ALPO COMET NEWS

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

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The title of "Comet of 2021" has been awarded to C/2021 A1 (Leonard). Michael Jäger and Lukas Demetz used the Skygems Observatory 20" f/6.8 AG Optical iDK reflector and FLI Proline 16803 camera located at Hakos, Namibia to image Leonard on 2022 January 2 at 19:00 UT. The image is a LRGB composite consisting of 3 x 150/120/120/120sec exposures. Field of view is 25x25'. Details within the coma and tail enhanced using the Larson-Sekanina processing filter and unsharp masking.

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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/805504-alpo-comet-news-for-january-2022/). 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 appreciated.

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

Happy New Year from the ALPO!

After a year of "will it, won't it", C/2021 A1 (Leonard) developed into the best comet of 2021. While a difficult object to observe when at its brightest due to a small solar elongation, several outbursts resulted in a peak brightness between magnitude 2.5 and 3.0. As the year begins, the comet has faded to around magnitude 5.0. The comet remains very dynamic with imagers following nightly changes in its coma and tail. Speaking of tails, some images are showing a tail nearly 40 deg in length! Northern observers will only have a few more days to observe Leonard while southern hemisphere observers should be able to follow Leonard throughout the month.

Leonard may be the brightest comet out there, but it isn't the only one in the range of modest backyard equipment. 19P/Borrelly is around 8-9th magnitude in the evening sky. 67P/Churyumov-Gerasimenko and C/2019 L3 (ATLAS) are also at a similar brightness near opposition. Slightly fainter comets (magnitude 10-11) include 6P/d'Arrest, 104P/Kowal, and C/2017 K2 (PANSTARRS).

Since December 1, the ALPO Comets Section has received 118 magnitude estimates and 120 images and sketches of comets C/2021 A1 (Leonard), C/2019 T4 (ATLAS), C/2019 L3 (ATLAS), 104P/Kowal, 67P/Churyumov-Gerasimenko, 29P/Schwassmann-Wachmann, 19P/Borrelly, 6P/d'Arrest, and 4P/Faye. Observations were contributed by Michael Amato, Salvador Aguirre, Dan Bartlett, Michel Deconinck, Lukas Demetz, Walter Elias, J. J. Gonzalez, Christian Harder, Jan Hattenbach, Carl Hergenrother, Eliot Herman, Michael Jäger, Kardasis Manos, Luis Alberto Mansilla, Frank McCague, Martin Mobberley, Michael Olason , Uwe Pilz, Olivier Planchon, Efrain Morales Rivera, Michael Rosolina, Gregg Ruppel, Chris Schur, Leandro Sid, Willian Souza, Tenho Tuomi, Jim Twellman, Chris Wyatt, and Skygems Observatory.

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 are used to produce the lightcurves and orbit diagrams in these pages. And last but not least, we'd like to thank Syuichi Nakano and the Minor Planet Center for their comet orbit 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.

Comets Calendar for January 2022

Jan 02 - New Moon
Jan 02 - 429P/LINEAR-Hill at perihelion (q = 1.81 au, 6.7-yr period, V ~ 18-19, discovered in 2008, 3rd observed return)
Jan 03 - C/2021 A1 (Leonard) at perihelion (q = 0.62 au, V ~ 4-5, more below)
Jan 04 - C/2019 L3 (ATLAS) passes within 30' of galaxies IC 2176 & 2178
Jan 07 - 19P/Borrelly passes within arc minutes of galaxies NGC 135 and IC 26 and 0.3 deg of galaxy IC 28
Jan 08 - 19P/Borrelly passes within 10' of galaxy NGC 154
Jan 08 - 19P/Borrelly passes within 5' of galaxy NGC 217
Jan 08 - 181P/Shoemaker-Levy at perihelion (q = 1.16 au, 7.6-yr period, V ~16-17, discovered in 1991, 4th observed return)
Jan 09 - First Quarter Moon
Jan 09 - C/2019 L3 (ATLAS) at perihelion (q = 3.55 au, V ~ 8-9, more below)
Jan 11 - 104P/Kowal at perihelion (q = 1.07 au, 5.8-yr period, V ~ 10, discovered in 1972 and 1979, 8th observed return, more below)
Jan 12 - P/2021 R5 (Rankin) at perihelion (3.32 au, 10.5-yr period, V ~ 17-18, first observed return)
Jan 12 - 104P/Kowal passes within 10' of galaxy NGC 271
Jan 13 - 104P/Kowal passes within arc minutes of galaxy NGC 307
Jan 13 - 205P/Giacobini at perihelion (q = 1.53 au, 6.7-yr period, V ~ 17, at very small elongation this month, discovered in 1896, rediscovered in 2008, 4th observed return, outbursts and splitting events in 2008, major 5-6 magnitude outburst in 2015)
Jan 13 - 152P/Helin-Lawrence at perihelion (q = 3.10 au, 9.5-yr period, V ~ 17, at small elongation this month, discovered in 1993, 4th observed return)
Jan 13 - 422P/Christensen at perihelion (q = 3.11 au, 15.9-yr period, V ~ 16-17, discovered in 2006, 2nd observed return)
Jan 15 - 104P/Kowal passes within 20' of galaxies NGC 359 & 364
Jan 16 - 19P/Borrelly passes within 5' of galaxy NGC 273
Jan 16-17 - 104P/Kowal passes within arc minutes of galaxies IC 1639 & IC 1640
Jan 17 - 104P/Kowal passes within 12' of galaxies NGC 426, 429, 430 & IC 1643
Jan 17 - Full Moon
Jan 19 - 19P/Borrelly passes within 0.5 deg of galaxy group consisting of NGC 321, 325, 327 & 329
Jan 19 - 19P/Borrelly passes within 0.5 deg of galaxies NGC 426, 429, 430 & IC 1643
Jan 19 - 104P/Kowal passes within 4' of galaxy IC 1681 and 10' of galaxy IC 1697
Jan 22 - 104P/Kowal passes within 0.5 deg of galaxies NGC 622 and IC 145
Jan 25 - Last Quarter Moon
Jan 26 - C/2021 Q3 (ATLAS) at perihelion (q = 5.20 au, 640-yr period, V ~ 18)
Jan 26 - C/2021 U5 (PANSTARRS) at perihelion (q = 2.37 au, 5200-yr period, V ~ 16-17)
Jan 27 - 104P/Kowal passes within 0.5 deg of galaxies IC 194 & 197
Jan 29 - 104P/Kowal passes within 0.5 deg of galaxies NGC 851 & IC 211
Jan 29-30 - 19P/Borrelly passes within 0.5 deg of galaxy group consisting of NGC 467, 470 & 474
Jan 31 - 19P/Borrelly passes within arc minutes of interacting galaxy NGC 520
Jan 31 - C/2019 L3 (ATLAS) passes within 20' of open cluster NGC 2266
Jan 31 - New Moon

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 Minor Planet Center MPEC 2021-X165)

