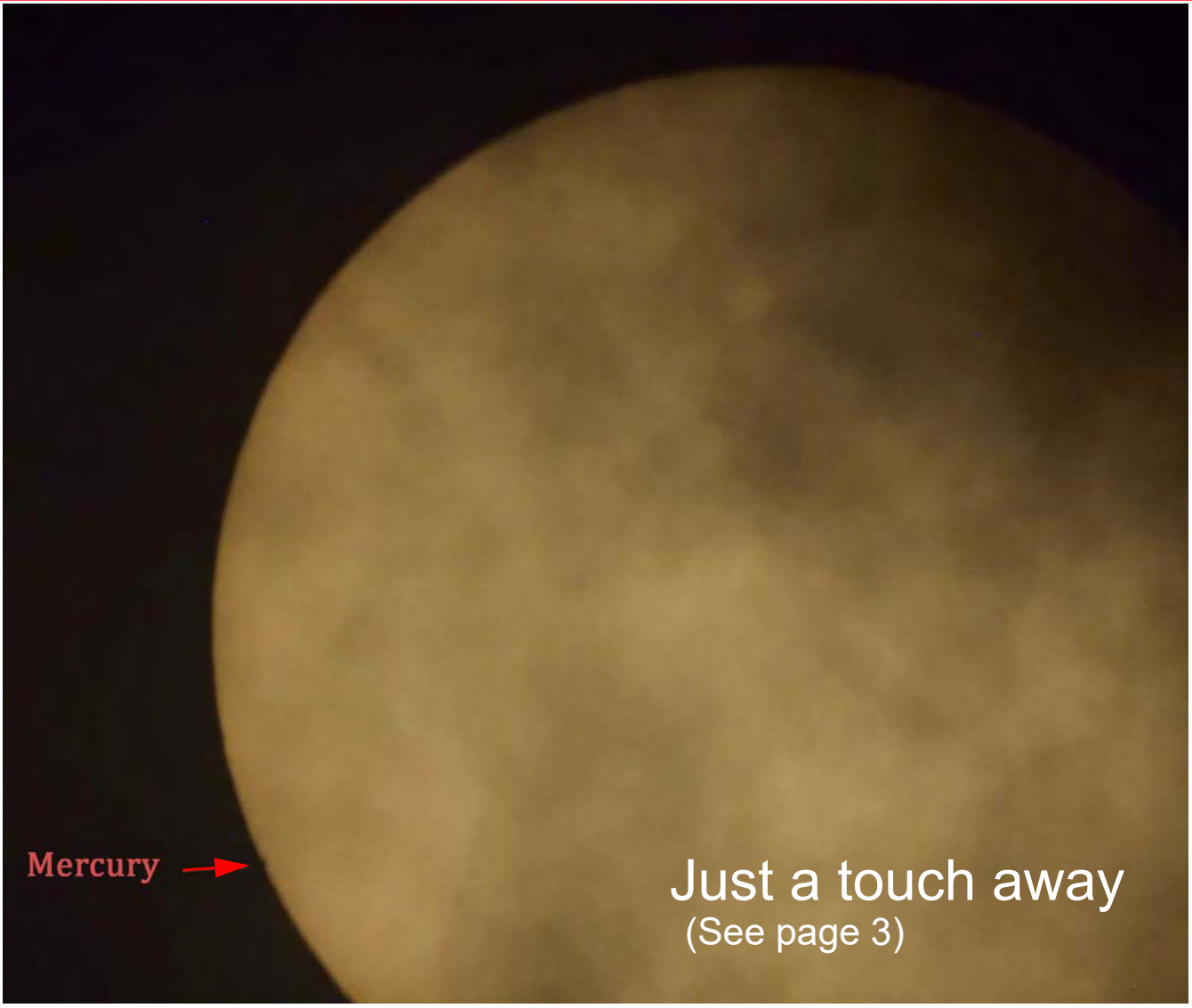

Papers & Presentations

ALPO Observations of Mercury During the 2018 Apparitions

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Abstract

There were seven apparitions of Mercury in 2018. There were three observers who submitted 11 images and two drawings, for a total of 13 observations, using apertures ranging from 152 mm (6 in.) to 360 mm (14 in.). In addition, a single wide-angle view of a Moon and Venus conjunction with Mercury was submitted. The telescopic views revealed albedo features that matched known features depicted in the images made by the MESSENGER spacecraft (Melillo, 2010) and in the 1971 albedo chart prepared by Murray, Smith and Dollfus (Murray, Smith, and Dollfus, 1972; see Figure 1).

