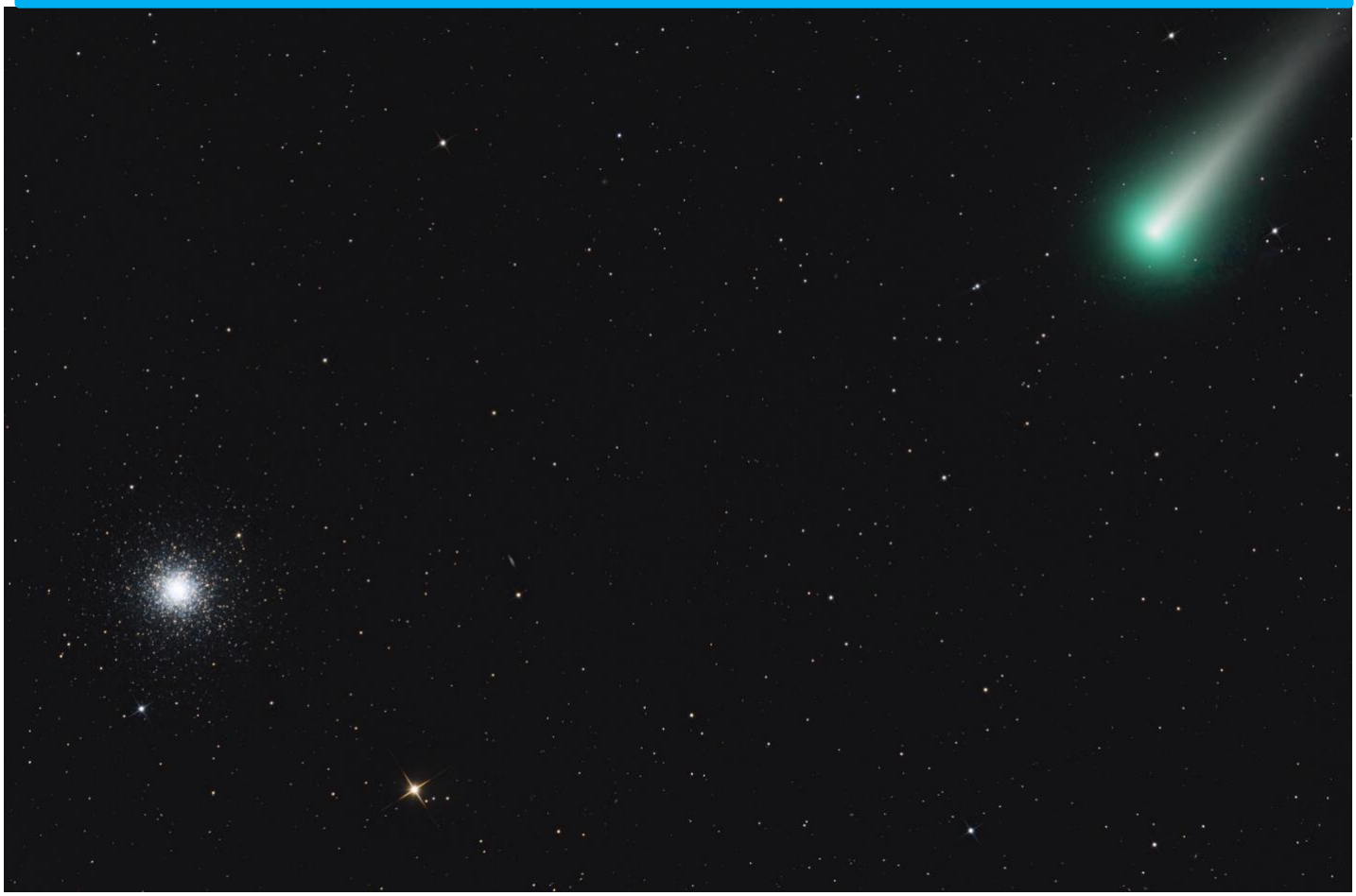
ALPO COMET NEWS

A Publication of the Comets Section of the Association of Lunar and Planetary Observers

December 2021
alpo-astronomy.org
comets@alpo-astronomy.org



C/2021 A1 (Leonard) closing in on globular cluster M3 in Canes Venatici. Gregg Ruppel took this image on the morning of 2021 December 2 with an ASA 10N f/3.7 and STL11000M from Dark Sky, New Mexico. Image is a composite LRGB with 60 minutes of total exposure.

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The monthly ALPO Comet News PDF can be found on the ALPO Comets Section website (http://www.alpo-astronomy.org/cometblog/). A shorter version of this report is posted on a dedicated Cloudy Nights forum (https://www.cloudynights.com/topic/801076-alpo-comet-news-for-december-2021/). All are encouraged to join the discussion over at Cloudy Nights. The ALPO Comet Section welcomes all comet related articles, observations, images, drawings, magnitude estimates, or spectra. One does not have to be a member of ALPO to submit material, though membership is encouraged.

Please send your observations to the Comets Section at < comets@alpo-astronomy.org >, Coordinator Carl Hergenrother < carl.hergenrother@alpo-astronomy.org > and/or Acting Assistant Coordinator Michel Deconinck < michel.deconinck@alpo-astronomy.org >.

To learn more about the ALPO, please visit us @ http://www.alpo-astronomy.org.

Summary

It is now or never for C/2021 A1 (Leonard). Currently magnitude 6.5, Leonard has the potential to become a few magnitudes brighter as it passes 0.23 au from Earth on December 12. Complicating any forecast of how bright or observable it might get are a very low solar elongation (down to 15 degrees), uncertainty in the effect of dust forward scattering to enhance Leonard's brightness, and signs that the comet is fading or perhaps even breaking up. This is an object well worth watching in the morning sky from the northern hemisphere during the first half of the month and in the evening sky during the second half of December (though at that time it will be much easier to observe from the southern hemisphere).

Other comets brighter than 10th magnitude in December include C/2019 L3 (ATLAS), 19P/Borrelly, and 67P/Churyumov-Gerasimenko.

In addition to observations submitted directly to the ALPO, we occasionally use data from other sources to augment our analysis. We would like to acknowledge with thanks observations submitted directly to the ALPO as well as those originally submitted to the International Comet Quarterly, Minor Planet Center, and COBS Comet Observation Database. We would also like to thank the Jet Propulsion Laboratory for making available their Small-Body Browser and Orbit Visualizer and Seiichi Yoshida for his Comets for Windows programs that is used to produce the lightcurves in these pages. And last but not least, we'd like to thank Syuichi Nakano and the Minor Planet Center for their comet orbital elements, the asteroid surveys and dedicated comet hunters for their discoveries, and all of the observers who volunteer their time to adding to our knowledge of these amazing objects.

Aperture Corrections to Magnitude Measurements

We try to include up to date lightcurves for most of the objects discussed in this report as well as applying aperture corrections to the visual observations. All magnitude estimates are affected by many factors including instrumental (aperture, focal length, magnification, type of optics), environmental (sky brightness due to moonlight, light pollution, twilight, aurora activity, zodiacal light, etc), cometary (degree of condensation, coma color, strength and type of gas emission lines, coma-tail interface) and personal (sensitivity to different wavelengths, personal technique, observational biases). The correction used here only corrects for differences in aperture [C. S. Morris, On Aperture Corrections for Comet Magnitude Estimates. Publ Astron Soc Pac 85, 470, 1973]. Visual observations are corrected to a standard aperture of 6.78 cm by 0.019 magnitudes per centimeter for refractors and 0.066 magnitudes per centimeter for reflectors. As our work develops, we will investigate the determination of personal corrections for each observer for each individual comet as well as for digital observations.

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Comets Calendar for December 2021

Dec 02-03 – C/2021 A1 (Leonard) passes ~0.1 deg of 6th mag globular cluster M3
Dec 02 – 430P/Scotti at perihelion (q = 1.55 au, 5.5-year orbit, V ~ 17, 2nd observed return, discovered in 2011, missed at 2016 return)
Dec 04 – New Moon
Dec 06 – 19P/Borrelly orbit plane crossing
Dec 08 – C/2021 A1 (Leonard) orbit plane crossing
Dec 08 – 436P/Garradd at perihelion (q = 1.96 au, 14.4-year orbit, V ~ 19, 2nd observed return, discovered in 2007)
Dec 10 – First Quarter Moon
Dec 12 – C/2021 A1 (Leonard) passes ~0.2 deg of 9th mag globular cluster NGC 6366
Dec 12 – C/2021 A1 (Leonard) passes 0.2334 au (34.9 million km, 21.7 million miles) from Earth (Dec 12 – 13:53 UT)
Dec 14 – C/2021 A1 (Leonard) passes across bright emission nebula M16, the Eagle Nebula
Dec 14 – 402P/LINEAR at perihelion (q = 3.94 au, 18.6-year orbit, V ~ 16-17, 2nd observed return, discovered in 2003)
Dec 16 – 173P/Mueller at perihelion (q = 4.22 au, 13.6-year orbit, V ~ 19, very asymmetric lightcurve with peak activity 1-2 years BEFORE perihelion, peaked at V~16, 3rd observed return)
Dec 16 – P/2021 R1 (PANSTARRS) at perihelion (q = 4.89 au, 24.4-year orbit, V ~ 20, discovered last September)
Dec 18 – C/2021 A1 (Leonard) passes 0.0285 au (4.26 million km, 2.65 million miles) from Venus (Dec 18 - 02:06 UT), will appear 5.1 deg from Venus as seen from Earth
Dec 18 – Full Moon
Dec 18 – 221P/LINEAR at perihelion (q = 1.75 au, 6.4-year orbit, V ~ 19, currently in solar conjunction, 4th observed return, discovered in 2002)
Dec 19 – C/2017 K2 (PANSTARRS) orbit plane crossing
Dec 21 – C/2021 U4 (Leonard) at perihelion (q = 1.79 au, ~300-year orbit, V ~ 20-21)
Dec 21 – C/2021 R2 (PANSTARRS) at perihelion (q = 7.31 au, ~110,000-year orbit, V ~ 20)
Dec 21 – 8P/Tuttle orbit plane crossing
Dec 26 – Last Quarter Moon
Dec 30 – 395P/Catalina-NEAT at perihelion (q = 4.06 au, 16.8-year orbit, V ~ 17-18, 2nd observed return, discovered in 2005)
Dec 30-Jan 1 – 4P/Faye passes between 9th mag open cluster NGC 2254 and emission nebula IC 448

Comets Brighter Than Magnitude 10

C/2021 A1 (Leonard)

Discovered 2021 January 3 by Greg Leonard of the Catalina Sky Survey with the 1.5-m on Mount Lemmon

Orbit (from Syuichi Nakano, personal email)

```
   C/2021 A1 (Leonard)
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2022 Jan. 3.29809 TT                                  Nakano
q   0.6152601           (2000.0)            P              Q
z  -0.0000451      Peri.  225.09163     +0.63774181     +0.29161284
 +/-0.0000011      Node   255.89505     +0.72791572     -0.53079785
e   1.0000277      Incl.  132.68632     -0.25184139     -0.79574845
From 1274 observations 2020 Apr. 11-2021 Nov. 18, mean residual 0".57.
  (1/a)org.= +0.000501, (1/a)fut.= -0.000105 (+/-0.000001), Q= 8.
```

Comet Magnitude Formula (from ALPO and COBS data)

```
m1 = 11.4 + 5 log d +  5.7 log r [T-325 to T-240 days, where T = date of perihelion]
m1 =  7.3 + 5 log d + 12.5 log r [T-240 to T-47 days]
m1 =  8.3 + 5 log d -  3.8 log r [from T-47 days and onward?]
```

Recent Magnitude Measurements Contributed to the ALPO Comets Section

```
Recent Magnitude Measurements in ICQ format:
Comet Des  YYYY MM DD.DD     Mag SC APER FL POW    COMA     TAIL    ICQ    CODE  Observer Name
               (UT)                    T          Dia  DC  LENG  PA
   2021A1  2021 12 02.49  Z  6.5 U4  7.2R 5a600  26.3    > 1.0  313 ICQ xx HER02 Carl Hergenrother
   2021A1  2021 12 02.48  M  6.7 TK  5.0B    10   8    5/  0.7  320 ICQ xx HER02 Carl Hergenrother
   2021A1  2021 12 01.46  M  7.0 TK  5.0B    10   6    5/  0.3  320 ICQ xx HER02 Carl Hergenrother
   2021A1  2021 12 01.17  I  6.8 TK 12.6B 5  25  10    6   45.0m300 ICQ XX DECaa Michel Deconinck
   2021A1  2021 11 30.47  M  7.1 TK  5.0B    10   5    5   0.3  320 ICQ xx HER02 Carl Hergenrother
   2021A1  2021 11 28.50  M  7.2 TK  5.0B    10   7    5   0.2  315 ICQ xx HER02 Carl Hergenrother
   2021A1  2021 11 28.18  E  7.9 TK 25.0C10  62   6    4   25.0m300 ICQ XX DECaa Michel Deconinck
   2021A1  2021 11 26.46  C  7.9 GG  5.0R 4a 60  10.6              ICQ XX OLAaa Michael Olason
   2021A1  2021 11 23.15  S  8.4 TK 32.0L 5  80   4    5/  5.0  310 ICQ XX PIL01 Uwe Pilz
   2021A1  2021 11 18.24  S  7.9 TK 10.0B    25   8    3   0.15 320 ICQ XX GON05 Juan Jose Gonzalez Suarez
   2021A1  2021 11 17.51  S  8.2 TK  5.0B    10   7    4            ICQ xx HER02 Carl Hergenrother
   2021A1  2021 11 17.50  V  8.5 U4 10.6R 5a600  13.4      20  m320 ICQ xx HER02 Carl Hergenrother
   2021A1  2021 11 16.20  I  8.4 TK 25.0C10  62   2.5  7    5.0m280 ICQ XX DECaa Michel Deconinck
   2021A1  2021 11 15.48  V  9.0 U4 10.6R 5a600  12.8      12  m320 ICQ xx HER02 Carl Hergenrother
   2021A1  2021 11 15.52  S  8.2 TK  5.0B    10   5    4            ICQ xx HER02 Carl Hergenrother
   2021A1  2021 11 13.50  S  8.5 TK  5.0B    10   6    4            ICQ xx HER02 Carl Hergenrother
   2021A1  2021 11 11.51  S  9.4 TK 12.5B    30   5    5            ICQ xx HER02 Carl Hergenrother
   2021A1  2021 11 11.22  S  8.7 TK 10.0B    25   8    3   0.4  320 ICQ XX GON05 Juan Jose Gonzalez Suarez
   2021A1  2021 11 10.17  S  9.4 TI 29.8L 4  92   4    4    6.5m310 ICQ XX HAR11 Christian Harder
   2021A1  2021 11 07.49  S  9.9 TK 12.5B    30   3    5            ICQ xx HER02 Carl Hergenrother
   2021A1  2021 11 05.23  S  9.7 TK 20.3T10  77   5    3/  0.3  330 ICQ XX GON05 Juan Jose Gonzalez Suarez
   2021A1  2021 11 04.49  S 10.0 TK 12.5B    30   4    4            ICQ xx HER02 Carl Hergenrother
   2021A1  2021 11 02.15  S 10.3 TI 29.8L 4  79   3    4    6.0m340 ICQ XX HAR11 Christian Harder
```

As of December 2-3, C/2021 A1 (Leonard) is around magnitude 6.5, bright enough that some observers have reported it visible to the naked eye. Visual observers have also been observing a tail up to 0.75 degrees in length. Imagers have noted some interesting coma features, which unfortunately are sometimes associated with splitting or disruption events.