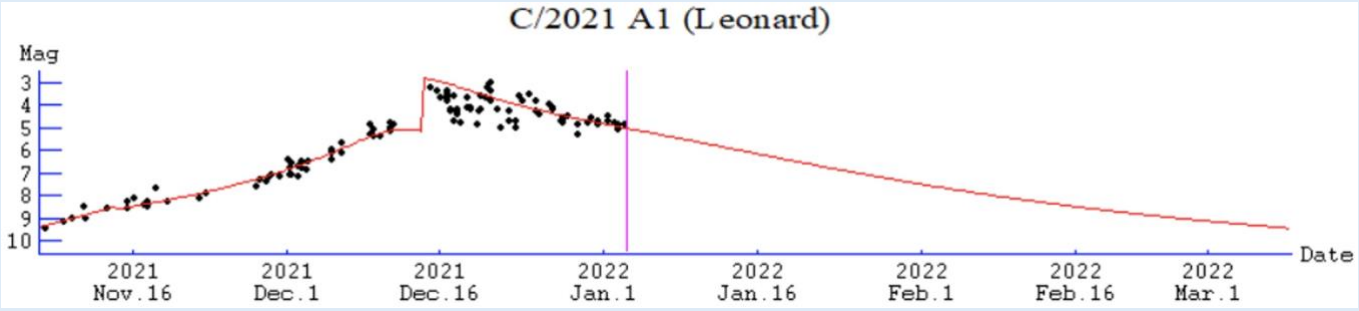
```
   C/2021 A1 (Leonard)
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2022 Jan. 3.30004 TT                                  Veres
q   0.6152471            (2000.0)            P             Q
z  -0.0000277      Peri.  225.09379     +0.63774099     +0.29161013
 +/-0.0000018      Node   255.89643     +0.72790869     -0.53081999
e   1.0000170      Incl.  132.68653     -0.25186379     -0.79573468
From 2172 observations 2020 Apr. 11-2021 Dec. 8, mean residual 1".6.
1/a(orig) = +0.000528 AU**-1, 1/a(fut) = -0.000077 AU**-1.
```

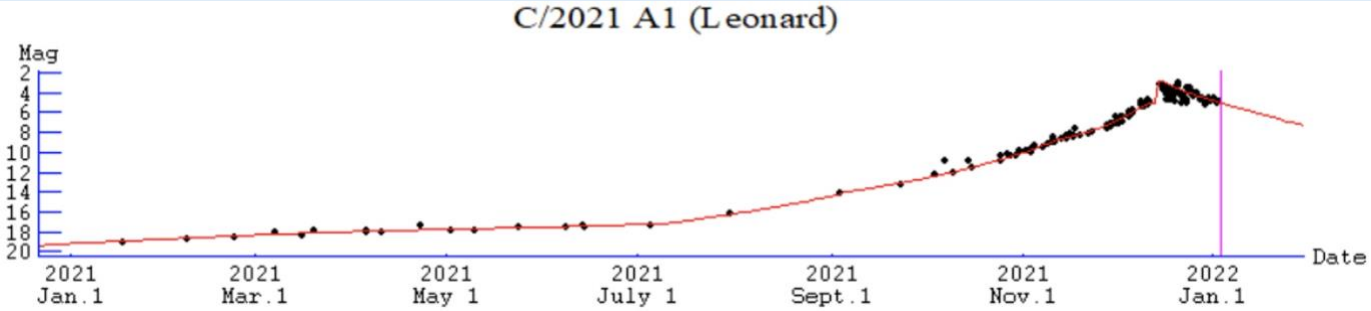
Ephemerides (produced with Seiichi Yoshida's Comets for Windows program)

```
C/2021 A1 (Leonard)                                                  Max El
                                                                     (deg)
    Date      R.A.   Decl.     r       d    Elong  Const  Mag    40N  40S
2022 Jan 01  21 33  -35 25   0.617   0.832    38E    PsA   4.8     1   16
2022 Jan 06  21 40  -36 02   0.618   1.016    35E    PsA   5.3     0   14
2022 Jan 11  21 42  -36 19   0.638   1.187    32E    PsA   5.7     0   12
2022 Jan 16  21 41  -36 24   0.674   1.342    28E    PsA   6.2     0   10
2022 Jan 21  21 39  -36 21   0.724   1.479    25E    PsA   6.6     0    7
2022 Jan 26  21 37  -36 12   0.784   1.597    22E    PsA   7.0     0    5
2022 Jan 31  21 34  -36 00   0.851   1.698    20E    PsA   7.4     0    3
2022 Feb 05  21 32  -35 47   0.922   1.783    20E    PsA   7.8     0    1
```

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

```
m1 =  7.4 + 5 log d + 11.7 log r [to T-370 days, where T = date of perihelion]
m1 = 11.7 + 5 log d +  5.6 log r [T-370 to T-177 days]
m1 =  4.6 + 5 log d + 20.6 log r [T-177 to T-120 days]
m1 =  7.3 + 5 log d + 12.5 log r [T-120 to T-50 days]
m1 =  8.3 + 5 log d +  0.7 log r [T-50 to T-20 days]
m1 =  6.8 + 5 log d +  7.5 log r [T-20 days and onwards, assumed]
```





Recent Magnitude Measurements Contributed to the ALPO Comets Section

Recent Magnitude Measurements in ICQ format:

Comet Des	YYYY MM DD.DD (UT)	Mag	SC	APER	FL	POW	COMA Dia	COMA DC	TAIL LENG	TAIL PA	ICQ	CODE	Observer Name
2021A1	2021 12 31.44 xM	4.9	TK	7.0B		15	6.5	6	3.2	092	ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 31.44 xM	4.7	TK	0.0E			20.0	5/	1.0	092	ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 30.76 S	4.8	TK	10.0B		25	6	7			ICQ XX	GON05	Juan Jose Gonzalez Suarez
2021A1	2021 12 30.44 xM	4.8	TK	7.0B		15	8	6/	2.4	90	ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 30.06 V	5.4	TK	5.0R	4		5				ICQ xx	OLAaa	Michael Olason
2021A1	2021 12 29.44 xM	5.3	TK	7.0B		15	7.0	6	8.5	090	ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 29.44 xM	4.8	TK	0.0E			17.0	3/	1.0	090	ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 28.44 xM	4.5	TK	7.0B		15	10	6	9.0	90	ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 27.99 M	4.8	TK	9.0R	5	28	10	7	0.5	90	ICQ XX	SOU01	Willian Souza
2021A1	2021 12 27.98 M	4.7	TK	9.0R	5	16	10	7	0.5	90	ICQ XX	SOU01	Willian Souza
2021A1	2021 12 27.96 M	4.6	TK	4.2B		10	8	7	0.2	90	ICQ XX	SOU01	Willian Souza
2021A1	2021 12 27.06 V	3.9	TK	2.5R	4		8		>2.0	94	ICQ xx	OLAaa	Michael Olason
2021A1	2021 12 26.98 B	4.0	TK	5.0B		7	8	6		90	ICQ XX	SOU01	Willian Souza
2021A1	2021 12 26.97 B	4.2	TK	7.0B		15	10	7	0.2	90	ICQ XX	SOU01	Willian Souza
2021A1	2021 12 25.43 xM	3.7	TK	0.0E			20.0	4	1.5	090	ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 25.44 xM	4.3	TK	7.0B		15	10.7	5/	2.6	088	ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 24.07 V	4.5	TK	5.0R	4		7		>1.0	94	ICQ xx	OLAaa	Michael Olason
2021A1	2021 12 23.43 sM	4.6	TK	0.0E			20.0	4			ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 23.44 sM	5.0	TK	7.0B		15	8.0	6	2.5	090	ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 23.08 V	4.7	TK	5.0R	4		6		>1.0	94	ICQ xx	OLAaa	Michael Olason
2021A1	2021 12 22.75 S	4.5	TK	10.0B		25	6	7	0.6	80	ICQ XX	GON05	Juan Jose Gonzalez Suarez
2021A1	2021 12 22.72 I	5.3:	TK	15.6R	8	30	10	3	25.0m	95	ICQ XX	DECaa	Michel Deconinck
2021A1	2021 12 21.96 B	5.0	TK	7.0B		15	10	5	0.2	90	ICQ XX	SOU01	Willian Souza
2021A1	2021 12 21.72 I	4.8	TK	15.6R	8	30	5	3	25.0m	95	ICQ XX	DECaa	Michel Deconinck
2021A1	2021 12 21.07 aM	3.7	TK	5.0B		10	6	6	0.3	85	ICQ xx	HER02	Carl Hergenrother
2021A1	2021 12 21.06 V	3.4	TK	5.0R	4		11		>1.0	94	ICQ xx	OLAaa	Michael Olason
2021A1	2021 12 20.93 B	3.0	TK	7.0B		15	10	8	0.2	90	ICQ XX	SOU01	Willian Souza
2021A1	2021 12 20.72 I	3.8	TK	15.6R	8	30	5	6	12.0m		ICQ XX	DECaa	Michel Deconinck
2021A1	2021 12 20.43 sB	3.6	TK	5.0R		10	5.0	8	30.0m	080	ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 20.06 aM	3.5	TK	5.0B		10	6	7	0.25	80	ICQ xx	HER02	Carl Hergenrother
2021A1	2021 12 20.06 V	4.2	TK	5.0R	4		11		>1.2	92	ICQ xx	OLAaa	Michael Olason
2021A1	2021 12 19.72 I	5.5	-	15.6R	8	30		4/			ICQ XX	DECaa	Michel Deconinck
2021A1	2021 12 19.06 aM	4.0	TK	5.0B		10	7	5	0.25	80	ICQ xx	HER02	Carl Hergenrother
2021A1	2021 12 19.05 V	4.1	TK	5.0R	4		11		>0.4	89	ICQ xx	OLAaa	Michael Olason
2021A1	2021 12 19.03 M	4.8	TK	5.0B	4	20	7	5			MAN04	MAN04	Luis Alberto Mansilla
2021A1	2021 12 18.71 E	4.7	TK	15.6R	8	30	10	3	15.0m	90	ICQ XX	DECaa	Michel Deconinck
2021A1	2021 12 18.06 V	4.8	TK	5.0R	4		11				ICQ xx	OLAaa	Mike Olason
2021A1	2021 12 17.75 S	4.3	TK	5.0B		10	5	7			ICQ XX	GON05	Juan Jose Gonzalez Suarez
2021A1	2021 12 17.43 sS	3.6	TK	7.0B		15	14.0	3			ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 17.41 &M	5.0	TK	25.0L	5	40	16	6	16.0m	90	ICQ XX	WYA	Christopher Wyatt
2021A1	2021 12 17.06 V	4.3	TK	5.0R	4		12		>1.0	82	ICQ xx	OLAaa	Mike Olason
2021A1	2021 12 17.06 M	4.1	TK	5.0B		10	5	4			ICQ xx	HER02	Carl Hergenrother
2021A1	2021 12 17.05 Z	4.3	U4	7.2R	5a	130	10.6		0.12	75	ICQ xx	HER02	Carl Hergenrother
2021A1	2021 12 16.75 S	3.4	TK	5.0B		10	7	6			ICQ XX	GON05	Juan Jose Gonzalez Suarez
2021A1	2021 12 16.73 E	4.0:	TK	15.6R	8	30	5	5	30.0m	290	ICQ XX	DECaa	Michel Deconinck
2021A1	2021 12 16.05 V	3.7	TK	5.0R	4		13				ICQ xx	OLAaa	Mike Olason
2021A1	2021 12 15.75 S	3.3	TK	5.0B		10	7	6/			ICQ XX	GON05	Juan Jose Gonzalez Suarez
2021A1	2021 12 15.06 V	3.2	TK	5.0R	4		11				ICQ xx	OLAaa	Mike Olason
2021A1	2021 12 11.54 M	4.8	TK	5.0B		10	7	5	0.7	330	ICQ xx	HER02	Carl Hergenrother
2021A1	2021 12 11.24 S	4.9	TK	5.0B		10	16	6/	1.7	330	ICQ XX	GON05	Juan Jose Gonzalez Suarez
2021A1	2021 12 11.25 I	4.7	TK	0.0E			12	7			ICQ XX	GON05	Juan Jose Gonzalez Suarez
2021A1	2021 12 09.53 Z	5.4	U4	7.2R	5a	840	28.9		>1.4	327	ICQ xx	HER02	Carl Hergenrother
2021A1	2021 12 09.50 M	5.0	TK	5.0B		10	12	5	1.5	320	ICQ xx	HER02	Carl Hergenrother
2021A1	2021 12 09.19 I	5.3	TK	12.6B	5	40	12	3/	1.2	315	ICQ XX	DECaa	Michel Deconinck
2021A1	2021 12 06.53 Z	5.7	U4	7.2R	5C	480	30.7		>1.35	321	ICQ xx	HER02	Carl Hergenrother
2021A1	2021 12 06.47 M	6.0	TK	5.0B		10	10	6	1.0	320	ICQ xx	HER02	Carl Hergenrother
2021A1	2021 12 05.53 Z	6.0	U4	7.2R	5C	000	28.1		>1.5	321	ICQ xx	HER02	Carl Hergenrother
2021A1	2021 12 05.51 GS	6.0	AC	5.0B		7	& 3	3			ICQ XX	AGUaa	Salvador Aguirre
2021A1	2021 12 05.47 M	6.3	TK	5.0B		10	7	5/	0.5	320	ICQ xx	HER02	Carl Hergenrother
2021A1	2021 12 03.25 S	6.4	TK	5.0B		10	12	5	2.4	310	ICQ XX	GON05	Juan Jose Gonzalez Suarez
2021A1	2021 12 03.06 S	7.0	TI	10.0L	4	36	5	4	14.0m	320	ICQ XX	HAR11	Christian Harder
2021A1	2021 12 02.49 Z	6.5	U4	7.2R	5a	600	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 02.19 S	7.1	TK	5.0B	4	7	4	5/	0.28	328		PIL01	Uwe Pilz
2021A1	2021 12 01.51 Z	6.6	U4	7.2R	5A	020	26.3		>1.3	314	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

I think it safe to say that C/2021 A1 (Leonard) has officially won the award of "Best Comet of 2021". Barring a surprise discovery or outburst, it may also win the award for "Best Comet of 2022".