Introduction

There were three evening and four morning apparitions of Mercury during 2018. Table 1 indicates the characteristics of these apparitions.

Only three observers contributed and made a total of 13 observations. As in the last several years, the ALPO Mercury section received fewer observations than it did in the years of the previous decade. For example, in 2007 the Mercury Section received 65 telescopic observations (Melillo, 2009). The 2018 observers used telescopes ranging from 250 mm to 360 mm (10 to 14 inches). This author contributed the most observations with six digital "lucky images" (webcam images) with fair resolution (See *Table 2*).

Observing Scales

Standard ALPO Scale of Intensity:

0.0 = Completely black
10.0 = Very brightest features

Intermediate values are assigned along the scale to account for observed intensity of features

ALPO Scale of Seeing Conditions:

0 = Worst
10 = Perfect

Scale of Transparency Conditions:

Magnitude of the faintest star visible near Mercury when allowing for daylight and twilight

IAU directions are used in all instances (so that Mercury rotates from west to east).

Tiny Mercury is the most challenging of the classical planets to observe. Due to

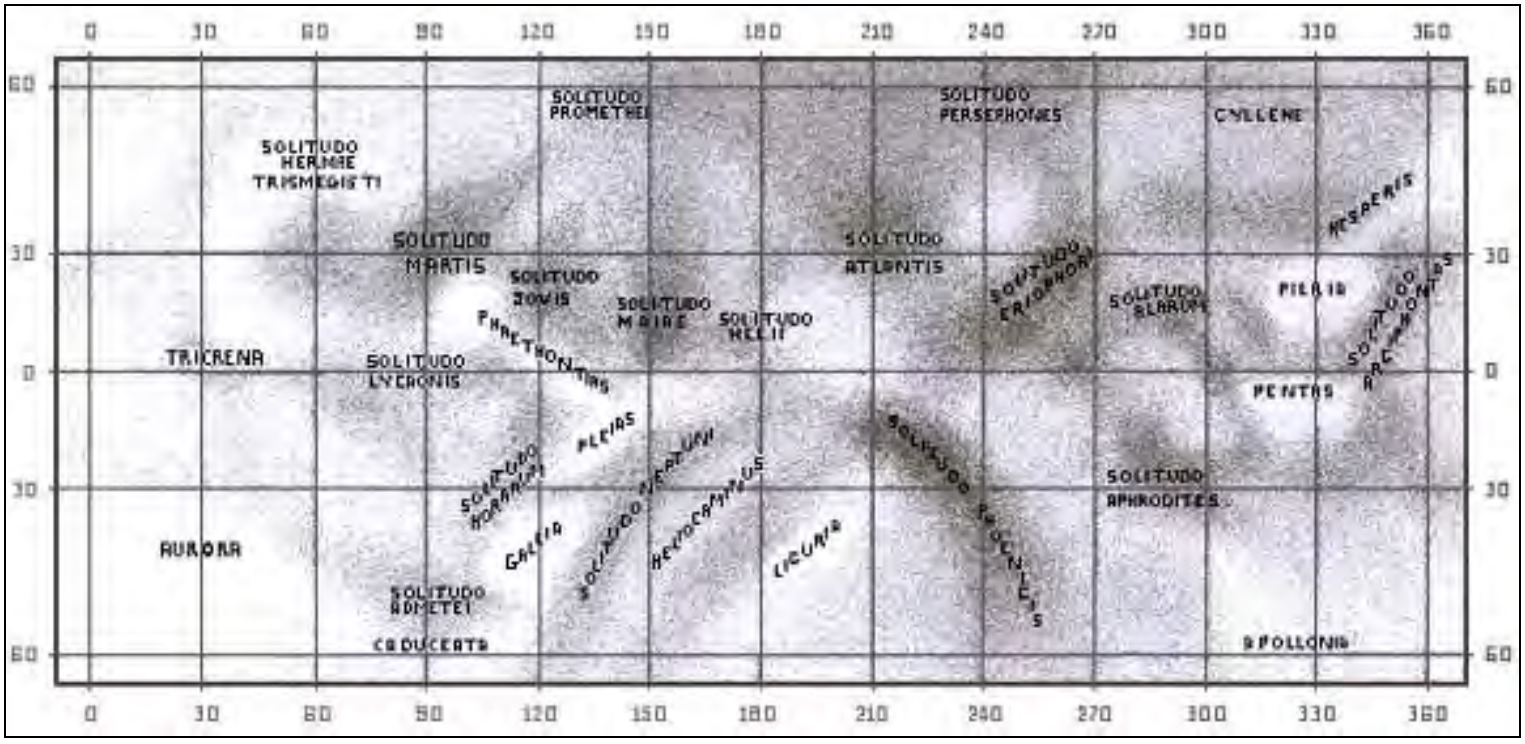

Figure 1. Albedo chart prepared by Murray, Smith and Dollfus

Table 1. Characteristics of the Apparitions of Mercury in 2018*

No. & Type	Beginning Conjunction**	Greatest Elongation	Elongation Distance***	Magnitude At Elong.	Ending Conjunction**
1. Morning	13 Dec 2017 (i)	1 Jan	22.7° W	- 0.35	16 Feb (s)
2. Evening	16 Feb (s)	15 Mar	18.4° E	- 0.35	2 Apr (i)
3. Morning	2 Apr (i)	29 Apr	27.0° W	+ 0.34	6 Jun (s)
4. Evening	6 Jun (s)	12 Jul	26.4° E	+ 0.39	8 Aug (i)
5. Morning	8 Aug (i)	26 Aug	18.3° W	- 0.24	20 Sep (s)
6. Evening	20 Sep (s)	6 Nov	23.3° E	- 0.26	27 Nov (i)
7. Morning	27 Nov (i)	15 Dec	21.3° W	- 0.47	29 Jan 2019 (s)

* All dates are UT.