Eleven months ago, C/2021 A1 (Leonard) was discovered at 19th magnitude by Catalina Sky Survey astronomer Greg Leonard with the Mount Lemmon 1.5-m reflector when the comet was a distant 5.1 au from the Sun. The comet could have easily been discovered months earlier as pre-discovery observations from Mount Lemmon and PANSTARRS were found back to April 2020 when the comet was 7.5 au from the Sun. With a relatively small perihelion distance of 0.62 au in 2022 January and close approach to Earth on December 12 at 0.233 au (34.9 million km, 21.7 million miles), there was some excitement that Leonard could become a bright object.

The story of Comet Leonard has seen a few twists and turns. Based on the Pan-STARRS and Mount Lemmon photometry submitted to the Minor Planet Center, Leonard rapidly brightened throughout 2020 at a 2.5n ~ 11.7 rate. Between January and June 2021, that rapid brightening slowed significantly to a sluggish 2.5n ~ 5.6 rate suggesting activity was barely increasing beyond steady state. Six months ago, Leonard's prospects weren't looking good, but in July a new rapid brightening phase commenced. A fit to the photometry shows two possible brightening "legs" (2.5n ~ 20.6 between July and early October and 2.5n ~ 12.5 between early October and mid-November). Regardless of the exact fits or the number of "legs", the comet brightened from apparent magnitude 17 to 8 and excitement started to build again.

Then something changed in mid-November. Since about November 16, Leonard has not only ceased its rapid brightening, but has faded in an absolute sense with a fading trend of 2.5n ~ -4. Leonard has faded by ~2 magnitudes after accounting for changes in heliocentric and geocentric distance. That is a dramatic decrease in activity for an inbound comet and suggests C/2021 A1 may not be healthy.

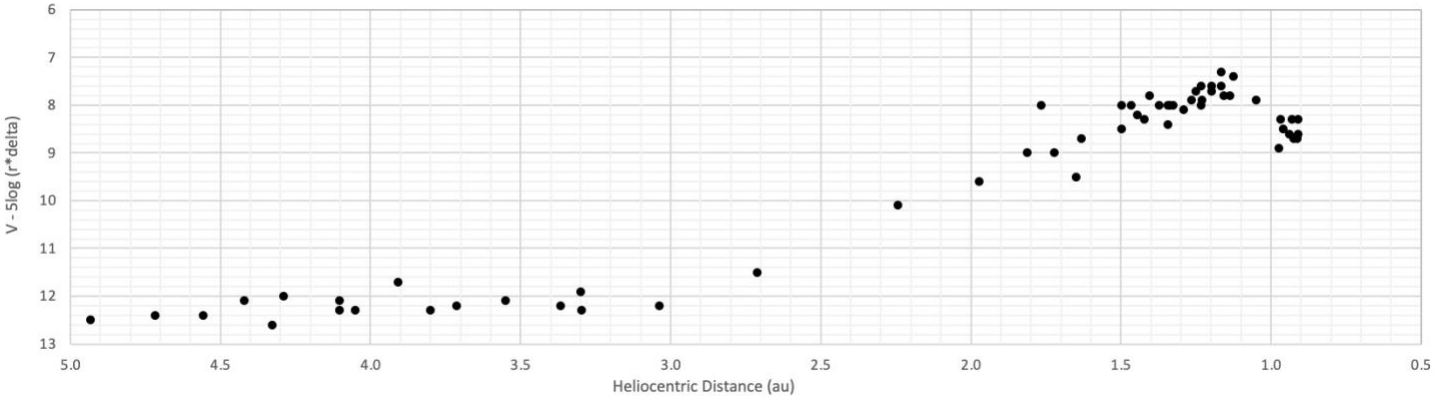


Figure 1 - Brightness evolution of C/2021 A1 (Leonard) since the start of 2020. The comet photometry has been corrected foraperture, phase angle effects as well as normalized to 1 au from the Earth and Sun. Data includes CCD/CMOS and visual photometry submitted to the ALPO and data submitted to the COBS site by Michael Lehmann.

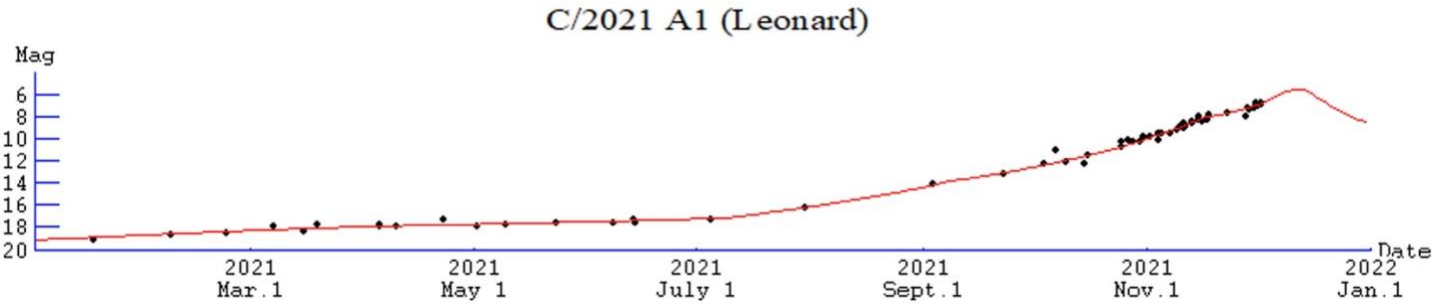


Figure 2 – Same data as above except plotted as aperture corrected apparent magnitude versus date. Plot produced in Seiichi Yoshida's Comets for Windows.

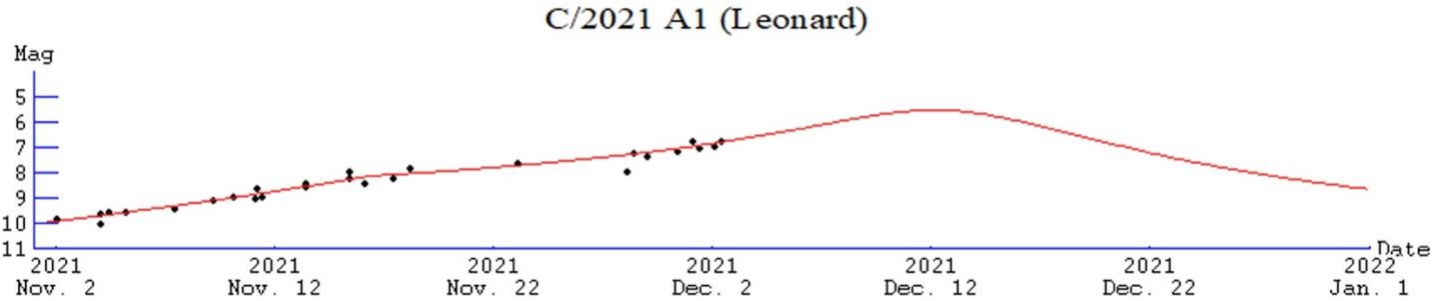


Figure 3 - Same as except only showing the most recent aperture corrected apparent magnitudes.

You may be wondering how a comet could intrinsically fade by two magnitudes while its apparent magnitude brightened from magnitude 8.2 to 6.8 over the same period. The reason is that between November 16 and December 3 Leonard's distance to the Sun has fallen from 1.16 to 0.90 au and its distance to Earth from 1.06 to 0.45 au. Its phase angle has also increased from 52 to 86 degrees though that change should have only produced ~0.1 magnitudes of fading.

If you are having a sense of deja vue, you're not alone. We saw a similar series of events in 2020 with C/2019 Y4 (ATLAS). Comet ATLAS was predicted to be a bright object but after brightening to ~7th magnitude about 2.5 months before perihelion, it's brightening stalled and then enter a slow fade. A few weeks after the brightening stall, the nucleus was observed to have split into several smaller components. Could we be seeing the same with Leonard? Possibly. Leonard brightness stall and fading is similar to that of C/ATLAS. So far, we haven't seen any sign of multiple nuclei, but then again it took a few weeks for ATLAS' secondary nuclei to become visible.

So, for the next few paragraphs, let's (mostly) focus on the things we can predict. Leonard starts the month at 0.93 au from the Sun and 0.52 au from Earth. On December 12, a minimum Earth-comet distance of 0.23 au is reached with the comet located 0.77 au from the Sun. Not only is the Earth-comet distance rapidly changing, but due to the comet passing Earth on its sunward side, Leonard's phase angle increases from 80 degrees on the 1st to 160.5 degrees on the 14th. Such a large phase angle could produce up to 3 magnitudes of extra brightness due to forward scattering by small dust in the comet's coma and tail. The exact amount of forward scattering remains to be seen and depends on the comet's dust-to-gas ratio and whether it is still producing fine sized dust at that time, something that could be in question if it has disintegrated.

Leonard is a morning object only visible from the northern hemisphere as the month begins though it is rapidly diving towards the Sun. On December 2-3, it will pass through the outer region of the bright 6th magnitude globular cluster M3. By December 12, the comet will too close to the Sun to be observed outside of astronomical twilight. The next night, the comet shifts into the evening sky and will be within 18 degrees of the Sun but only a degree above the horizon by the end of nautical twilight. Unless the comet is bright (1st-2nd magnitude) and condensed (like last year's NEOWISE) it may not be visible against such a bright sky. Unfortunately, the bright sky may prevent observation of Leonard photobombing two more deep sky objects: on December 12 is passes ~0.2 deg from 9th mag globular cluster NGC 6366 and on December 14 it passes over the bright emission nebula M16, the Eagle Nebula. How often do you see a comet pass over two Messier objects in an apparition, let alone in 12 days? The southern hemisphere finally gets their chance to observe the comet starting on December 17-18. The 18th also witnesses an extremely close approach to Venus of 0.0285 au (4.26 million km, 2.65 million miles). Here on the Earth the two will appear about 5.1 degrees apart.

The southern hemisphere will have the best views during the remainder of the month. While still visible from the northern hemisphere it will be a horizon hugger and only a few degrees above the horizon before the start of astronomical twilight. By the end of December, its distance to the Earth will have increased back to 0.83 au while its distance to the Sun continues to drop as it approaches perihelion on January 3 at 0.62 au. This month sees the comet move through the constellations of Canes Venatici (Dec 1-3), Boötes (3-8), Serpens (8-10), Hercules, (10-11), Ophiuchus (11-14), Scutum (14-15), Sagittarius (15-20), Microscopium (20-29), and Pisces Austrinus (29-31).

So now the difficult, or even foolish, discussion… how bright will Leonard get? We have a few complications: will the comet continue to intrinsically fade, or even disintegrate, and how much of an effect will dust forward scattering have? There are several scenarios that can play out. One could expect a resumption of the brightening trend and a 3-magnitude enhancement due to forward scattering. That would result in a 1st magnitude comet and perhaps visible even when at small elongations. Then again, if the fading continues and there is little to no

forward scattering, a peak around 5-6th magnitude would result in Leonard being much too faint to be seen when located close to the Sun. The ephemeris below presents two scenarios: the magnitude in the 'Mag NoFS' column assumes the fading continues and there is no enhancement due to forward scattering (peak brightness of 5.6), the 'Mag FS' column also assumes the fading continues but with a maximum of ~3 magnitudes of forward scattering enhancement for a peak brightness of 2.0. I guess we'll have to wait and see what happens.