Before talking about what we expect from Leonard in January, let's highlight its development (bullet point style):

- The first observation of Leonard was taken on 2020 April 11 by the Catalina Sky Survey's 1.5-m Mount Lemmon telescope when the comet was reported at magnitude 21.8 and located at distances of 7.5 au from the Sun and 6.9 au from Earth. These observations and others taken throughout the remainder of 2020 by the Mount Lemmon, Pan-STARRS, and GINOP-KHK telescopes would go unrecognized until…
- On the night of 2021 January 3 UT, Catalina astronomer Gregg Leonard would find C/2021 A1 at magnitude 19 with the Mount Lemmon 1.5-m, the same telescope that first imaged the comet 9 months earlier. At discovery, C/Leonard was 5.1 au from the Sun and 4.9 au from Earth.
- Leonard's rate of brightening has not be constant. From April 2020 to January 2021, it appeared to brighten at a better than average rate of 2.5n ~ 12. Then from January to July 2020, it barely brightened faster than steady state (2.5n = 5) at a rate of 2.5n ~ 6.
- By July of 2021, the comet had reached an apparent magnitude of 16-17. Around this time, the comet started to once again rapidly brighten. Between July and sometime in early September, an incredible rate of 2.5n ~ 21 was observed. Between September and mid-November, this rate slowed down to a still impressive 2.5n ~ 12. With the comet now around magnitude 8, its prospects were looking good for a bright object around the time of close approach to Earth in early to mid-December. But then…
- Leonard's brightening not only ground to a halt but went into reverse. While the comet would brighten to around magnitude 5 on December 11, its activity had decreased since mid-November. The apparent brightening being due to its decreasing distance to the Earth and Sun and not from any increase in activity. As the comet moved too close to the Sun to be seen from Earth, it looked like magnitude 5 might be the best we'd see from Leonard.
- After the 11th, the comet was at too small of a solar elongation for most Earthbound observers. On December 12, Leonard passed 0.233 au (34.9 million km, 21.7 million miles) from Earth and on the 14th, it reached a maximum phase angle of 160 deg.
- The 14th and 15th provided a surprise as Leonard was imaged by multiple observers and estimated to be around magnitude 2.5 to 3.5. While forward scattering of sunlight by Leonard's dust probably contributed to some of the increased brightness, a real outburst had occurred. Radio observations posted by Nicolas Biver showed a ~3x increase in gas production between December 13 and 15 [comets-ml post]. Also Jakub Cerny measured photometry from observations taken with the STEREO-A spacecraft that showed a ~1.5 magnitude outburst starting on December 13 [comets-ml post].
- In addition to the outburst from the 13th, the comet has experienced further outbursts on the 17th, 20th, 24th, and 30th. The later outbursts have occasionally given the comet more of a star-like appearance in small binoculars and by increasing the brightness of the inner coma, but they have not been very effective at increasing the total magnitude of the comet.
- Perhaps even more surprising than the outbursts is the development of a long, strong, dynamic gas tail. Jan Hattenbach has imaged a turbulent, kinked gas tail extending up to 36 deg in length on December 26, 27, 28, and 29 from the dark skies of La Palma. His most recent image from January 1 shows a much shorter tail though one that was still visually visible to over 7 deg in 10x50s. A Chris Wyatt observation from the 28th reported a 9 deg long visual tail in 15x70 binoculars.
- As January begins, visual observers are reporting the comet to be slightly brighter than magnitude 5.0.

Figure 1 – Jan Hattenbach imaged 36 deg of C/2021 A1 (Leonard)'s tail on 2021 December 26 from La Palma. This is a mosaic of two 50mm-images, 180s each, f/4, ISO 3200.

Leonard's propensity to outburst makes any prediction of its behavior in January uncertain. The comet should fade this month as it is rapidly moving away from the Earth. On January 1, Leonard is located 0.83 au from Earth which is more than three times the distance it was at during closest approach on December 12. The geocentric distance more than doubles again to 1.72 au by February 1. Assuming the comet's "normal" non-outburst brightness as the month begins is around magnitude 4.8 or so and assuming a 2.5n of 7.5, Leonard could fade to magnitude 6 by mid-month and 8 by the end of the month, but don't hold me to it.

One thing we can be certain is that the comet will become a more difficult object for all observers as its solar elongation drops from 39 deg on the January 1 to 21 deg on February 1. As January begins, Leonard will already have set by the end of astronomical twilight in the evening sky for most northern hemisphere observers. By January 10, it will be setting before the end of nautical twilight for northerners. Southern hemisphere observers will be able to follow the comet till the end of the month though even then it will be only a few degrees above the horizon at the end of astronomical twilight. Conditions will be at their worst in early to mid-February and then improve afterwards for southern observers though Leonard may have faded to 9-10th magnitude by then. Northern hemisphere observers are out of luck till late April when the comet will be no more than a faint visual object.

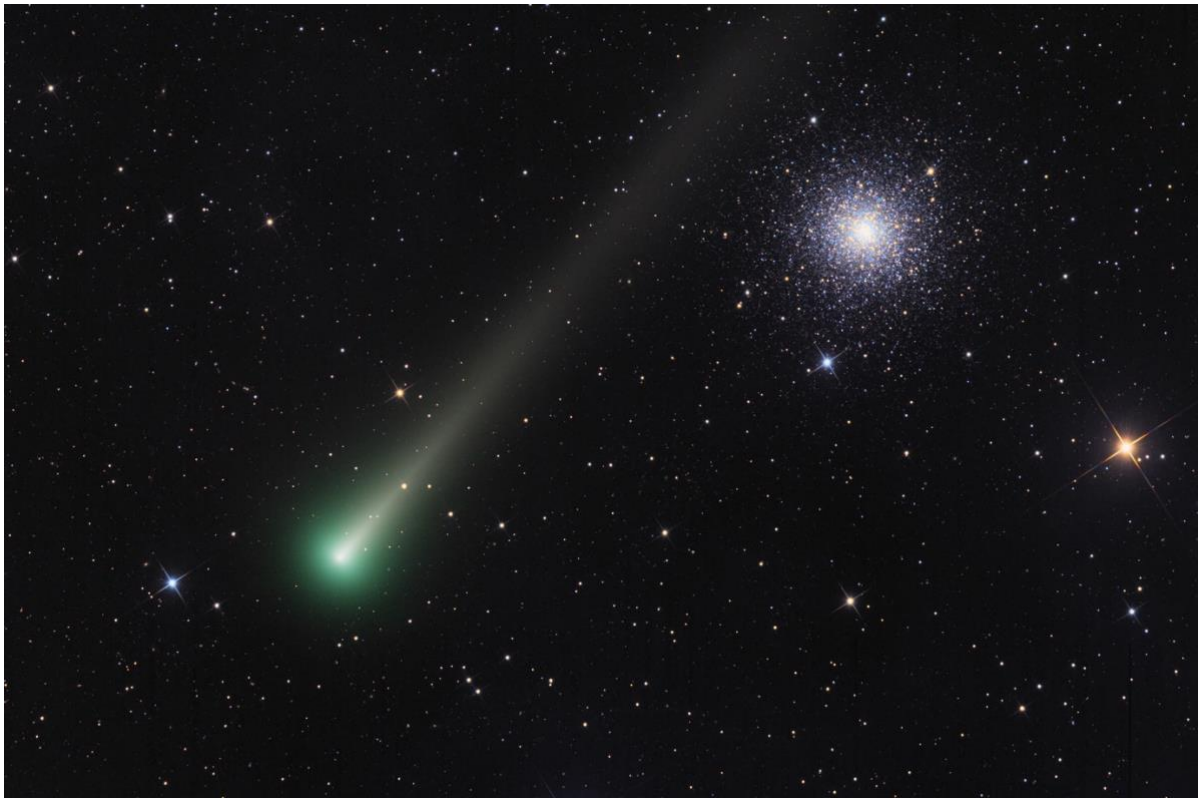


Figure 2 – C/2021 A1 spent the first half of the month in the morning sky. On 2021December 3, the comet passed close to the bright globular cluster M3. Gregg Ruppel caught the pair with his ASA 10N f/3.7 reflector and STL11000M camera.