** (i) is inferior conjunction, (s) is superior conjunction, when Mercury and Sun have the same right ascension.
*** Angular distance and approximate direction (east or west) from Sun on sky, not with reference to right ascension, in degrees.

Mercury's low altitude in twilight skies, the long optical path through Earth's atmosphere often causes image unsteadiness and blurring. This can be minimized by using a red filter such as a Wratten #25 or 610 nm long-pass, as redder wavelengths are less affected by atmospheric instability than blue.

Also, some observers have made good observations of the planet in daylight for which this author recommends the use of an orange Wratten #21 filter. Care must be taken, however, to minimize direct sunlight on the telescope's tube, to avoid the distortions caused by thermal air currents inside the tube (Melillo, 2004; Boudreau, 2009).

With current technology, digital lucky imaging results in the best images of Mercury. It involves selection of frames of high contrast and the stacking of many of them to yield a better signal-to-noise ratio than one can obtain by other techniques. Nevertheless, drawing the planet is a good way to train the eye in observing, and it can reveal subtle albedo features while conveying a unique satisfaction to the observer.

The MESSENGER global map is the most authoritative source of information to which we can compare our observations. It has proven that the bright features that we have been detecting on the surface of Mercury are large, bright crater ejecta systems that stand out against the darker background terrain. Also, we have detected some dark albedo features near the bright ray systems, which make a nice contrast. Keep in mind that the bright areas we see are not individual craters, but rather the broad ejecta blankets around those craters. It is similar to a naked-eye view of the Moon, by which we see the Kepler and Copernicus ray systems but not the craters themselves.

The 2018 observations are all presented and described in this paper. In all of the telescopic drawings and images in this article, north is up and planetary east (celestial west) is to the right.