C/2021 A1 (Leonard)

Date	R.A.	Decl.	r	d	PhAng	Elong	Mag NoFS	Mag FS	Max El (deg) 40N Ast	40N Nau	40S Ast	40S Nau
2021 Dec 01	13 21	+29 58	0.931	0.522	80	68M	7.0	7.0	49	55	0	0
2021 Dec 02	13 30	+29 17	0.917	0.487	83	67M	6.9	6.9	47	54	0	0
2021 Dec 03	13 40	+28 27	0.902	0.453	86	66M	6.8	6.8	46	52	0	0
2021 Dec 04	13 52	+27 24	0.888	0.419	90	64M	6.6	6.6	44	50	0	0
2021 Dec 05	14 05	+26 05	0.874	0.387	94	62M	6.5	6.4	41	47	0	0
2021 Dec 06	14 21	+24 26	0.859	0.356	99	59M	6.3	6.2	38	44	0	0
2021 Dec 07	14 39	+22 20	0.846	0.326	105	55M	6.1	5.8	34	40	0	0
2021 Dec 08	14 59	+19 39	0.832	0.299	112	51M	6.0	5.6	29	35	0	0
2021 Dec 09	15 23	+16 17	0.818	0.276	119	46M	5.8	5.2	22	29	0	0
2021 Dec 10	15 49	+12 06	0.805	0.256	128	39M	5.7	4.7	15	21	0	0
2021 Dec 11	16 19	+07 08	0.792	0.242	137	32M	5.6	4.1	7	13	0	0
2021 Dec 12	16 50	+01 32	0.779	0.235	147	25M	5.6	3.4	0	4	0	0
2021 Dec 13	17 22	-04 19	0.767	0.234	155	18E	5.6	2.6	0	1	0	0
2021 Dec 14	17 55	-09 58	0.755	0.241	160	15E	5.7	2.0	0	3	0	0
2021 Dec 15	18 25	-15 01	0.743	0.254	159	15E	5.8	2.3	0	4	0	0
2021 Dec 16	18 53	-19 15	0.731	0.273	154	18E	6.0	3.1	0	5	0	0
2021 Dec 17	19 18	-22 40	0.720	0.297	147	22E	6.2	4.0	1	6	0	4
2021 Dec 18	19 39	-25 22	0.709	0.324	141	26E	6.4	4.7	2	6	1	9
2021 Dec 19	19 58	-27 28	0.699	0.354	135	29E	6.6	5.3	2	7	4	12
2021 Dec 20	20 14	-29 06	0.689	0.387	130	32E	6.9	5.8	3	7	7	15
2021 Dec 21	20 28	-30 22	0.680	0.421	125	34E	7.1	6.2	3	7	10	18
2021 Dec 22	20 40	-31 23	0.671	0.456	120	36E	7.3	6.6	3	7	11	19
2021 Dec 23	20 50	-32 12	0.663	0.492	116	37E	7.4	6.9	3	7	13	21
2021 Dec 24	20 58	-32 51	0.655	0.529	111	38E	7.6	7.2	3	7	14	22
2021 Dec 25	21 05	-33 24	0.648	0.566	107	38E	7.8	7.5	3	7	14	23
2021 Dec 26	21 12	-33 51	0.641	0.604	104	39E	7.9	7.7	3	7	15	23
2021 Dec 27	21 17	-34 13	0.636	0.642	100	39E	8.1	7.9	3	7	15	24
2021 Dec 28	21 21	-34 32	0.631	0.680	97	39E	8.2	8.1	2	6	16	24
2021 Dec 29	21 25	-34 49	0.626	0.718	93	39E	8.4	8.4	2	6	16	24
2021 Dec 30	21 29	-35 03	0.622	0.757	90	39E	8.5	8.5	2	6	16	24
2021 Dec 31	21 32	-35 15	0.620	0.795	87	38E	8.6	8.6	1	5	16	24

Let's again assume a healthy normal comet for the remainder of the month, what will the tails of Leonard look like? Currently, the comet's dust and gas tails are superimposed on each other. Using the Finson-Probstein analysis program of the Comet Toolbox (https://www.comet-toolbox.com/FP.html), we should expect that to continue for another week and a half. With the Earth crossing the comet's orbital plane on December 8, the dust tail may become very narrow for a few days. After close approach, the dust tail should diverge from the anti-solar direction and fan out away from the gas tail.

One must be careful when interpreting the following figure. It only shows the possible orientation of the tails relative to the nucleus. It should not be used to infer the absolute or relative lengths of the tails. All bets are off if the comet continues to fade or even completely disrupt.

Here to a bunch of lost sleep this month watching C/Leonard!

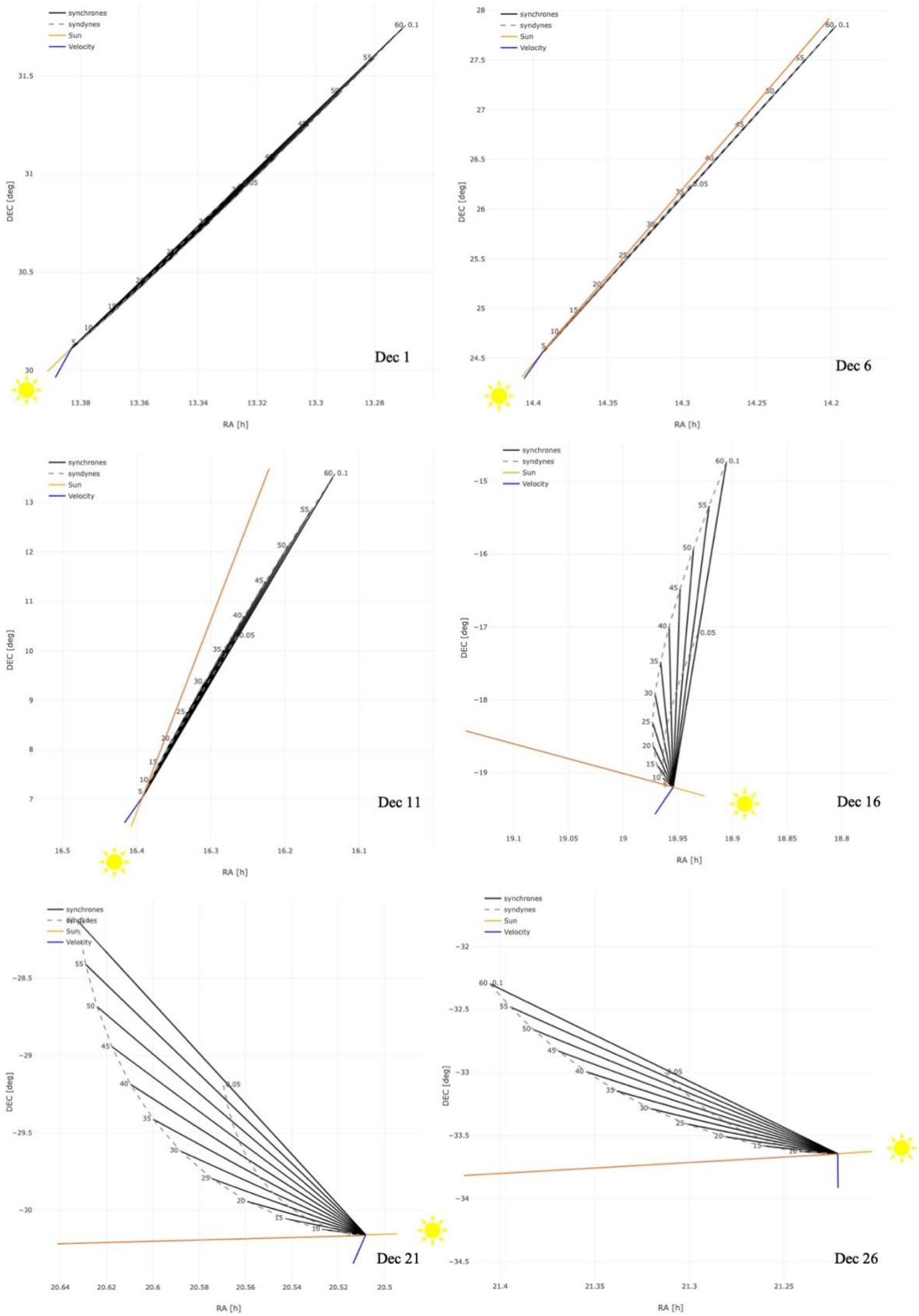


Figure 4 - Finson-Probstein analysis for C/2021 A1 (Leonard) as modeled with the Comet Toolbox (https://www.comet-toolbox.com/FP.html). Synchrones are lines of constant time of dust release (in days prior to the modeled data) while syndynes are lines of constant dust size. The values of the syndynes are the "beta" of the particles which is the ratio of solar radiation pressure to solar gravity and is inversely proportional to grain size.

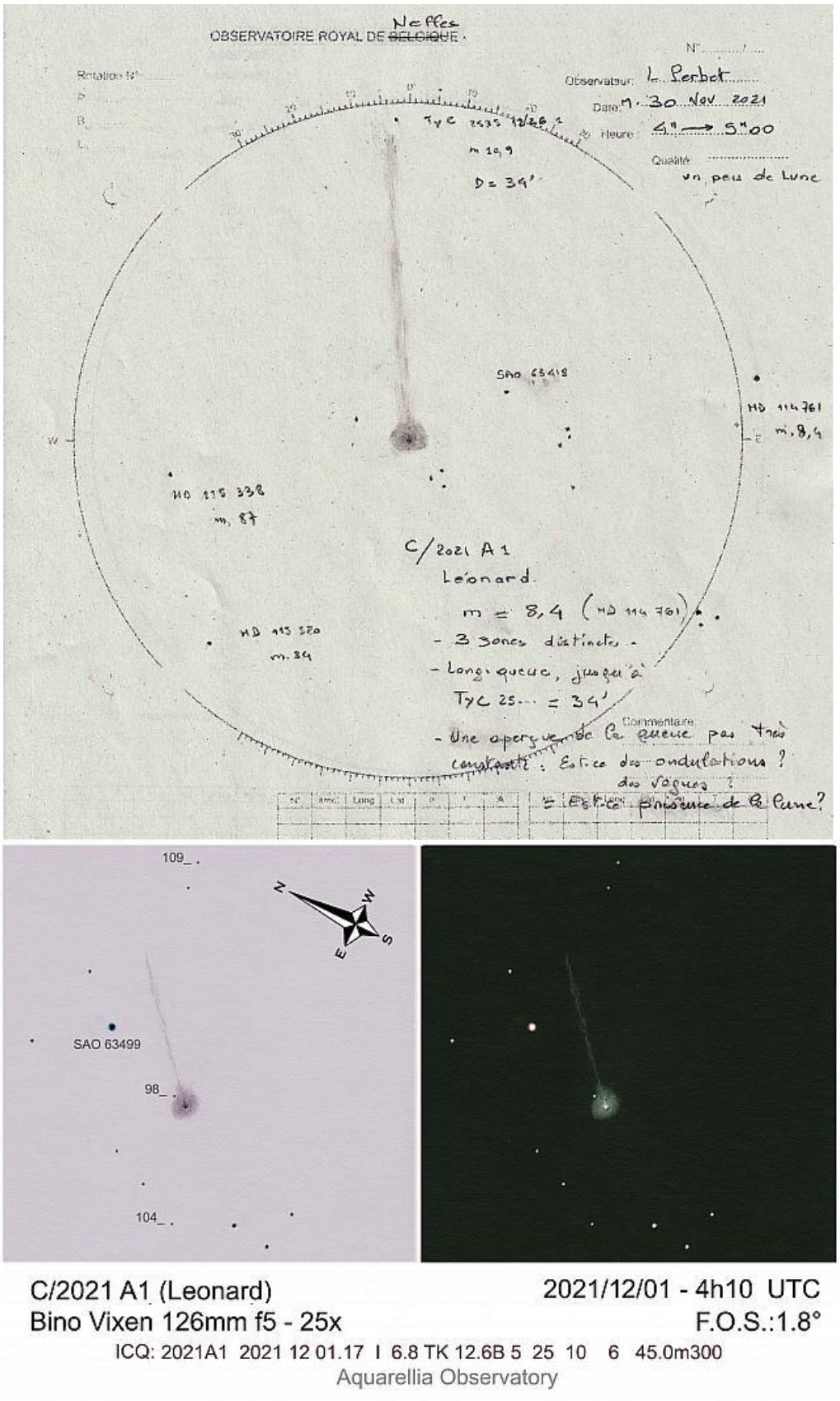


Figure 5 - Sketches of C/2021 A1 (Leonard) by [top] Ludovic Perbet on November 30 and [bottom] Michel Deconinck on December 1.

Figure 6 - Recent image of C/2021 A1 (Leonard) by Martin Mobberley.

8P/Tuttle

Discovered on 1790 January 9 by Pierre F. A. Mechain
Rediscovered on 1858 January 5 by Horace Tuttle

Orbit (from Minor Planet Center, MPEC 2021-W138)

```
   8P/Tuttle
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2021 Aug. 27.73567 TT                                  Rudenko
q   1.0259957            (2000.0)            P              Q
n   0.07229128     Peri.  207.48835     -0.26845021     -0.50831915
a   5.7070558      Node   270.20165     +0.96327501     -0.13638410
e   0.8202233      Incl.   54.91130     +0.00597787     -0.85030055
P  13.6
From 271 observations 2008 Feb. 12-2021 Nov. 23, mean residual 0".6.
     Nongravitational parameters A1 = +0.01, A2 = -0.0091.
```

Ephemerides (produced with Seiichi Yoshida's Comets for Windows program)

```
8P/Tuttle                                                          Max El
                                                                    (deg)
    Date      R.A.   Decl.     r       d    Elong  Const  Mag   40N  40S
2021 Dec 01  14 19  -49 21   1.707   2.381    37M   Lup  11.8     0   19
2021 Dec 06  14 37  -50 17   1.759   2.427    38M   Lup  12.2     0   20
2021 Dec 11  14 53  -51 04   1.810   2.470    38M   Lup  12.5     0   21
2021 Dec 16  15 10  -51 45   1.862   2.512    39M   Lup  12.8     0   21
2021 Dec 21  15 25  -52 19   1.913   2.550    40M   Lup  13.1     0   22
2021 Dec 26  15 40  -52 47   1.965   2.585    41M   Nor  13.4     0   24
2021 Dec 31  15 55  -53 11   2.016   2.616    43M   Nor  13.7     0   25
2022 Jan 05  16 08  -53 32   2.068   2.644    44M   Nor  14.0     0   27
```

Comet Magnitude Formula

```
m1 = 7.0 + 5 log d + 20 log r(t-25) [Ref: Seiichi Yoshida]
```

Magnitude Measurements Submitted to the ALPO Comets Section

```
Recent Magnitude Measurements in ICQ format:
Comet Des  YYYY MM DD.DD     Mag SC APER FL POW    COMA     TAIL    ICQ CODE Observer Name
               (UT)                      T         Dia  DC  LENG  PA
  8        2021 11 13.71 xS 10.4 TK 40.0L 4  59   3.5  3            ICQ XX WYA   Christopher Wyatt
```

A large geocentric distance, small solar elongation, and invisibility from the northern hemisphere have limited observations of 8P/Tuttle during the current return. Perihelion was back on 2021 August 27 with a peak brightness of 8.5-9.0 during September. Last month Chris Wyatt visually observed Tuttle on November 13 with a 0.4-m reflector at 59x. He measured a brightness of 10.4 with a weakly condensed (DC = 3) 3.5' coma.

The comet will be rapidly fading in December from around magnitude ~12 to ~14 as it moves through Lupus (Dec 1-22) and Norma (22-31). As has been the case for much of this apparition, Tuttle will only be visible to southern hemisphere observers.