Figure 3 - Comet Leonard showing a parabolic dust coma (in fact it looks like there are multiple parabolas within the inner coma) and trubulent gas tail. Image was taken by Raymond Nagron from La Parguera, Puerto Rico on 2021 December 27 (23:06 to 23:26 UT) with an Astro-Physics 92 Stowaway, ZWO ASI183MC-Pro camer, and Astronomik L-2 UV-IR blocking filter. The image is a composite of 15x60s exposures.

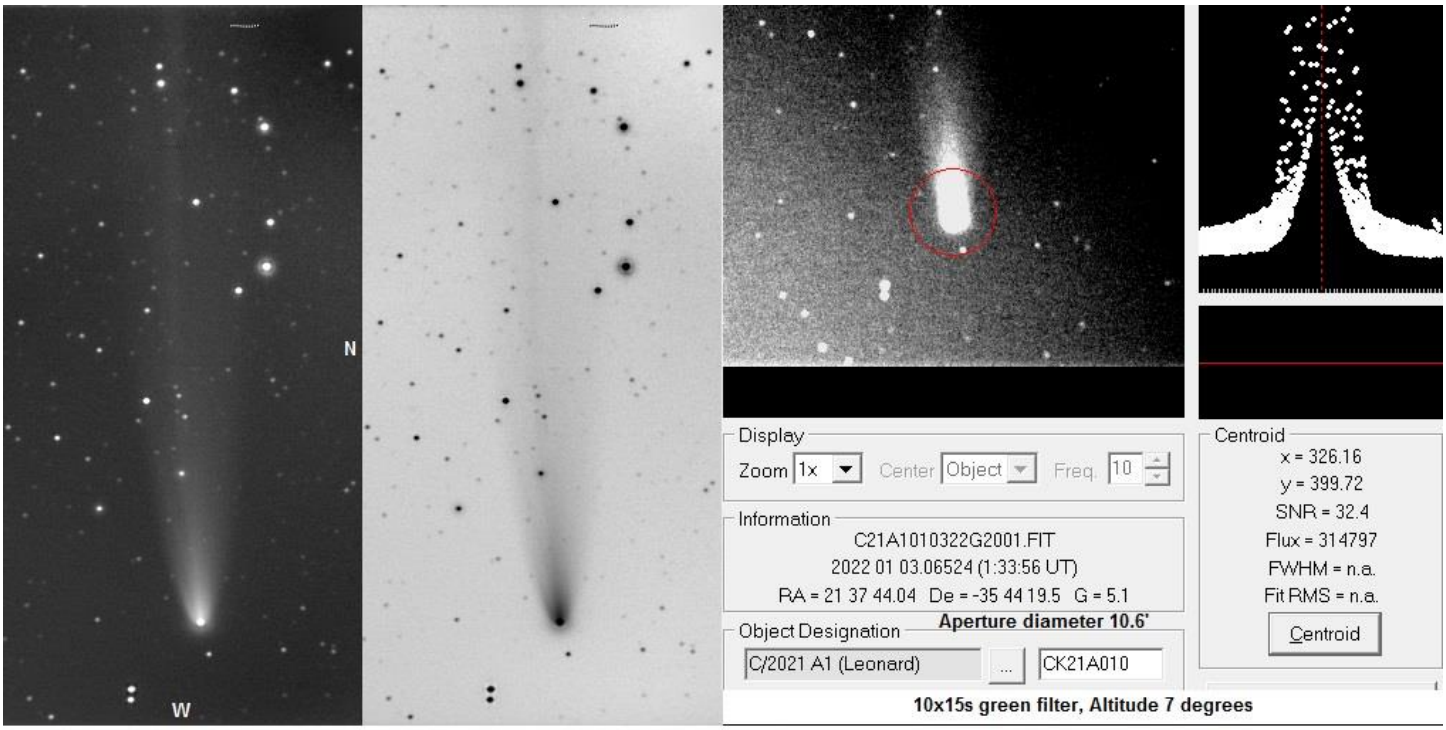


Figure 4 - A recent image of C/Leonard taken by Michael Olason from Tucson, Arizona with a 50mm f/3.5 lens and ST-402ME camera. The image is a composite of 10x30s exposures taken on 2022 January 3.

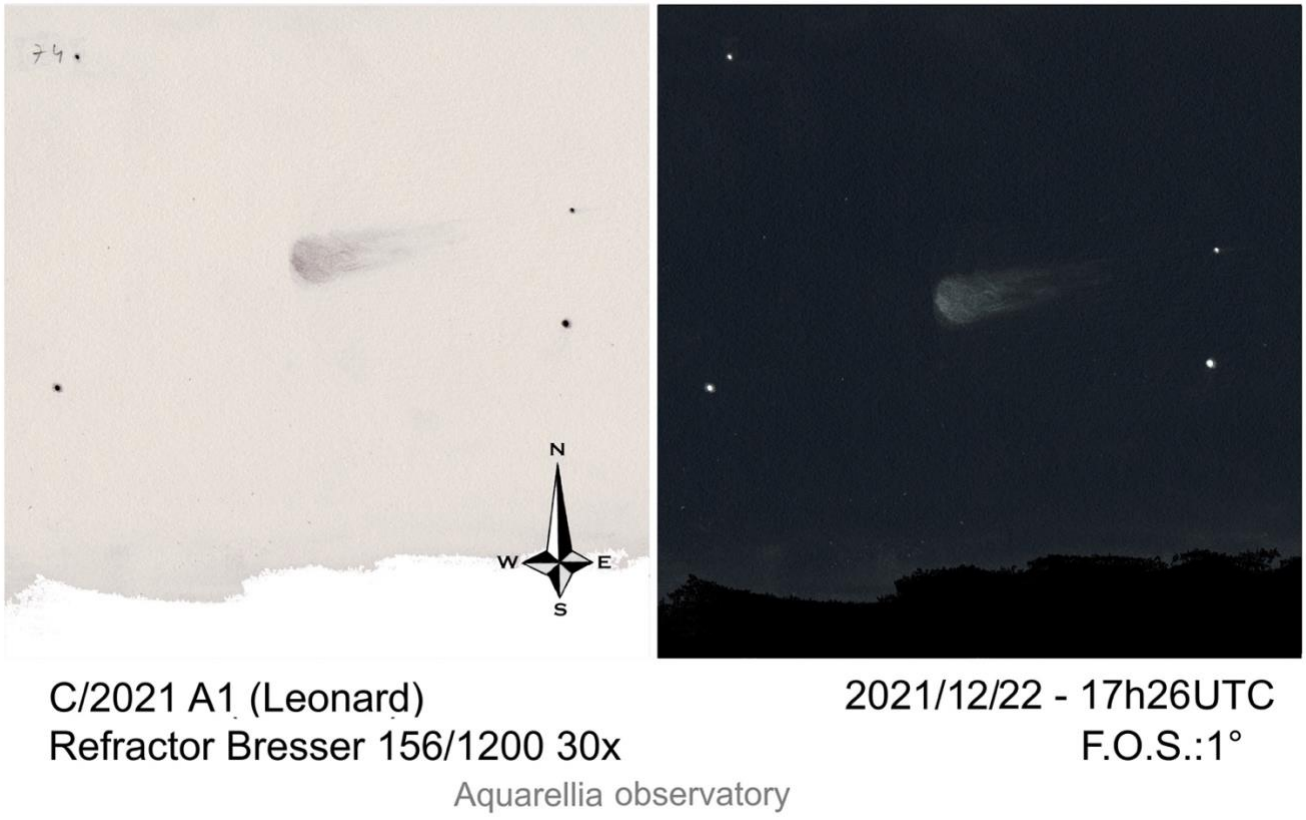


Figure 5 - A visual impression of Leonard on 2021 December 22 as sketched by Michel Deconinck with a Bresser 156mm f/7.7 refractor at 30x.