Apparition 1: Morning, 13 Dec (2017) - 16 Feb

After inferior conjunction with the Sun on 13 Dec (2017), Mercury entered the morning sky. The greatest elongation occurred on 1 Jan with a reasonable distance of 22.7 degrees from the Sun. Unfortunately, it was winter in Earth's Northern Hemisphere, a factor that is known to limit the number of observations that Mercury observers make, and we received no observation reports for this apparition. Mercury went behind the Sun in superior conjunction on 16 Feb.

Apparition 2: Evening, 16 Feb - 2 Apr

This was Mercury's best evening appearance of the year, and the planet became easily visible to the naked eye in evening twilight.

One new ALPO member, Michel Deconinck of France, produced two drawings, both of which showed shady markings. On 2 Mar (CM = 216 degrees), he made a drawing of Mercury at nearly a full phase (see *Figure 2, Drawing A*), and his second drawing was made on 15 Mar (CM = 276 degrees) (see *Figure 2, Drawing B*) when the planet appeared as a thick crescent. These drawings show that Mercury changed its phase quite rapidly in just 13 days.

On the evening of 18 Mar (Eastern Time), this author captured a wide-angle shot of a loose conjunction of Mercury,

Table 2. Observers of Mercury in 2018

Observer	Location	Telescope (aperture, type)	Number & Type of Observations	Apparitions Observed
Michel Deconinck	Verdon Canyon, France	152 mm RFR	2 drawings	2
Simon Kidd	Cottered, England	360 mm SCT	4 webcam images	4
Frank J Melillo	Holtsville, NY, United States	250 mm SCT	6 webcam images 1 sky view	2, 5, 7

Telescope Types: RFR = Refractor (RFR); SCT = Schmidt Cassegrain

Figure 2. Three observations of Apparition 2.
A. Drawing by Michel Deconinck, 2 Mar 2018, 16:20 UT, CM = 216 degrees.
B. Drawing by Michel Deconinck, 15 Mar 2018, 15:22 UT, CM = 276 degrees.
C. Image by Frank J. Melillo, 19 Mar 2018, 00:00 UT. A triple conjunction with a young (34hr 48min old) Moon, Venus (middle) and Mercury (upper right). This is a five-second exposure made with a Nikon 3200D digital camera through a lens of 135 mm focal length at f/8.

Venus and the thin crescent Moon shortly after sunset (see *Figure 2, Image C*). This conjunction was unusual in that Mercury appeared farther from the Sun than both Venus and the Moon. The Moon was only 35 hours after new and appeared only 3.4 degrees above the theoretical horizon, while Mercury was at an altitude of 6.6 degrees at a distance of 3.9 degrees from Venus and 7.7 degrees from the Moon.

Mercury went through inferior conjunction with the Sun on 2 Apr.

Apparition 3: Morning, 2 Apr - 6 Jun

On 2 Apr, Mercury entered the morning sky for the second time in 2018. Although the 27.0-degree elongation on 29 Apr was the greatest of the year, an imaginary line from the Sun to Mercury was tilted only 23 degrees from the morning horizon as seen from 41 degrees north latitude on Earth so that Mercury was very low in the sky during morning twilight for observers in Earth's Northern Hemisphere. The ALPO Mercury Section did not receive any reports of observations made during this apparition.

Mercury reached superior conjunction with the Sun on 6 Jun.

Apparition 4: Evening, 6 Jun - 8 Aug

After 6 Jun, Mercury moved into the evening sky. It reached its greatest elongation on 12 Jul with a distance of 26.4 degrees from the Sun. As seen from Earth's Northern Hemisphere, Mercury was close to the evening horizon despite the extent of its elongation.

The ALPO Mercury Section received four observations, all from Simon Kidd of Cottered, England, who made all of his observations while Mercury was in the daytime sky. This enabled him to take advantage of the large elongation from the Sun while avoiding the problem of the low altitude of the planet after sundown. He used a 742 IR filter in all of his images to decrease the blurring effect caused by Earth's roiling atmosphere.