Imagers are encouraged to take deep, wide field images of Tuttle during the 2nd half of the December as the Earth will be crossing the Tuttle's orbital plane on December 21. The dust trail consists of larger dust particles orbiting along the comet's orbit. These particles are populating the Ursid meteor stream, so any image of Tuttle's dust trail may be an image of future Ursids.

This will probably be the last month we report on 8P as it will fainter than our 13th magnitude cutoff next month. Looking towards the future, two returns from now will be much better with Tuttle passing 0.18 au from Earth on 2048 December 28 and brightening to 4th magnitude.

67P/Churyumov-Gerasimenko

Discovered 1969 September 11 by the Klim Ivanovic Churyumov and Svetlana Ivanovna Gerasimenko

Orbit (from Minor Planet Center, MPEC 2021-W138)

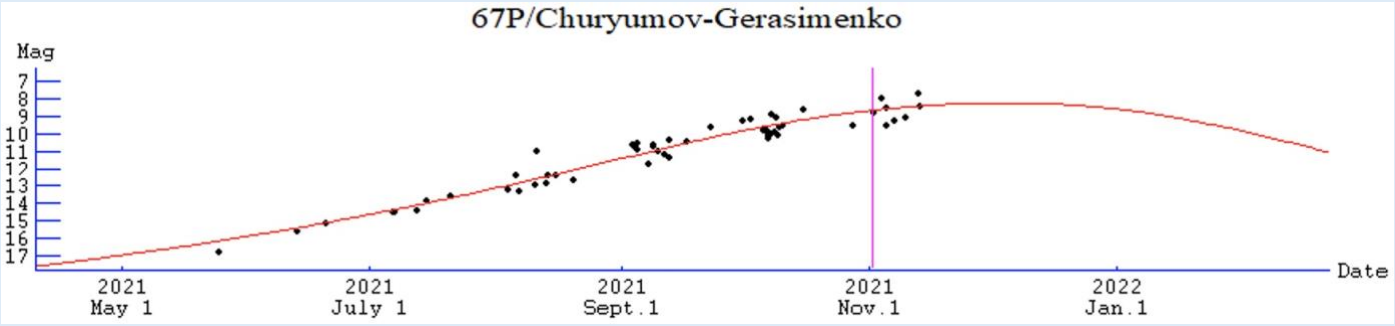
```
  67P/Churyumov-Gerasimenko
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2021 Nov. 2.06613 TT                                  Rudenko
q   1.2106365            (2000.0)            P             Q
n   0.15341012     Peri.   22.13772     +0.52344271     -0.85112125
a   3.4559442      Node    36.33307     +0.77128090     +0.45334133
e   0.6496944      Incl.    3.87158     +0.36212360     +0.26471542
P   6.42
From 8556 observations 1995 July 3-2021 Nov. 29, mean residual 0".8.
     Nongravitational parameters A1 = +0.09, A2 = +0.0111.
```

Ephemerides (produced with Seiichi Yoshida's Comets for Windows program)

```
67P/Churyumov-Gerasimenko                                              Max El
                                                                        (deg)
    Date       R.A.    Decl.      r       d     Elong  Const  Mag    40N  40S
2021 Dec 01   08 47   +26 55    1.263   0.428    121M    Cnc    8.3     77   19
2021 Dec 06   08 54   +27 03    1.283   0.433    124M    Cnc    8.3     77   20
2021 Dec 11   08 59   +27 15    1.304   0.438    128M    Cnc    8.3     77   20
2021 Dec 16   09 03   +27 29    1.328   0.446    132M    Cnc    8.3     77   21
2021 Dec 21   09 04   +27 46    1.354   0.454    137M    Cnc    8.4     78   22
2021 Dec 26   09 03   +28 05    1.382   0.465    142M    Cnc    8.5     78   22
2021 Dec 31   09 01   +28 23    1.412   0.479    147M    Cnc    8.6     78   22
2022 Jan 05   08 58   +28 39    1.443   0.496    153M    Cnc    8.7     79   21
```

Comet Magnitude Formula (modified from Seiichi Yoshida, H value brighter by 0.6 mag) & Lightcurve

```
m1 = 8.9 + 5 log d + 14.0 log r(t-40)
```



Recent Magnitude Measurements Contributed to the ALPO Comets Section

```
Recent Magnitude Measurements in ICQ format:
Comet Des  YYYY MM DD.DD     Mag SC APER FL POW    COMA     TAIL    ICQ CODE Observer Name
              (UT)                      T          Dia  DC  LENG  PA
 67        2021 11 15.35  C  9.2 GG 27.9T 6a840                    ICQ XX OLAaa Michael Olason
 67        2021 11 13.67 xM  9.1 TK 40.0L 4  59   3.3  6   12.0m275 ICQ XX WYA   Christopher Wyatt
 67        2021 11 11.11  S  9.2 TK 10.0B    25   4    5/          ICQ XX GON05 Juan Jose Gonzalez Suarez
 67        2021 11 11.10  S  9.8 TK 20.3T10  77   4    5   0.25 280 ICQ XX GON05 Juan Jose Gonzalez Suarez
 67        2021 11 09.94  S  9.5 TI 29.8L 4  92   2    4   10.0m280 ICQ XX HAR11 Christian Harder
 67        2021 11 07.21  B  9.6 TK 25.0C10 195  1.8  7    2.2m260 ICQ XX DECaa Michel Deconinck
 67        2021 11 05.35  S  9.0 TK 12.5B    30   4    6/          ICQ xx HER02 Carl Hergenrother
 67        2021 11 05.21  S  9.9 TK 20.3T10  77   4    5   0.15 280 ICQ XX GON05 Juan Jose Gonzalez Suarez
 67        2021 11 02.11  S  9.2 TI 29.8L 4  79   2.3  4/  11.0m280 ICQ XX HAR11 Christian Harder
```

67P was discovered on photographic plates taken on 1969 September 11 by Kiev University Astronomical Observatory astronomers Klim Ivanovic Churyumov and Svetlana Ivanovna Gerasimenko working at the Alma-Ata Astrophysical Institute in current day Kazakhstan. The current apparition is 67P's 9th observed return with perihelion back on 2021 November 2 at 1.21 au. A close approach to Earth at 0.42 au on November 12 makes this the comet's best return since 1982 when it came marginally closer to Earth at 0.39 au. Though this return

will be the best for the remainder of the century, it will make similar, but slightly larger, approaches to Earth in 2034 (0.45 au), 2067 (0.44 au), and 2080 (0.49 au).

Last month, visual observers found 67P to be between magnitude 9.0 and 9.9 (aperture corrected to 8.6 to 9.6). with up to a quarter degree of tail. The comet spends December in the morning sky in Cancer. Based on previous apparitions, 67P should be at its brightest during the first half of December at around magnitude 8.3 and slightly fade to around 8.6 by New Year's.

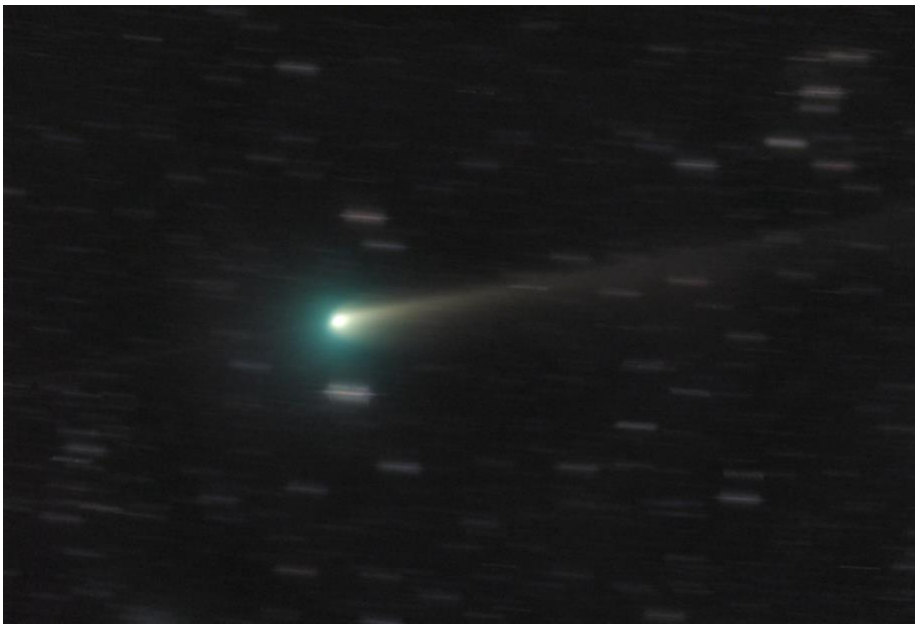


Figure 7 – Image of 67P taken by Chris Schur on November 13 with a 10" f/3.9 Orion Astrograph Newtonian.

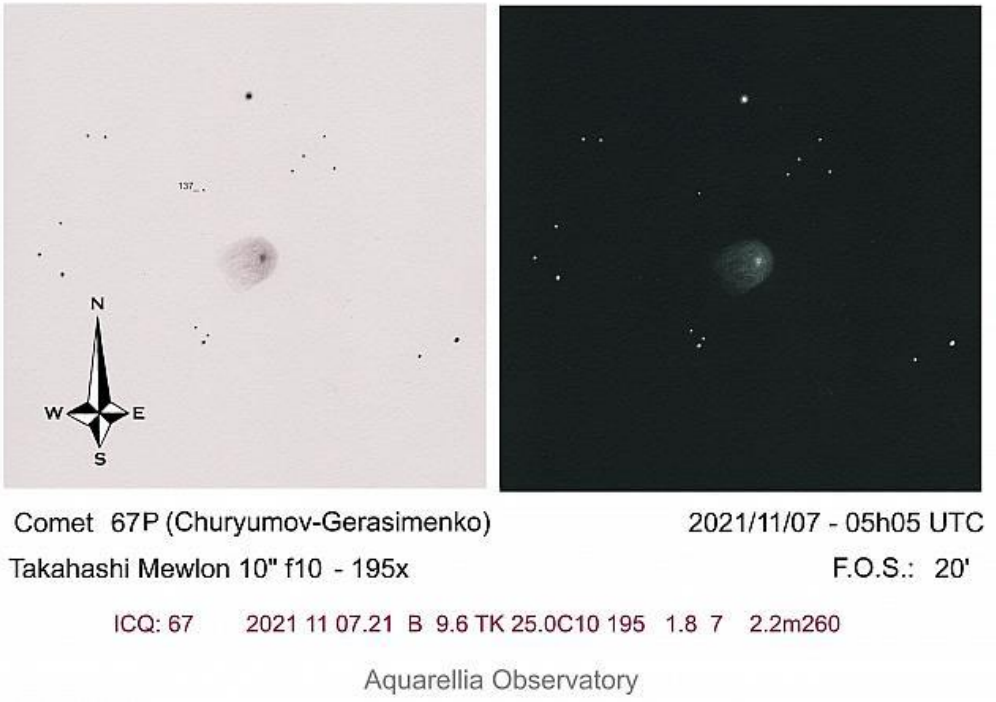


Figure 8 - Sketch of 67P by Michel Deconinck on Nov 7 with a Takahashi Mewlon 0.25-m at 195x.

C/2019 L3 (ATLAS)

Discovered 2019 June 10 by the ATLAS survey with one of their 0.5-m f/2 Schmidt
Dynamically old long-period comet

Orbit (from Syuichi Nakano, personal email)

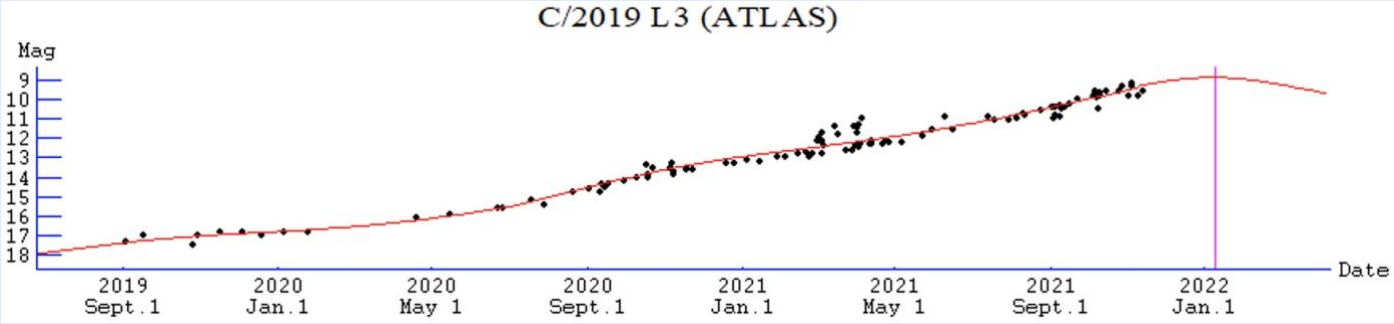
```
    C/2019 L3 (ATLAS)
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2022 Jan.  9.61930 TT                                  Rudenko
q   3.5545066            (2000.0)            P              Q
z  -0.0004534      Peri.  171.61066     -0.26052094     -0.66630823
 +/-0.0000003      Node   290.79019     +0.83675993     +0.20517882
e   1.0016115      Incl.   48.36122     +0.48162398     -0.71689259
From 2893 observations 2019 June 10-2021 Nov. 19, mean residual 0".4.
1/a(orig) = +0.000102 AU**-1, 1/a(fut) = -0.000881 AU**-1.
```

Ephemerides (produced with Seiichi Yoshida's Comets for Windows program)

```
C/2019 L3 (ATLAS)                                                    Max El
                                                                      (deg)
    Date       R.A.    Decl.      r       d     Elong  Const  Mag   40N  40S
2021 Dec 01   07 40   +37 31    3.573   2.798   135M   Lyn    9.1    87   12
2021 Dec 06   07 37   +36 55    3.568   2.746   141M   Lyn    9.0    87   13
2021 Dec 11   07 33   +36 15    3.564   2.700   146M   Lyn    9.0    86   14
2021 Dec 16   07 29   +35 33    3.561   2.661   152M   Aur    8.9    85   15
2021 Dec 21   07 24   +34 48    3.559   2.629   157M   Gem    8.9    85   15
2021 Dec 26   07 19   +33 59    3.557   2.605   162M   Gem    8.9    84   16
2021 Dec 31   07 14   +33 07    3.555   2.589   167M   Gem    8.9    83   17
2022 Jan 05   07 08   +32 12    3.554   2.581   170M   Gem    8.9    82   18
```