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-Y10)

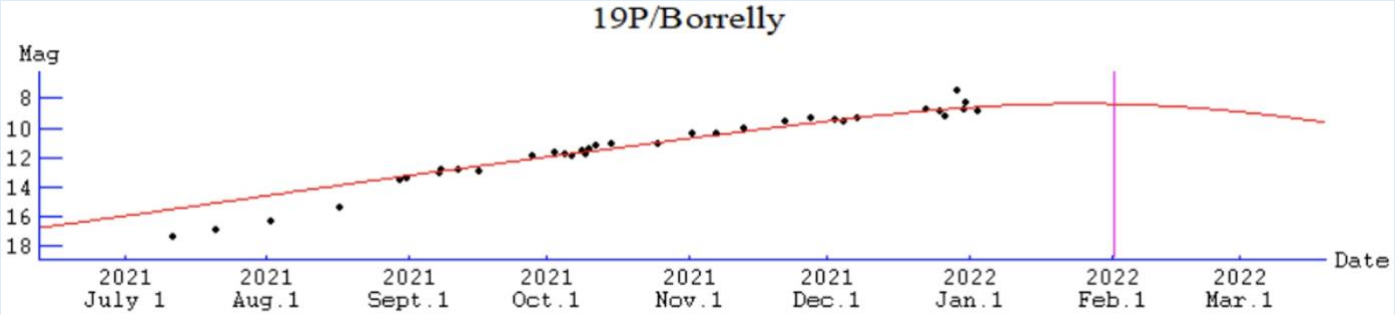
```
  19P/Borrelly
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2022 Feb. 1.82839 TT                                  Rudenko
q   1.3062665            (2000.0)            P             Q
n   0.14400467     Peri.  351.91926     +0.38676925     -0.79278100
a   3.6048317      Node    74.24711     +0.87109013     +0.14641844
e   0.6376345      Incl.   29.30471     +0.30267396     +0.59165862
P   6.84
From 544 observations 2015 Jan. 11-2021 Dec. 15, mean residual 0".7.
     Nongravitational parameters A1 = -0.52, A2 = -0.5264.
```

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
2022 Jan 01  00 18  -18 13    1.360   1.184     77E    Cet    8.6     31   35
2022 Jan 06  00 28  -14 39    1.344   1.190     75E    Cet    8.5     34   32
2022 Jan 11  00 38  -11 02    1.331   1.199     74E    Cet    8.4     37   28
2022 Jan 16  00 49  -07 22    1.321   1.211     73E    Cet    8.4     39   25
2022 Jan 21  01 00  -03 43    1.313   1.224     72E    Cet    8.4     41   22
2022 Jan 26  01 11  -00 04    1.308   1.240     70E    Cet    8.3     43   19
2022 Jan 31  01 23  +03 32    1.306   1.259     69E    Psc    8.4     44   17
2022 Feb 05  01 35  +07 05    1.306   1.281     68E    Psc    8.4     45   14
```

Comet Magnitude Formula & Lightcurve (from ALPO and COBS photometry)

m1 = 5.0 + 5 log d + 23.0 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
 19        2022 01 03.08  S  9.3 TK 12.5B    30   3    5            ICQ xx HER02 Carl Hergenrother
 19        2021 12 31.45 xM  9.5 TK  7.0B    15   9.5  5/           ICQ XX WYA   Chris Wyatt
 19        2021 12 30.83  S  9.1 TK 20.3T10  77   5    4            ICQ XX GON05 Juan Jose Gonzalez Suarez
 19        2021 12 29.47 xM  9.0 TK 25.0L 5  40   7.5  4/           ICQ XX WYA   Chris Wyatt
 19        2021 12 26.72  S  9.6 TI 29.8L 4  79   2.2  3/           ICQ XX HAR11 Christian Harder
 19        2021 12 25.72  S  9.3 TI 29.8L 4  79   3.5  3/           ICQ XX HAR11 Christian Harder
 19        2021 12 02.82  S  9.8 TK 20.3T10  77   6    3/           ICQ XX GON05 Juan Jose Gonzalez Suarez
```

While out observing Leonard in the early evening, don't forget to take the time to observe 19P/Borrelly. The current apparition marks the comet's 16th observed return. Its orbit has been stable since discovery with perihelion staying between 1.30 and 1.46 au (this year it is at 1.31 au so nearly as close as it's been since discovery). The comet approached within 1 au of Earth during its first 4 observed returns (1904, 1911, 1918 and 1925) and peaked between 8th and 10th magnitude. There was a stretch of 6 perihelion passages between 1938

and 1974 when the comet arrived at perihelion almost directly behind the Sun at ~2.3 to 2.5 au from Earth. Returns in 1987 and 1994 were much better with approaches to 0.48 and 0.62 au of Earth when the comet reached magnitude 7.0 to 7.5. 2022 begins a new series of good apparitions. Though still a distant 1.18 au from Earth at its closest this time around, it will come closer in 2028 (0.41 au), 2035 (0.62 au), 2042 (1.13 au), 2084 (1.12 au), 2091 (0.87 au) and 2097 (0.63 au). The next return in 2028 will be Borrelly's best between 1900 and 2100.

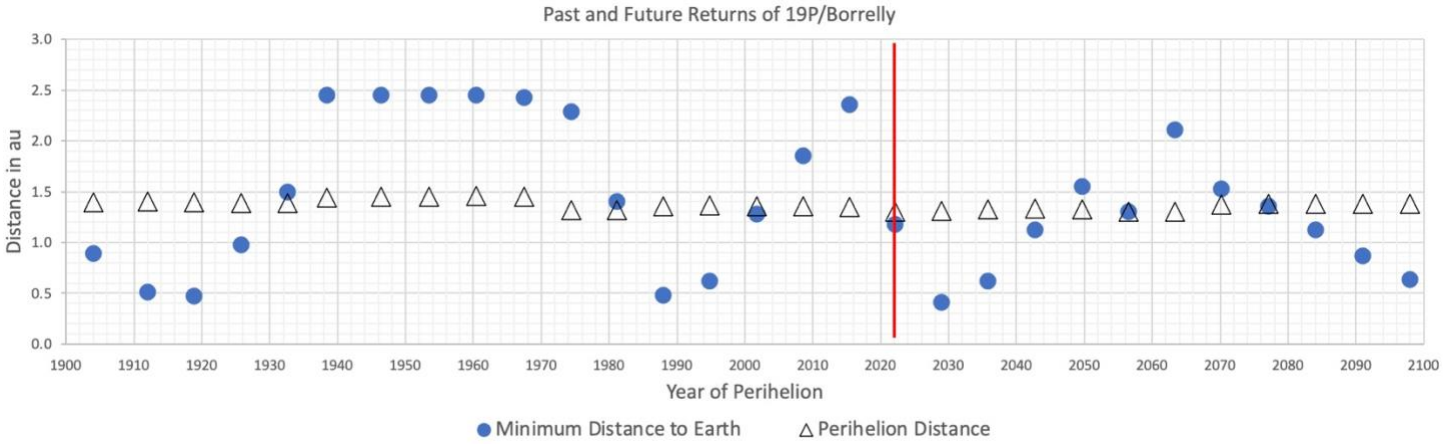


Figure 6 - Orbital evolution of 19P/Borrelly. Red vertical line highlights the current apparition. Ephemeris data from JPL Horizons.