He started observing and imaging Mercury on 25 Jun (CM = 81 degrees)

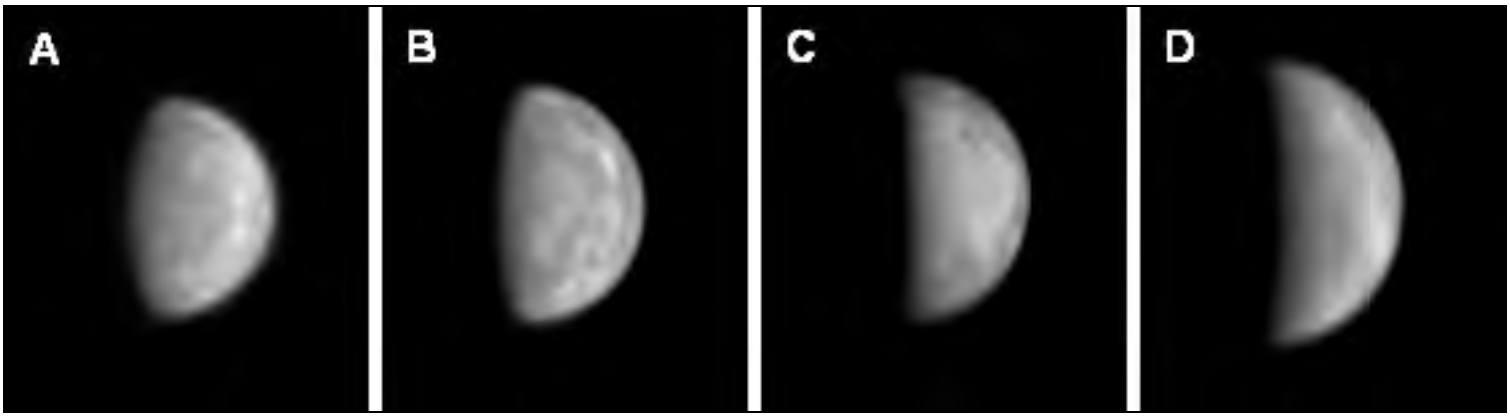

Figure 3. Four images of Apparition 4.
A. Image by Simon Kidd, 25 Jun 2018, 16:12 UT, CM = 81 degrees.
B. Image by Simon Kidd, 02 Jul 2018, 18:37 UT, CM = 114 degrees.
C. Image by Simon Kidd, 08 Jul 2018, 18:58 UT, CM = 144 degrees.
D. Image by Simon Kidd, 12 Jul 2018, 18:50 UT, CM = 164 degrees.