Comet Magnitude Formula and Lightcurve (from ALPO and COBS data)

```
m1 =  2.0 + 5 log d + 12.3 log r [through T-550 days; T = date of perihelion]
m1 = -4.6 + 5 log d + 20.8 log r [T-550 to T-60 days]
m1 =  2.4 + 5 log d +  8.0 log r [T-60 days and onwards]
```



Recent Magnitude Measurements Contributed to the ALPO Comets Section

```
Recent Magnitude Measurements in ICQ format:
Comet Des YYYY MM DD.DD    Mag SC APER FL POW   COMA     TAIL   ICQ CODE Observer Name
               (UT)                  T       Dia  DC  LENG  PA
   2019L3  2021 12 02.78  S  9.7 TI 29.8L 4  92   1.9  4/          ICQ XX HAR11 Christian Harder
   2019L3  2021 11 13.72 xM 10.2 AQ 40.0L 4  59   4    6    5.8m290 ICQ XX WYA   Christopher Wyatt
   2019L3  2021 11 11.13  S  9.6 TK 20.3T10  77   4    5            ICQ XX GON05 Juan Jose Gonzalez Suarez
   2019L3  2021 11 09.93  S 10.2 TI 29.8L 4  92   2.4  5    4.5m305 ICQ XX HAR11 Christian Harder
   2019L3  2021 11 05.35  S  9.7 TK 12.5B    30   3    4            ICQ xx HER02 Carl Hergenrother
   2019L3  2021 11 05.13  S  9.5 TK 20.3T10  77   5    4/           ICQ XX GON05 Juan Jose Gonzalez Suarez
   2019L3  2021 11 02.12  S 10.2 TI 29.8L 4  79   1.8  4    6.0m275 ICQ XX HAR11 Christian Harder
```

The next two comets also share the near-opposition sky with C/2019 L3 (ATLAS). With only a month to go till its perihelion at 3.57 au (T = 2022 January 9), ATLAS should finally reach peak brightness around magnitude 9. In November, Chris Wyatt, Carl Hergenrother, Christian Harder, and J. J. Gonzalez made 6 visual observations finding the comet between magnitude 9.5 and 10.2 (aperture corrected range of 9.2 and 9.8). Chris and Christian were also able to visually detect a tail up to 6' in length in 0.3- to 0.4-m telescopes.

C/2019 L3 (ATLAS) will be approaching opposition while moving through Lynx (Dec 1-14), Auriga (14-17), and Gemini (17-31) in the morning sky. While well placed for northern observers, it is also visible but low from the southern hemisphere.

Figure 9 - C/2019 L3 (ATLAS) cruised past galaxy PGC 21754 (just above the comet's head) and interacting galaxies NGC 2444 and 2445 (near upper left corner of image). Eliot Herman took this image with the iTelescopes T19 0.43-m reflector on November 16. The image consists of a series of 300 sec exposures co-added to total 30 min in Luminance and 15 min in H-alpha filters.

19P/Borrelly

Discovered 1904 December 28 by the Alphonse Borrelly
Short-period comet with orbital period of ~6.85 years

Orbit (from Minor Planet Center, MPEC 2021-W138)

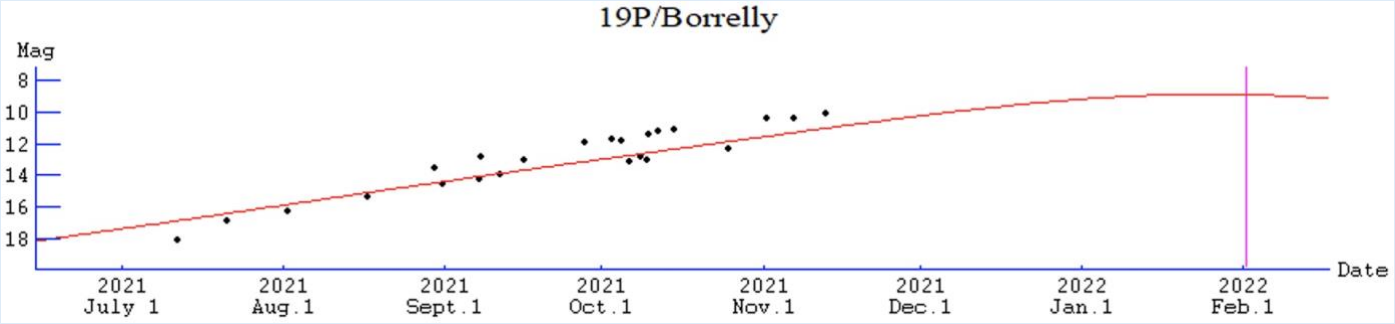
```
  19P/Borrelly
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2022 Feb. 1.83020 TT                                  Rudenko
q   1.3062541            (2000.0)            P             Q
n   0.14401007     Peri.  351.92096     +0.38674585     -0.79279248
a   3.6047416      Node    74.24710     +0.87109441     +0.14639270
e   0.6376289      Incl.   29.30470     +0.30269155     +0.59164961
P   6.84
From 480 observations 2015 Jan. 11-2021 Nov. 29, mean residual 0".7.
     Nongravitational parameters A1 = -0.86, A2 = -0.7759.
```

Ephemerides (produced with Seiichi Yoshida's Comets for Windows program)

```
19P/Borrelly                                                        Max El
                                                                     (deg)
    Date      R.A.    Decl.     r       d     Elong  Const  Mag    40N  40S
2021 Dec 01  23 26  -38 07   1.500   1.175    87E    Gru  10.3     12   63
2021 Dec 06  23 33  -35 14   1.473   1.174    85E    Scl  10.1     15   58
2021 Dec 11  23 41  -32 12   1.447   1.173    83E    Scl   9.9     18   54
2021 Dec 16  23 49  -29 03   1.423   1.174    82E    Scl   9.7     21   49
2021 Dec 21  23 58  -25 47   1.401   1.175    80E    Scl   9.5     24   44
2021 Dec 26  00 07  -22 24   1.381   1.178    78E    Cet   9.4     27   40
2021 Dec 31  00 16  -18 56   1.363   1.183    77E    Cet   9.2     31   36
2022 Jan 05  00 26  -15 23   1.347   1.189    76E    Cet   9.1     33   32
```

Comet Magnitude Formula (from Seiichi Yoshida)

```
m1 = 5.5 + 5 log d + 25.0 log r
```



Recent Magnitude Measurements Contributed to the ALPO Comets Section

```
Recent Magnitude Measurements in ICQ format:
Comet Des  YYYY MM DD.DD     Mag SC APER FL POW    COMA     TAIL    ICQ    CODE  Observer Name
               (UT)                    T         Dia  DC  LENG  PA
None
```

19P/Borrelly should be one of the better comets of 2022 when it may reach 9th magnitude around the time of its 2022 February 1 perihelion (at 1.31 au). Borrelly is steadily moving north and is now visible in the evening sky from both hemispheres as it moves through Grus (Dec 1), Sculptor (1-22), and Cetus (22-31). While no magnitude estimates were submitted to the ALPO for Borrelly in November, observations submitted to the COBS site place the comet around magnitude 10.5 at the end of November which is line with the prediction above. By the end of the year, the comet should be around magnitude 9.2. Images from the past week show a long dust trail located along the orbit of Borrelly. This feature should become stronger and better defined as the Earth crosses the plane of Borrelly's orbit on December 6.

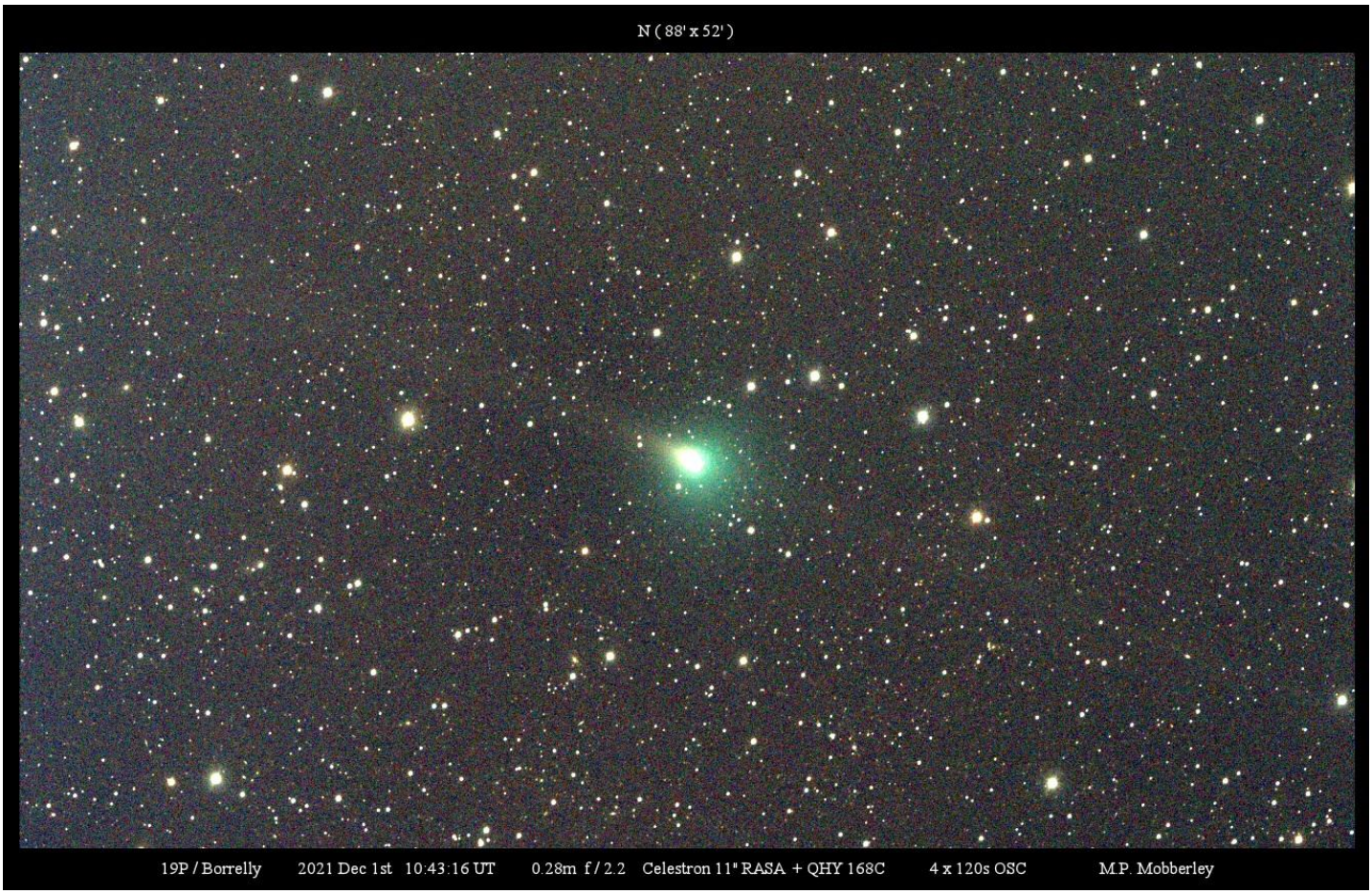


Figure 10 - Image of 19P/Borrelly taken by Martin Mobberley on December 1 with a iTelescopes Celestron RASA 11". The dust trail along Borrelly's orbit extends from the lower right to upper left and runs through the coma of the comet.

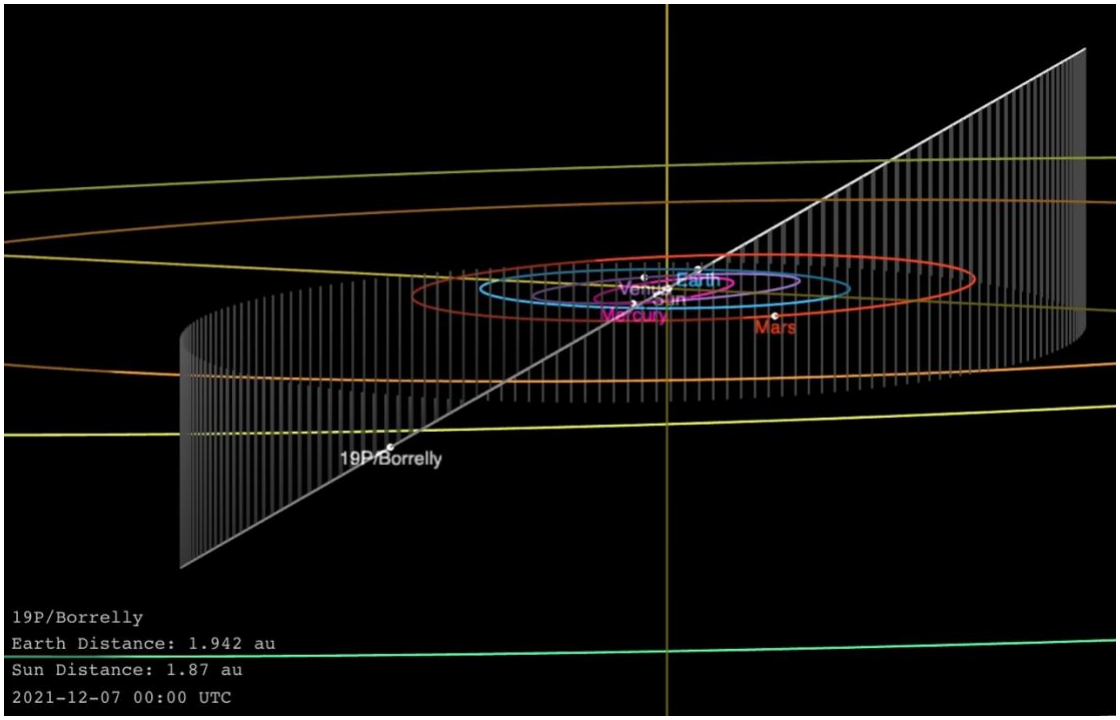


Figure 11 - The Earth crossing the plane of 19P/Borrelly's orbit in early December. Image made with the JPL Small Body Database Orbit Viewer.