Borrelly is now far enough north to be observed from both hemispheres. In December, Christian Harder, Chris Wyatt and J. J. Gonzalez found Borrelly to be between magnitude 9.0 and 9.8 with a coma between 2.2 and 7.5' but no visually visible tail. January sees the comet in the evening sky moving through Cetus (Jan 1-29) and Pisces (29-31) as it reaches a peak brightness at the end of the month around magnitude 9.5. Borrelly and 104P/Kowal (more below) will approach to within ~7 deg of each other this month. The two will also pass close to many NGC/IC galaxies providing imagers with lots of photo ops (see the Comet Calendar in this report).

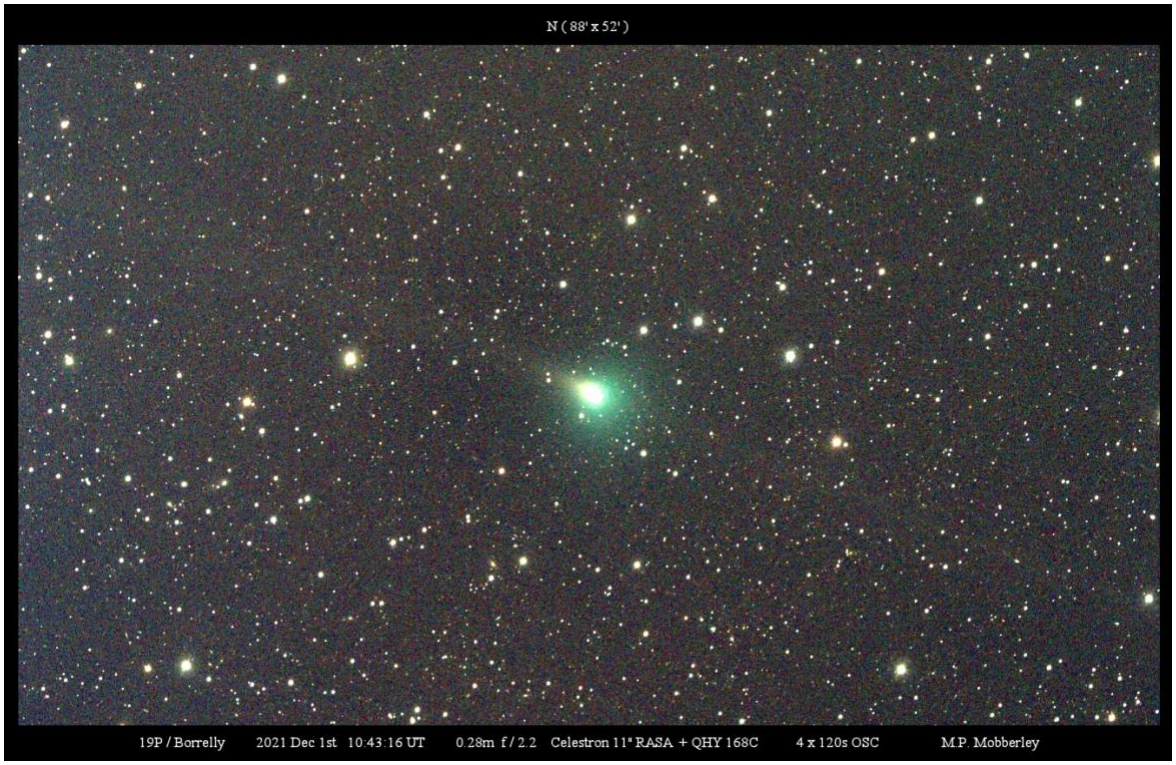


Figure 7 - Image of 19P/Borrelly taken by Martin Mobberley on December 1 with an iTelescopes Celestron RASA 11". The dust trail along Borrelly's orbit extends from the lower right to upper left and runs through the coma of the comet.

67P/Churyumov-Gerasimenko

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

Orbit (from Minor Planet Center, MPEC 2021-Y10)

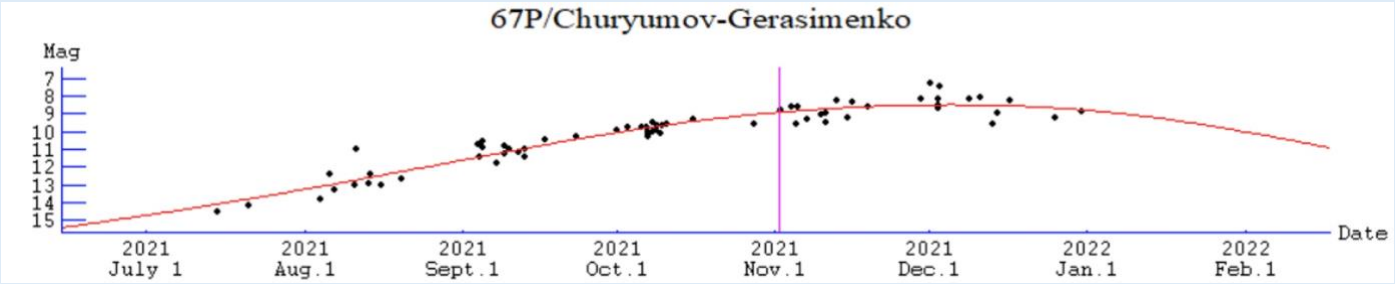
```
  67P/Churyumov-Gerasimenko
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2021 Nov. 2.06610 TT                                  Rudenko
q   1.2106359           (2000.0)            P              Q
n   0.15341014     Peri.   22.13769     +0.52344296     -0.85112109
a   3.4559438      Node    36.33308     +0.77128073     +0.45334146
e   0.6496946      Incl.    3.87159     +0.36212359     +0.26471573
P   6.42
From 8801 observations 1995 July 3-2021 Dec. 16, 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
2022 Jan 01   09 00   +28 26    1.418    0.482   148M    Cnc    8.8     78   22
2022 Jan 06   08 57   +28 42    1.450    0.499   154M    Cnc    8.9     79   21
2022 Jan 11   08 52   +28 54    1.483    0.520   159M    Cnc    9.1     79   21
2022 Jan 16   08 47   +29 02    1.517    0.546   164M    Cnc    9.3     79   21
2022 Jan 21   08 42   +29 04    1.552    0.575   168M    Cnc    9.5     79   21
2022 Jan 26   08 37   +29 00    1.588    0.609   169M    Cnc    9.7     79   21
2022 Jan 31   08 33   +28 51    1.625    0.648   167E    Cnc   10.0     79   21
2022 Feb 05   08 29   +28 37    1.662    0.692   163E    Cnc   10.2     79   21
```

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

m1 = 9.2 + 5 log d + 13.2 log r(t-42)