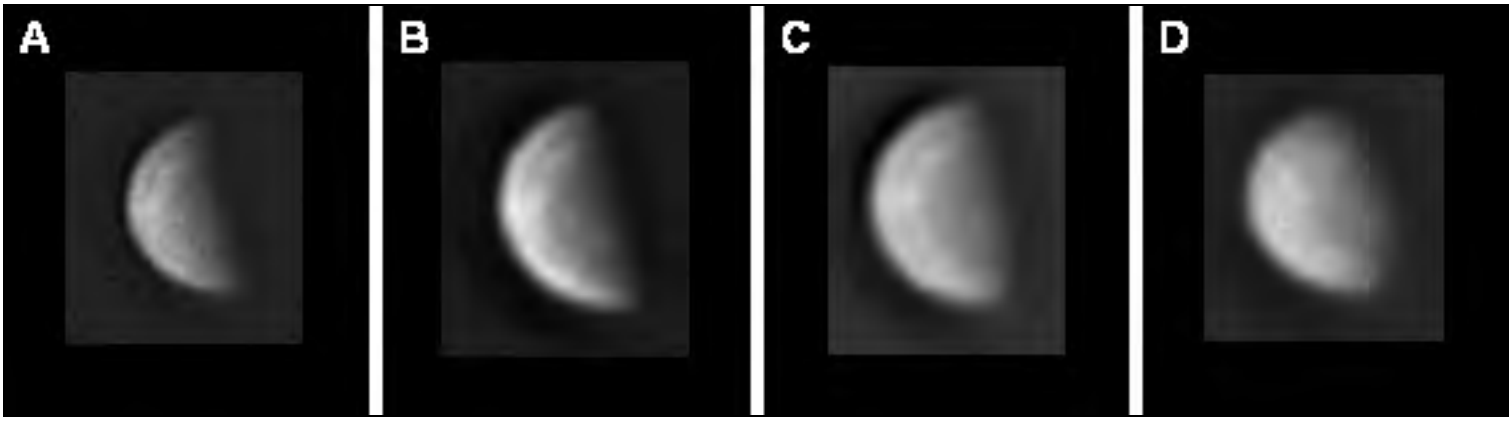

Figure 4. Four images of Apparition 5.
A. Image by Frank J Melillo, 9 Sept 2017, at 14:35 UT. CM was 71 degrees.
B. Image by Frank J Melillo, 10 Sept 2017, at 14:35 UT. CM was 77 degrees.
C. Image by Frank J Melillo, 23 Sept 2017, at 14:35 UT. CM was 139 degrees.
D. Image by Frank J Melillo, 24 Sept 2017, at 14:25 UT. CM was 143 degrees.

(see *Figure 3, Image A*). In his image, it is remarkable that he captured the bright rayed crater Kepler as a white spot near the limb. There are other white patches scattered around the disk, suggesting the presence of rayed craters at those spots. In the second image on 2 Jul (CM = 114 degrees) (see *Figure 3, Image B*), Mercury rotated 33 degrees (toward the right, in the image) to bring some more features into view. The image shows several bright smaller patches, which are rayed craters. Kidd imaged Mercury again on 8 Jul (CM = 144 degrees) (see *Figure 3, Image C*) and on 12 Jul (CM = 164 degrees) (see *Figure 3, Image D*), but not all of the features shown in these images can be recognized, though the evolution of the phase is plainly seen. These four images are outstanding and the clearest received by this Section in 2018.

Mercury went through inferior conjunction with the Sun on 8 Aug.

Apparition 5: Morning, 8 Aug - 21 Sept

Mercury entered the morning sky for the third time on 8 Aug 2018. It was the best morning apparition of the year.

After the 26 Aug greatest elongation of 18.3 degrees west of the Sun, this author began imaging. The image of 28 Aug (CM = 91 degrees) (see *Figure 4, Image A*) displays a half-phase. Though the seeing was not exceptional, there are scattered white spots and a known cluster of small rayed craters below center near the terminator is seen. An image taken the next day, 29 Aug (CM = 96 degrees) (see *Figure 4, Image B*), shows the same feature, while other white patches are evident in the planet's Northern Hemisphere. The next day's image, 30 Aug (CM = 101 degrees) (see *Figure 4, Image C*), shows the same features. Note the slight phase change in just three days.

Finally, one more image was taken on 3 Sept (CM = 119 degrees) (see *Figure 4, Image D*) by this author. Mercury displayed a gibbous phase at 75% illumination, which is often the phase at which details are best seen. Some features that were seen in the previous three images were captured again, but with less clarity, as the seeing condition was below average. The features can be seen to have moved with the planet's rotation.

On 20 Sept, Mercury went through superior conjunction with the Sun.

Apparition 6: Evening, 20 Sept - 27 Nov

This evening appearance was quite poor as seen from Earth's Northern Hemisphere. On 6 Nov, Mercury reached greatest elongation at 23.3 degrees from the Sun, but was quite low in the southwestern sky due to the very shallow ecliptic path.

The only interesting date was on 28 Oct when Mercury underwent a conjunction with Jupiter with a separation of about 3 degrees. No observations of this apparition were received.

Apparition 7: Morning, 27 Nov - 29 Jan (2019)

This apparition was nearly as favorable for northern observers as Apparition 5 and the elongation brought Mercury a little further out, to 21.3 degrees west of the Sun. This author's two observations were the only ones received.