Comets Between Magnitude 10 and 13

4P/Faye

Discovered visually on 1843 November 23 by the Herve Faye

Orbit (from MPEC 2021-W138)

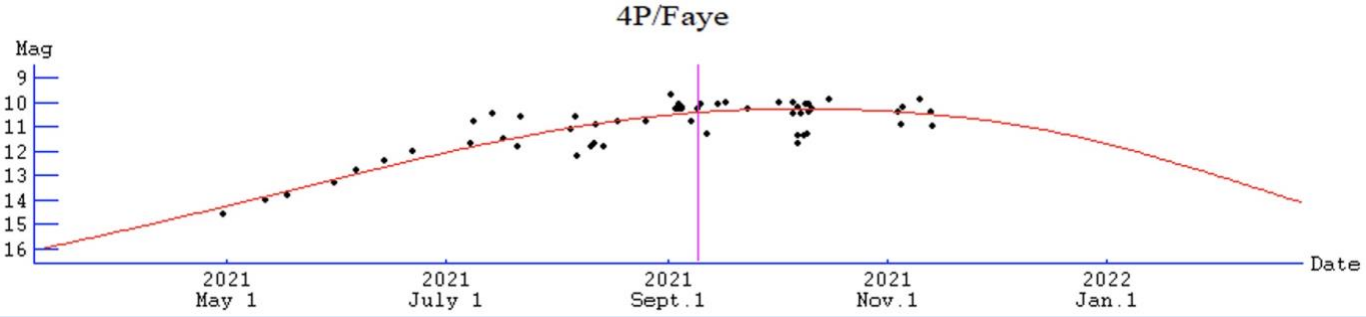
```
   4P/Faye
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2021 Sept. 8.84459 TT                                  Rudenko
q   1.6189102            (2000.0)            P              Q
n   0.13180036     Peri.  207.00519     +0.76775595     -0.63998354
a   3.8240625      Node   192.93053     +0.61016079     +0.74509813
e   0.5766517      Incl.    8.00831     +0.19558786     +0.18774941
P   7.48
From 5784 observations 1998 May 24-2021 Nov. 29, mean residual 0".9.
     Nongravitational parameters A1 = +0.55, A2 = -0.0287.
```

Ephemerides (produced with Seiichi Yoshida's Comets for Windows program)

```
4P/Faye                                                                Max El
                                                                        (deg)
    Date       R.A.    Decl.      r       d     Elong  Const  Mag    40N  40S
2021 Dec 01   06 54   +07 49    1.820   0.938    142M   Mon   10.8     58   42
2021 Dec 06   06 52   +07 28    1.843   0.937    146M   Mon   10.9     57   43
2021 Dec 11   06 49   +07 14    1.866   0.940    151M   Mon   11.0     57   43
2021 Dec 16   06 45   +07 06    1.891   0.948    156M   Mon   11.2     57   43
2021 Dec 21   06 41   +07 05    1.916   0.961    160M   Mon   11.3     57   43
2021 Dec 26   06 37   +07 11    1.942   0.979    163M   Mon   11.5     57   43
2021 Dec 31   06 33   +07 22    1.968   1.003    164E   Mon   11.7     57   43
2022 Jan 05   06 29   +07 39    1.995   1.033    163E   Mon   11.9     58   42
```

Comet Magnitude Formula (from fit to ALPO and COBS data)

```
m1 = 5.4 + 5 log d + 21.3 log r
```



Recent Magnitude Measurements Contributed to the ALPO Comets Section

```
Recent Magnitude Measurements in ICQ format:
Comet Des  YYYY MM DD.DD     Mag SC APER FL POW    COMA     TAIL        ICQ CODE Observer Name
               (UT)                        T         Dia  DC  LENG  PA
  4        2021 11 13.72 xS 11.6 AQ 40.0L 4 108    1.9  3                ICQ XX WYA   Christopher Wyatt
  4        2021 11 11.17  S 11.0 TK 20.3T10 100    3    2/               ICQ XX GON05 Juan Jose Gonzalez Suarez
  4        2021 11 10.19  S 10.3 TI 29.8L 4  92    2.8  2                ICQ XX HAR11 Christian Harder
  4        2021 11 05.36  S 10.6 TK 12.5B    30    2    4                ICQ xx HER02 Carl Hergenrother
  4        2021 11 05.09  S 11.2 TK 20.3T10 100    3    2/               ICQ XX GON05 Juan Jose Gonzalez Suarez
```

4P/Faye was a visual discovery by Herve Faye (Royal Observatory, Paris, France) on 1843 November 23. The comet was abnormally bright and reported to be visible to the naked eye only days after discovery. It has never rivaled its discovery apparition in brightness and at its best only gets to 9th magnitude (in 1991 and 2006).

This year's apparition is Faye's 22nd observed return with the comet having been missed at its 1903 and 1918 returns. 2021 is a moderately good, but not great, apparition with perihelion on 2021 September 8 at 1.62 au. Even though perihelion was a month ago, the comet will continue to move closer to the Earth until December 5 (0.94 au). As a result, it will stay close to maximum brightness through November. It is a morning object observable from both hemispheres as its moves through Monoceros.

Faye was well observed in October with no less than a dozen visual observations submitted to the ALPO. The most recent observations from November 5th placed the comet around magnitude 10.6-11.2 (aperture corrected to 10.2 to 10.9). While the tail has been a striking feature in images, visual observers have also caught glimpses of the tail. Chris Wyatt reported a 7.5' long tail with a 0.4-m reflector on October 9.

Photo Op: Dec 30-Jan 1 – 4P/Faye passes between 9th mag open cluster NGC 2254 and emission nebula IC 448

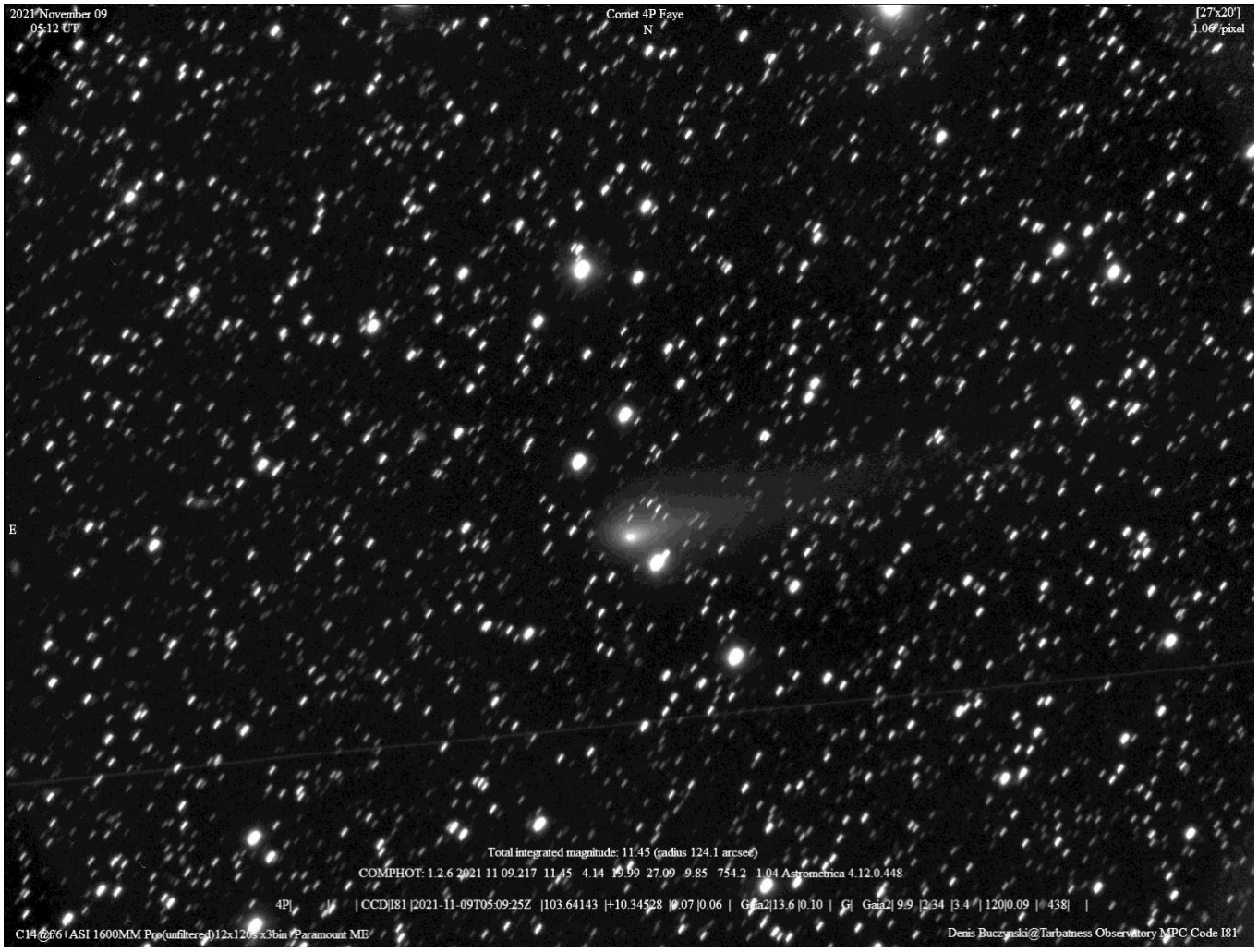


Figure 12 - Denis Buczynski caught 4P/Faye on November 9 with a Celestron C14 and ASI1600MM camera. The final image consists of 12x120s co-added image.

6P/d'Arrest

Discovered on 1851 June 28 by the Heinrich Ludwig d'Arrest

Orbit (from MPEC 2021-W138)

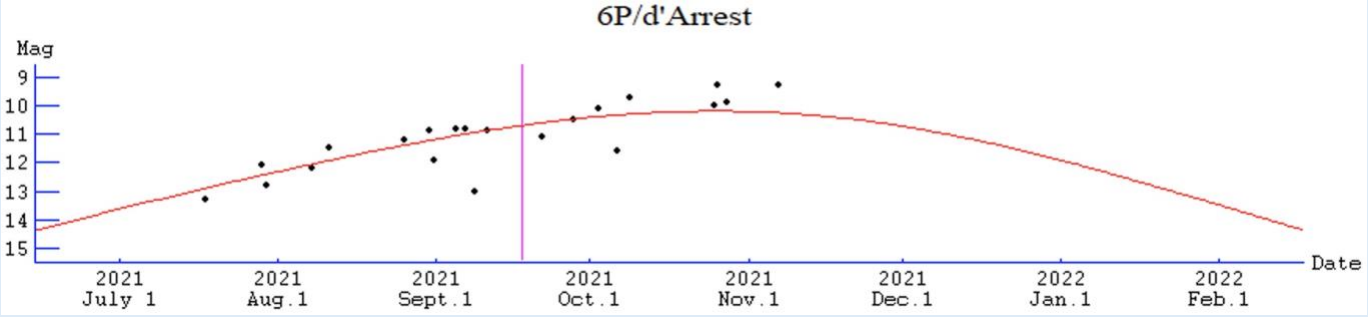
```
   6P/d'Arrest
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2021 Sept. 17.76118 TT                                  Rudenko
q   1.3545380            (2000.0)            P              Q
n   0.15067344     Peri.  178.08852     +0.73289133     +0.64399340
a   3.4976653      Node   138.93495     -0.62855292     +0.76434200
e   0.6127308      Incl.   19.51219     -0.26036805     -0.03246255
P   6.54
From 3229 observations 1987 Mar. 31-2021 Nov. 29, mean residual 1".0.
     Nongravitational parameters A1 = +0.54, A2 = +0.0991.
```

Ephemerides (produced with Seiichi Yoshida's Comets for Windows program)

```
6P/d'Arrest                                                          Max El
                                                                      (deg)
    Date       R.A.    Decl.      r        d     Elong  Const  Mag    40N  40S
2021 Dec 01   22 30   -27 33    1.593    1.423     80E    PsA  10.7     22   48
2021 Dec 06   22 45   -26 23    1.622    1.483     79E    PsA  10.9     24   45
2021 Dec 11   23 00   -25 09    1.651    1.545     78E    PsA  11.0     25   42
2021 Dec 16   23 14   -23 50    1.682    1.609     76E    Aqr  11.2     26   40
2021 Dec 21   23 28   -22 30    1.714    1.675     75E    Aqr  11.4     27   37
2021 Dec 26   23 41   -21 07    1.746    1.743     73E    Aqr  11.6     28   35
2021 Dec 31   23 54   -19 44    1.779    1.813     72E    Aqr  11.9     29   33
2022 Jan 05   00 06   -18 20    1.812    1.884     70E    Cet  12.1     29   31
```

Comet Magnitude Formula (from fit to ALPO and COBS data, seasonal offset fixed at T+60 days)

```
m1 = 6.6 + 5 log d + 24.8 log r(t-60)
```



Recent Magnitude Measurements Contributed to the ALPO Comets Section

```
Recent Magnitude Measurements in ICQ format:
Comet Des  YYYY MM DD.DD     Mag SC APER FL POW    COMA     TAIL    ICQ CODE Observer Name
               (UT)                    T         Dia  DC  LENG  PA
None
```

6P/d'Arrest is also past perihelion [T = 2021 September 17 @ 1.35 au]. Due to an asymmetrical lightcurve, the comet peaks in brightness a month or two after perihelion. December should see the comet fade from around magnitude 10.7 to 11.9 though observations in late October and early November suggest 6P may be 0.5-1.0 magnitudes brighter than the above prediction.

This month, 6P is an evening object moving through Pisces Austrinus (Dec 1-12), Aquarius (12-31) and Cetus (31). Though better placed for southern observers, it is observable from both hemispheres.

29P/Schwassmann-Wachmann

Discovered 1927 November 15 by the Arnold Schwassmann and Arno Arthur Wachmann at the Hamburg Observatory in Bergedorf, Germany
Centaur comet with orbital period of ~14.8 years

Orbit (from Minor Planet Center, MPEC 2021-W138)

```
  29P/Schwassmann-Wachmann
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2019 Apr. 4.85113 TT                                  Rudenko
q   5.7713405            (2000.0)            P              Q
n   0.06636470     Peri.   49.81465     +0.99174187     -0.04468182
a   6.0419613      Node   312.38189     -0.02059024     +0.86971579
e   0.0447902      Incl.    9.36627     +0.12658632     +0.49152618
P  14.9
From 11652 observations 2018 June 18-2021 Nov. 29, mean residual 0".6.
```

Ephemerides (produced with Seiichi Yoshida's Comets for Windows program)

```
29P/Schwassmann-Wachmann                                                Max El
                                                                         (deg)
    Date      R.A.    Decl.     r       d     Elong  Const  Mag    40N  40S
2021 Dec 01  04 37  +31 59   5.935   4.963   169M   Per  10-13    82   18
2021 Dec 06  04 35  +31 52   5.937   4.964   170E   Per  10-13    82   18
2021 Dec 11  04 32  +31 44   5.938   4.973   167E   Per  10-13    82   18
2021 Dec 16  04 29  +31 34   5.940   4.990   163E   Per  10-13    82   18
2021 Dec 21  04 27  +31 25   5.941   5.014   158E   Per  10-13    81   19
2021 Dec 26  04 24  +31 14   5.943   5.045   153E   Per  10-13    81   19
2021 Dec 31  04 22  +31 03   5.944   5.084   148E   Per  10-13    81   19
2022 Jan 05  04 20  +30 52   5.946   5.129   143E   Tau  10-13    81   19
```

Comet Magnitude Formula

```
None, due to frequent outbursts.
```

Recent Magnitude Measurements Contributed to the ALPO Comets Section

```
Recent Magnitude Measurements in ICQ format:
Comet Des  YYYY MM DD.DD     Mag SC APER FL POW    COMA     TAIL    ICQ    CODE  Observer Name
               (UT)                    T          Dia  DC  LENG  PA
 29        2021 12 02.77  S 11.3 TI 29.8L 4 108   3    1            ICQ XX HAR11 Christian Harder
 29        2021 11 13.69 xS 11.0 AQ 40.0L 4  59   2.9  2/           ICQ XX WYA   Christopher Wyatt
 29        2021 11 11.09  S 10.1 TK 20.3T10  77   5    3            ICQ XX GON05 Juan Jose Gonzalez Suarez
 29        2021 11 09.92  S 10.8 TI 29.8L 4  92   4    2            ICQ XX HAR11 Christian Harder
 29        2021 11 05.11  S 10.0 TK 20.3T10  77   4    3            ICQ XX GON05 Juan Jose Gonzalez Suarez
 29        2021 11 04.50  S 10.7 TK 12.5B    30   3    2            ICQ xx HER02 Carl Hergenrother
 29        2021 11 02.13  S 10.6 TI 29.8L 4  92   2.9  2            ICQ XX HAR11 Christian Harder
 29        2021 11 01.85  S 11.4:TI 53.1L   139   1.8  3            ICQ XX HAR11 Christian Harder
```

29P/Schwassmann-Wachmann was discovered photographically on 1927 November 15 by German observing team Arnold Schwassmann and Arno Arthur Wachmann. 29P is one of the more enigmatic comets as it experiences outbursts multiple times per year that can reach 10-14th magnitude.

29P has been especially active of late with multiple outbursts observed since late September. As a result, the comet is about as bright as it ever gets with many visual observers reporting the comet to be between magnitude 10.0 and 11.4 with a coma diameter between ~2-5'.

The comet is at opposition on December 2 in Perseus and observable from both hemispheres. If you observe 29P, please consider contributing to two pro-am efforts to better understand this object: the British Astronomical Society's (BAA) Mission 29P monitoring program coordinated by Richard Miles. (https://britastro.org/node/18562 & https://britastro.org/node/25120) and the University of Maryland's 29P Observation campaign (https://wirtanen.astro.umd.edu/29P/29P_obs.shtml).

57P/du Toit-Neujmin-Delporte

Discovered on 1941 July 18 by Daniel du Toit at the Harvard College Observatory's Boyden Station in South Africa, on 1941 July 25 by Grigory N. Neujmin at the Simeis Observatory in Russia, and on 1941 August 19 by Eugéne Joseph Delporte of the Royal Observatory in Uccle, Belgium
Jupiter-family comet with orbital period of 6.4 years

Orbit (from Minor Planet Center, MPEC 2021-W138)

```
  57P/du Toit-Neujmin-Delporte
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2021 Oct. 17.39693 TT                                  Rudenko
q   1.7200339            (2000.0)            P              Q
n   0.15397450     Peri.  115.25496     +0.55935853     +0.82889115
a   3.4474940      Node   188.76828     -0.77729950     +0.52132122
e   0.5010770      Incl.    2.85132     -0.28796444     +0.20288827
P   6.40
From 1126 observations 2015 Feb. 18-2021 Nov. 29, mean residual 0".7.
```

Ephemerides (produced with Seiichi Yoshida's Comets for Windows program)

```
57P/du Toit-Neujmin-Delporte                                          Max El
                                                                       (deg)
    Date      R.A.   Decl.     r       d    Elong  Const  Mag   40N  40S
2021 Dec 01  20 12  -18 24   1.769   2.187    52E   Cap  11-13   21   17
2021 Dec 06  20 26  -17 44   1.780   2.231    50E   Cap  11-13   21   14
2021 Dec 11  20 40  -17 00   1.792   2.276    49E   Cap  11-13   21   11
2021 Dec 16  20 53  -16 12   1.806   2.321    47E   Cap  11-13   21    8
2021 Dec 21  21 07  -15 21   1.820   2.367    45E   Cap  11-13   20    6
2021 Dec 26  21 20  -14 28   1.835   2.414    43E   Aqr  11-13   20    4
2021 Dec 31  21 33  -13 31   1.851   2.461    41E   Cap  11-13   19    2
2022 Jan 05  21 46  -12 32   1.868   2.509    40E   Cap  11-13   18    0
```

Comet Magnitude Formula

```
Currently in outburst
```

Recent Magnitude Measurements Contributed to the ALPO Comets Section

```
Recent Magnitude Measurements in ICQ format:
Comet Des  YYYY MM DD.DD     Mag SC APER FL POW    COMA     TAIL    ICQ    CODE  Observer Name
              (UT)                    T         Dia  DC  LENG  PA
 57        2021 11 09.71  S 11.0:TK 32.0L 5  80   0.5              ICQ XX PIL01 Uwe Pilz
```

Daniel du Toit was the first to discover 57P/du Toit-Neujmin-Delporte on 1941 July 18 from the Harvard College Observatory's Boyden Station in South Africa only a few days after a close approach to Earth of 0.30 au. Due to World War II, communications were slow and two other observers, Grigory N. Neujmin at Simeis Observatory in Russia and Eugéne Joseph Delporte of the Royal Observatory in Uccle, Belgium also found the comet over the next month or so. 57P is making its 9th observed return and was not expected to become much brighter than 16th magnitude. That was the case until October 17, its perihelion date, when it was observed 5 magnitudes brighter at 11th magnitude.

While not as outburst prone as 29P, 57P experienced a 6-magnitude outburst in 1996 which may have produced 19 or more secondary nuclei that were observed during its next return in 2002. Its abnormal brightness in 1941 also suggests an outburst in that year.

While observations to the ALPO and COBS have been few in November, they do suggest the comet is still as bright as magnitude 11.0 on November 9 (Uwe Pilz) and 11.7 on November 24 (Steffen Fritsche to COBS). December sees 57P as an evening object in Capricornus (Dec 1-25), Aquarius (25-28), and Capricornus (28-31). Unless another outburst occurs, 57P should fade over the coming weeks.

C/2017 K2 (PANSTARRS)

Discovered 2017 May 21 by the Pan-STARRS survey with the Pan-STARRS1 1.8-m on Haleakala
Dynamically old long-period comet

Orbit (from MPEC 2021-U138)

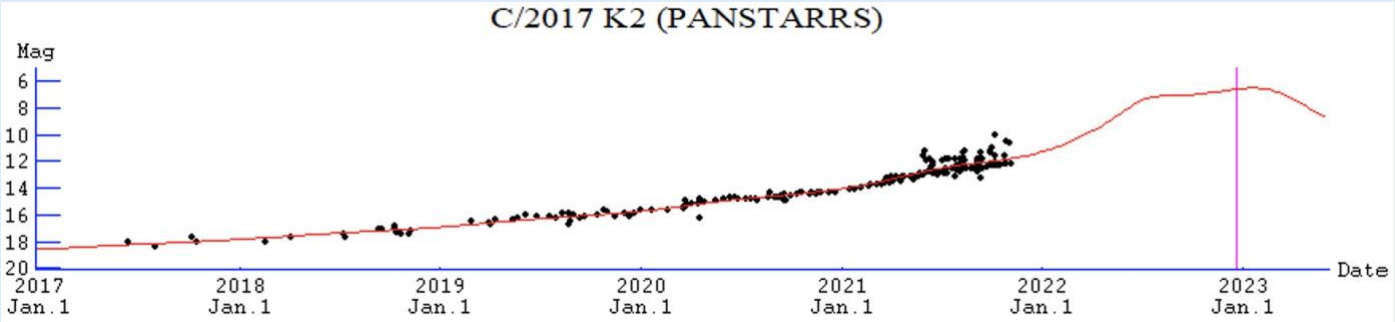
```
    C/2017 K2 (PANSTARRS)
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2022 Dec. 19.69196 TT                                   Rudenko
q   1.7971155            (2000.0)            P               Q
z  -0.0003894      Peri.  236.19330     +0.01825440     +0.04925462
 +/-0.0000008      Node    88.23673     -0.18101700     +0.98244314
e   1.0006999      Incl.   87.55886     -0.98331054     -0.17994295
From 7072 observations 2013 May 12-2021 Nov. 22, mean residual 0".4.
1/a(orig) = -0.000031 AU**-1, 1/a(fut) = +0.001161 AU**-1.
```

Ephemerides (produced with Seiichi Yoshida's Comets for Windows program)

```
C/2017 K2 (PANSTARRS)                                                  Max El
                                                                        (deg)
    Date       R.A.    Decl.      r       d     Elong  Const  Mag    40N  40S
2021 Dec 01  17 33  +16 20    4.671   5.366     41E    Her  11.6     19    0
2021 Dec 06  17 37  +15 44    4.627   5.339     39E    Her  11.6     16    0
2021 Dec 11  17 41  +15 11    4.582   5.308     38E    Her  11.5     12    0
2021 Dec 16  17 45  +14 40    4.538   5.272     38E    Her  11.5      9    0
2021 Dec 21  17 49  +14 12    4.494   5.232     37M    Oph  11.4      8    0
2021 Dec 26  17 53  +13 46    4.449   5.187     37M    Oph  11.4     11    0
2021 Dec 31  17 57  +13 22    4.405   5.138     37M    Oph  11.3     14    0
2022 Jan 05  18 01  +13 00    4.360   5.084     38M    Oph  11.2     17    0
```

Comet Magnitude Formula (from ALPO and COBS data)

```
m1 =  2.6 + 5 log d + 8.0 log r
```



Recent Magnitude Measurements Contributed to the ALPO Comets Section

```
Recent Magnitude Measurements in ICQ format:
Comet Des  YYYY MM DD.DD     Mag SC APER FL POW    COMA     TAIL    ICQ    CODE  Observer Name
              (UT)                    T         Dia  DC  LENG  PA
   2017K2  2021 11 01.79  S 11.6 TI 53.1L   155   1.3  3           ICQ XX HAR11 Christian Harder
```

C/2017 K2 (PANSTARRS) was discovered on 2017 May 21 by the Pan-STARRS1 1.8-m telescope at Haleakala on the Hawaiian island of Maui. At discovery the comet was around 21st magnitude and located at 16.1 au from the Sun. Pre-discovery observations were found back to May of 2013 when the comet was 23.7 au from the Sun which is further than the distance of Uranus. Even though it was discovered over 2.5 years ago, perihelion is still over a year away on 2022 December 19 at 1.80 au.

C/2017 K2 is poorly placed for observation this month as it passes through solar conjunction, though it will be ~37 degrees north of the Sun at conjunction. As a result, it will be invisible to southern hemisphere observers but visible at low elevations from the northern hemisphere (moving through Hercules [Dec 1-20] and

Ophiuchus [20-31]. Northern observers with a clear and dark northern horizon should be able to watch K2 brighten from around magnitude 11.6 to 11.2 this month.

The comet will reappear for southern hemisphere observers in February 2022 when it should be magnitude 10.5. Northern observers will be able to follow the comet continuously till late September when it will travel too far south (around magnitude 7.0 at that time). C/2017 K2 should peak in January 2023 around magnitude 6.5 and at a far southern declination of -70 deg. Northern observers won't see the comet again till August 2023 when it will have faded to around magnitude 10.0.

Like 8P/Tuttle, 19P/Borrelly, and C/2021 A1 (Leonard), C/2017 K2 will also have an orbit plane crossing this month (on December 19). While first time Oort Cloud comets usually have yet to release enough dust to produce dust trails before perihelion, K2 has been active out to 23 au and possible further. Imagers should attempt to image any dust trail in mid-December since the existence and morphology of a trail may provide additional constraints on the start of K2's activity.

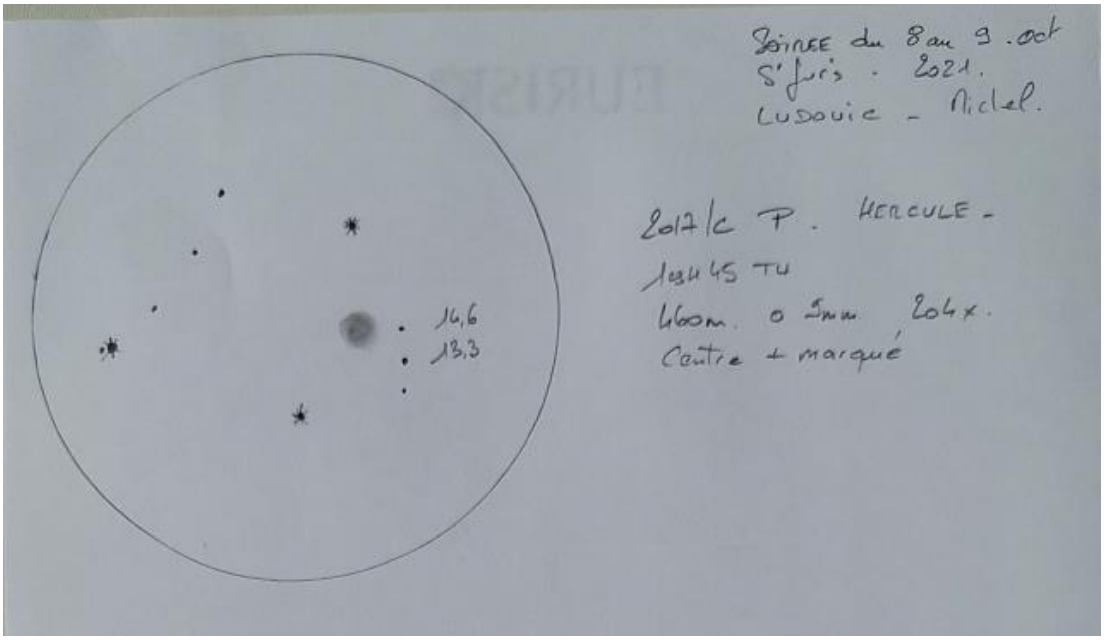


Figure 13 – Michel Besson and Ludovic Prebet sketched C/2017 K2 (PANSTARRS) on 2021 October 8.