On 12 Dec (CM = 280 degrees), Mercury was imaged in daylight (see *Figure 5, Image A*). To find Mercury, the author noted the right ascension and declination of both Venus and Mercury. He first found Venus, which was visible in the finder scope, and then used setting circles to accurately span the gap to Mercury, which was visible only through the telescope's main optics. Though the weather was severe, there were moments of good seeing which permitted good resolution. Mercury displayed a little more than a half disk at 54% illumination. The most reliable features

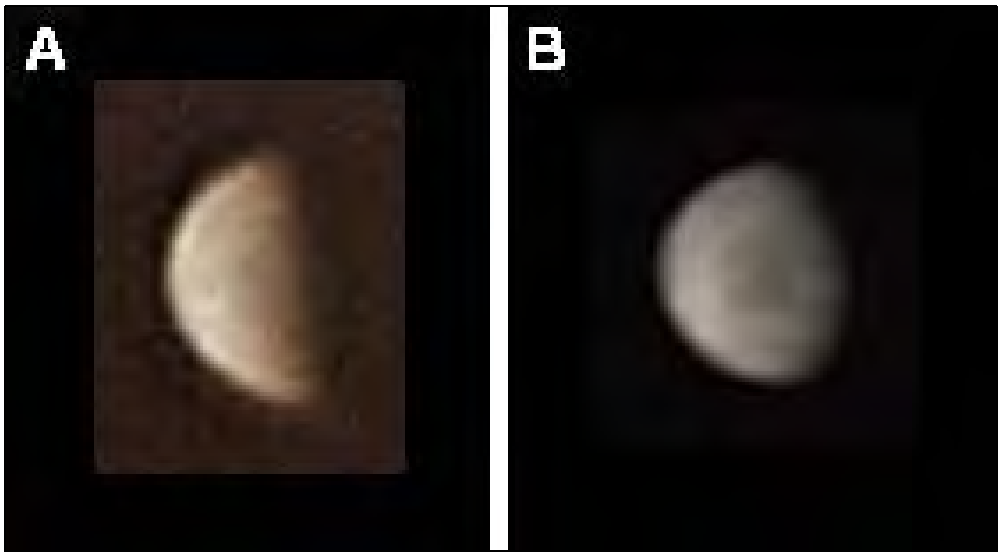

Figure 5. Two images of Apparition 7.
A. Image by Frank J Melillo, 12 Dec 2018, 15:09 UT, CM = 280 degrees.
B. Image by Frank J Melillo, 25 Dec 2018, 14:50 UT, CM = 344 degrees.

detected were two bright-rayed craters near the limb.

A better image was taken on Christmas Day, 25 Dec (CM = 344 degrees) (see *Figure 5, Image B)*. The phase was gibbous at 83% illumination. Much of the surface was exposed towards the Earth, so some details were seen. In fact, due to the rotation, the two white rayed craters that were seen on 12 Dec near the limb had moved across the disk and were close to the terminator. The rayed crater Debussy is located on the south side while the rayed crater Ellington is located northeast of it (upper right). They are believed to be the brightest rayed craters as seen from Earth.

No further observations were received before superior conjunction with the Sun on 29 Jan (2019).

Conclusions

The best observations of Mercury are now made with digital lucky imaging, which is still known in much of the amateur community as webcam imaging.

Daytime imaging of Mercury is seen to be useful, producing some of the best images of the planet. Many times, if the planet is to be observed in morning or evening twilight, its telescopic clarity will be poor due to its position very close to the horizon, even when it is at greatest elongation. Similarly, some good apparitions occur when the solar elongation is not particularly far because the angle the ecliptic makes with the horizon changes during the course of Earth's year.

Many albedo features that amateurs are detecting are not clearly seen in MESSENGER images and we suspect that some of them are nevertheless real. Differences in equipment, filters and processing used to create the MESSENGER spacecraft images and those of Earth-based observers may account for some or many of the differences in albedo features. A map of albedo features as detected by amateurs may eventually be made which will draw information from many observations that do not clearly correspond to the spacecraft images. This should be an encouragement to amateur astronomers to faithfully observe Mercury and hone their equipment and skills towards this end.

Mercury remains the most difficult of the classical planets to study, whether visually or by imaging. Readers are especially encouraged to read the references Boudreau (2009) and Melillo (2004) for further information about the challenges and the techniques of observing Mercury.

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