New Discoveries, Recoveries and Other Comets News

New Comet Numberings (Ref: WGSBN Bull. 1 #12)

```
436P/2007 R4   = 2021 U2 (Garradd)
435P/2021 T3   = 2015 K6 (PANSTARRS)
434P/2012 TK8  = 2021 S2 (Tenagra)
433P = (248370) Dual status
432P/2021 N4   = P/2016 U2 (PANSTARRS)
431P/2015 Q1   = P/2021 P5 (Scotti)
430P/2011 A2   = P/2021 Q2 (Scotti)
429P/2008 QP20 = P/2021 M1 (LINEAR-Hill)
428P/2014 W12  = P/2021 Q1 (Gibbs)
427P/2017 S5   = P/2021 L6 (ATLAS)
426P/2019 A7   = P/2021 K4 (PANSTARRS)
```

New Comet Discoveries

P/2021 V3 = P/2011 UE215 (PANSTARRS) – Discovered by the Pan-STARRS survey at 21st magnitude with the Pan-STARRS1 1.8-m on 2021 November 1. After additional observations in 2021 were found, the Minor Planet Center linked the new comet with observations in 2012 and a designated object from 2011 called 2011 UE215. Perihelion will be on 2022 August 18 at 3.40 au. According to Syuichi Nakano, the comet passed 0.39 au from Jupiter in 2007. Prior to the 2007 encounter, its perihelion was larger at 3.95 au. P/2021 V3 is unlikely to get brighter at this return. [CBET 5069, MPEC 2021-V173]

P/2021 V2 (Fuls) – Discovered by David Carson Fuls at 19th magnitude with the Mount Lemmon 1.5-m on 2021 November 7. This comet is a short-period comet with an orbital period of 27.2 years. Perihelion is on 2023 January 21 at 3.50 au. Perihelion will be next year on 2022 April 30 at 3.01 au with a peak brightness of 17th magnitude. [CBET 5068, MPEC 2021-V169]

C/2021 V1 (Rankin) – Discovered by David Rankin at 20th magnitude with the Mount Lemmon 1.5-m on 2021 November 5. Perihelion will be next year on 2022 April 30 at 3.01 au. The comet is unlikely to get brighter than 19th magnitude.[CBET 5067, MPEC 2021-V167]

C/2021 U5 (Catalina) – The Catalina Sky Survey found yet another comet. This time it was Alex Gibbs who used the Catalina 0.68-m Schmidt to find this 18th magnitude comet on October 29. Perihelion will be next month on 2022 January 25 at 2.37 au. It should peak in brightness next February and March at ~17th magnitude. [CBET 5070, MPEC 2021-V199]

As always, the Comet Section is happy to receive all comet observations, whether textual descriptions, images, drawings, magnitude estimates, or spectra. Please send your observations via email to the Comets Section < comets @ alpo-astronomy .org >, Comets Section Coordinator Carl Hergenrother < carl.hergenrother @ alpo-astronomy .org > and/or Comets Section Acting Assistant Coordinator Michel Deconinck < michel.deconinck @ alpo-astronomy .org >.

Thank you to everyone who contributed to the ALPO Comets Section!

Clear skies!
- Carl Hergenrother

Recent Magnitudes Contributed to the ALPO Comets Section

Comet Des	YYYY MM DD.DD (UT)		Mag	SC	APER	FL	POW	COMA Dia	COMA DC	TAIL LENG	TAIL PA	ICQ CODE	Observer Name
C/2021 A1 (Leonard)													
2021A1	2021 12 02.49	Z	6.5	U4	7.2R	5	a600	26.3	>	1.0	313	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 02.48	M	6.7	TK	5.0B		10	8	5/	0.7	320	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 01.46	M	7.0	TK	5.0B		10	6	5/	0.3	320	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 01.17	I	6.8	TK	12.6B	5	25	10	6	45.0m	300	ICQ XX	DECaa Michel Deconinck
2021A1	2021 11 30.47	M	7.1	TK	5.0B		10	5	5	0.3	320	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 28.50	M	7.2	TK	5.0B		10	7	5	0.2	315	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 28.18	E	7.9	TK	25.0C	10	62	6	4	25.0m	300	ICQ XX	DECaa Michel Deconinck
2021A1	2021 11 26.46	C	7.9	GG	5.0R	4a	60	10.6				ICQ XX	OLAaa Michael Olason
2021A1	2021 11 23.15	S	8.4	TK	32.0L	5	80	4	5/	5.0	310	ICQ XX	PIL01 Uwe Pilz
2021A1	2021 11 18.24	S	7.9	TK	10.0B		25	8	3	0.15	320	ICQ XX	GON05 Juan Jose Gonzalez Suarez
2021A1	2021 11 17.51	S	8.2	TK	5.0B		10	7	4			ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 17.50	V	8.5	U4	10.6R	5a	600	13.4		20	m320	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 17.47	k	9.0	U4	10.6R	5a	600	8.2		26	m325	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 16.20	I	8.4	TK	25.0C	10	62	2.5	7	5.0m	280	ICQ XX	DECaa Michel Deconinck
2021A1	2021 11 15.50	k	9.3	U4	10.6R	5a	360	5.8		15	m325	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 15.48	V	9.0	U4	10.6R	5a	600	12.8		12	m320	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 15.52	S	8.2	TK	5.0B		10	5	4			ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 15.51	M	8.4	TK	12.5B		30	5	6	6	m310	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 13.50	S	8.5	TK	5.0B		10	6	4			ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 13.50	M	8.9	TK	12.5B		30	5	6	5	m320	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 11.51	S	9.4	TK	12.5B		30	5	5			ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 11.22	S	8.7	TK	10.0B		25	8	3	0.4	320	ICQ XX	GON05 Juan Jose Gonzalez Suarez
2021A1	2021 11 11.21	S	9.2	TK	20.3T	10	77	6	3/	0.3	320	ICQ XX	GON05 Juan Jose Gonzalez Suarez
2021A1	2021 11 10.17	S	9.4	TI	29.8L	4	92	4	4	6.5m	310	ICQ XX	HAR11 Christian Harder
2021A1	2021 11 07.49	S	9.9	TK	12.5B		30	3	5			ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 05.23	S	9.7	TK	20.3T	10	77	5	3/	0.3	330	ICQ XX	GON05 Juan Jose Gonzalez Suarez
2021A1	2021 11 04.49	S	10.0	TK	12.5B		30	4	4			ICQ xx	HER02 Carl Hergenrother
2021A1	2021 11 02.15	S	10.3	TI	29.8L	4	79	3	4	6.0m	340	ICQ XX	HAR11 Christian Harder
C/2019 L3 (ATLAS)													
2019L3	2021 12 02.78	S	9.7	TI	29.8L	4	92	1.9	4/			ICQ XX	HAR11 Christian Harder
2019L3	2021 11 13.72	xM	10.2	AQ	40.0L	4	59	4	6	5.8m	290	ICQ XX	WYA Christopher Wyatt
2019L3	2021 11 11.13	S	9.6	TK	20.3T	10	77	4	5			ICQ XX	GON05 Juan Jose Gonzalez Suarez
2019L3	2021 11 09.93	S	10.2	TI	29.8L	4	92	2.4	5	4.5m	305	ICQ XX	HAR11 Christian Harder
2019L3	2021 11 05.35	S	9.7	TK	12.5B		30	3	4			ICQ xx	HER02 Carl Hergenrother
2019L3	2021 11 05.13	S	9.5	TK	20.3T	10	77	5	4/			ICQ XX	GON05 Juan Jose Gonzalez Suarez
2019L3	2021 11 02.12	S	10.2	TI	29.8L	4	79	1.8	4	6.0m	275	ICQ XX	HAR11 Christian Harder
C/2017 K2 (PANSTARRS)													
2017K2	2021 11 01.79	S	11.6	TI	53.1L		155	1.3	3			ICQ XX	HAR11 Christian Harder
241P/LINEAR													
241	2021 11 15.42	C	17.2	GG	27.9T	6A	200	0.2	>	0.3m	270	ICQ XX	OLAaa Michael Olason
173P/Mueller													
173	2021 11 15.45	C	19.8	GG	27.9T	6A	680	0.2		1.0m	279	ICQ XX	OLAaa Michael Olason
132P/Helin-Roman-Alu													
132	2021 11 11.02	S	11.9	TK	20.3T	10	133	3	4			ICQ XX	GON05 Juan Jose Gonzalez Suarez
132	2021 11 01.81	S	14.5	TI	53.1L		215	0.5	4			ICQ XX	HAR11 Christian Harder
116P/Wild													
116	2021 11 15.43	C	16.6	GG	27.9T	6a	900	0.2	>	1.5m	285	ICQ XX	OLAaa Michael Olason
110P/Hartley													
110	2021 11 15.39	C	15.0	GG	27.9T	6a	900	0.3	>	1.3m	287	ICQ XX	OLAaa Michael Olason
106P/Schuster													
106	2021 11 15.34	C	17.1	GG	27.9T	6a	900	0.2	>	2	m281	ICQ XX	OLAaa Michael Olason
70P/Kojima													
70	2021 11 15.49	C	17.2	GG	27.9T	6a	900	0.2	>	0.5m	299	ICQ XX	OLAaa Michael Olason
67P/Churyumov- Gerasimenko													
67	2021 11 15.35	C	9.2	GG	27.9T	6a	840					ICQ XX	OLAaa Michael Olason
67	2021 11 13.67	xM	9.1	TK	40.0L	4	59	3.3	6	12.0m	275	ICQ XX	WYA Christopher Wyatt
67	2021 11 11.11	S	9.2	TK	10.0B		25	4	5/			ICQ XX	GON05 Juan Jose Gonzalez Suarez
67	2021 11 11.10	S	9.8	TK	20.3T	10	77	4	5	0.25	280	ICQ XX	GON05 Juan Jose Gonzalez Suarez
67	2021 11 09.94	S	9.5	TI	29.8L	4	92	2	4	10.0m	280	ICQ XX	HAR11 Christian Harder
67	2021 11 07.21	B	9.6	TK	25.0C	10	195	1.8	7	2.2m	260	ICQ XX	DECaa Michel Deconinck
67	2021 11 05.35	S	9.0	TK	12.5B		30	4	6/			ICQ xx	HER02 Carl Hergenrother
67	2021 11 05.21	S	9.9	TK	20.3T	10	77	4	5	0.15	280	ICQ XX	GON05 Juan Jose Gonzalez Suarez
67	2021 11 02.11	S	9.2	TI	29.8L	4	79	2.3	4/	11.0m	280	ICQ XX	HAR11 Christian Harder
57P/du Toit-Neujmin-Delporte													
57	2021 11 09.71	S	11.0:	TK	32.0L	5	80	0.5				ICQ XX	PIL01 Uwe Pilz
52P/Harrington-Abell													
52	2021 11 15.53	C	17.0	GG	27.9T	6a	720	0.2	>	0.9m	294	ICQ XX	OLAaa Michael Olason

```
29P/Schwassmann-Wachmann
 29        2021 12 02.77  S 11.3 TI 29.8L 4 108   3    1            ICQ XX HAR11 Christian Harder
 29        2021 11 13.69 xS 11.0 AQ 40.0L 4  59   2.9  2/           ICQ XX WYA   Christopher Wyatt
 29        2021 11 11.09  S 10.1 TK 20.3T10  77   5    3            ICQ XX GON05 Juan Jose Gonzalez Suarez
 29        2021 11 09.92  S 10.8 TI 29.8L 4  92   4    2            ICQ XX HAR11 Christian Harder
 29        2021 11 05.11  S 10.0 TK 20.3T10  77   4    3            ICQ XX GON05 Juan Jose Gonzalez Suarez
 29        2021 11 04.50  S 10.7 TK 12.5B    30   3    2            ICQ xx HER02 Carl Hergenrother
 29        2021 11 02.13  S 10.6 TI 29.8L 4  92   2.9  2            ICQ XX HAR11 Christian Harder
 29        2021 11 01.85  S 11.4:TI 53.1L   139   1.8  3            ICQ XX HAR11 Christian Harder15P/Finlay
 15        2021 11 15.40  C 16.9 GG 27.9T 6a900   0.4     > 0.5m285 ICQ XX OLAaa Michael Olason
9P/Tempel
  9        2021 11 15.54  C 14.8 GG 27.9T 6a300   0.4               ICQ XX OLAaa Michael Olason
8P/Tuttle
  8        2021 11 13.71 xS 10.4 TK 40.0L 4  59   3.5  3            ICQ XX WYA   Christopher Wyatt
4P/Faye
  4        2021 11 13.72 xS 11.6 AQ 40.0L 4 108   1.9  3            ICQ XX WYA   Christopher Wyatt
  4        2021 11 11.17  S 11.0 TK 20.3T10 100   3    2/           ICQ XX GON05 Juan Jose Gonzalez Suarez
  4        2021 11 10.19  S 10.3 TI 29.8L 4  92   2.8  2            ICQ XX HAR11 Christian Harder
  4        2021 11 05.36  S 10.6 TK 12.5B    30   2    4            ICQ xx HER02 Carl Hergenrother
  4        2021 11 05.09  S 11.2 TK 20.3T10 100   3    2/           ICQ XX GON05 Juan Jose Gonzalez Suarez
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