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 12 30.90  S  9.2 TK 20.3T10  77   5    5   0.3  280 ICQ XX GON05 Juan Jose Gonzalez Suarez
 67        2021 12 25.79  S  9.6 TI 29.8L 4  92   3.5  3/          ICQ XX HAR11 Christian Harder
 67        2021 12 14.68 xM  9.6 TK 40.0L 4  59   3.2  6   15.5m274 ICQ XX WYA   Chris Wyatt
 67        2021 12 13.67 xM 10.2 TK 40.0L 4  59   2.1  6   11.2m279 ICQ XX WYA   Chris Wyatt
 67        2021 12 11.19  S  8.3 TK 10.0B    25   8    5   0.5  290 ICQ XX GON05 Juan Jose Gonzalez Suarez
 67        2021 12 03.13  S  7.4 TK  5.0B 4   7   6    5                PIL01 Uwe Pilz
 67        2021 12 03.05  S  8.8 TI 25.2L 4  68   3.3  4   14.0m280 ICQ XX HAR11 Christian Harder
 67        2021 12 03.00  S  8.4 TK 10.0B    25   7    5/  0.6  290 ICQ XX GON05 Juan Jose Gonzalez Suarez
 67        2021 12 02.98  S  9.0 TK 20.3T10  77   4    5   0.4  290 ICQ XX GON05 Juan Jose Gonzalez Suarez
 67        2021 12 01.49  Z  8.5 U4  7.2R 5a300  13.2     >0.7  329 ICQ xx HER02 Carl Hergenrother
```

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 occurring back on 2021 November 2 at 1.21 au and closest approach to Earth at 0.42 au on November 12. The close approach makes this the comet's best return since 1982 when it came marginally closer

to Earth at 0.39 au. This is also the best apparition throughout the remainder of the century. Contrary to a few news articles out there saying 67P "…will disappear for 200 years", there will be similar, though slightly larger, approaches to Earth in 2034 (0.45 au), 2067 (0.44 au), and 2080 (0.49 au). The reason 67P won't get quite as close as in 2021 is due to approaches to Jupiter in 2030 and 2078 which act to increase 67P's perihelion distance from 1.21 au to between 1.26 and 1.34 au from 2030 to 2100 and beyond.

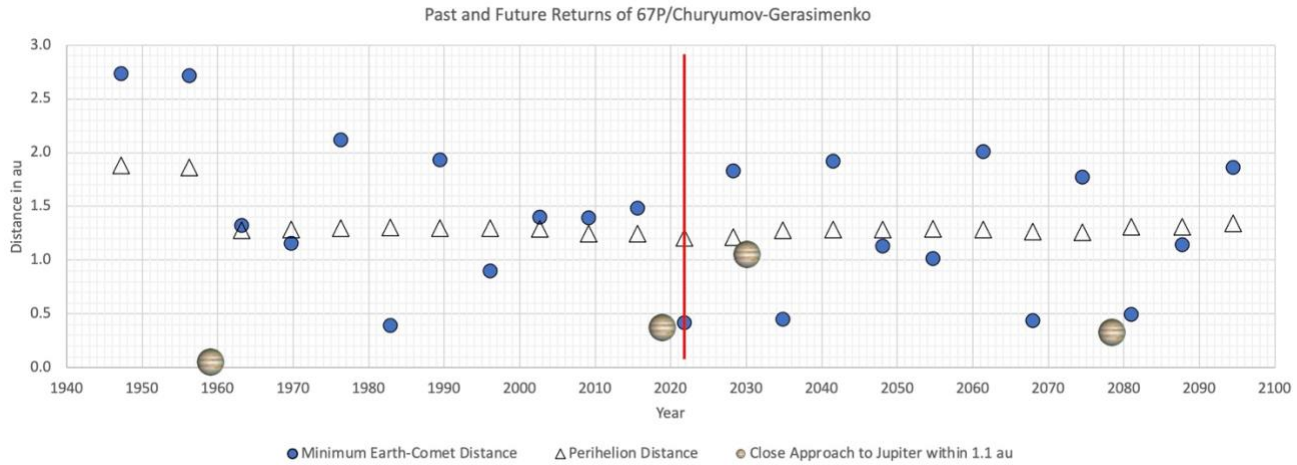


Figure 8 - Orbital evolution of 67P/C-G. Red vertical line highlights the current apparition. Ephemeris data from JPL Horizons.

Though perihelion and close approach to Earth both occurred in November, the comet likely peaked in brightness in early December around magnitude 8 to 9. Visual observations from December found a coma between 2 and 8' in diameter and a tail up to 0.6 deg in length. Imagers detected not only a long broad dust tail but also a narrow thin dust trail both leading the following the comet along its orbit. During December 67P will be in Cancer near opposition (opposition occurs on January 26). It should fade from around magnitude ~9.0 to ~10.0 over the course of the month.

Figure 9 – 67P/C-G showing both a long dust tail and dust trail in images taken by Dan Bartlett on 2021 December 5 with a RASA11 and ASI183MC-Pro. The image consists of 103 120s exposures.

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 Minor Planet Center, MPEC 2021-W138)

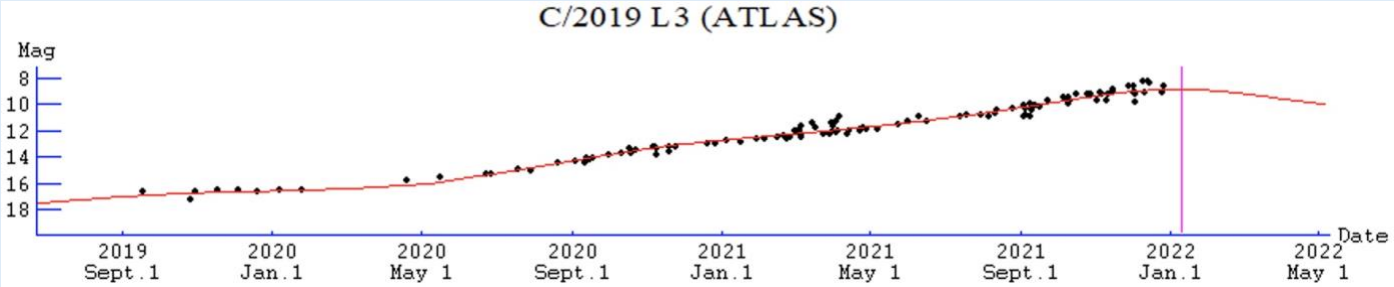
```
        C/2019 L3 (ATLAS)
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2022 Jan.  9.61923 TT                                  Rudenko
q   3.5545083            (2000.0)            P              Q
z  -0.0004535      Peri.  171.61063     -0.26052045     -0.66630835
 +/-0.0000003      Node   290.79018     +0.83675988     +0.20517934
e   1.0016118      Incl.   48.36122     +0.48162433     -0.71689234
From 2998 observations 2019 June 10-2021 Nov. 29, 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
2022 Jan 01   07 12   +32 56    3.555   2.586   168M    Gem    8.9    83   17
2022 Jan 06   07 07   +32 01    3.554   2.581   170M    Gem    8.9    82   18
2022 Jan 11   07 02   +31 03    3.554   2.583   169E    Gem    8.9    81   19
2022 Jan 16   06 57   +30 03    3.555   2.595   165E    Gem    8.9    80   20
2022 Jan 21   06 52   +29 02    3.556   2.615   160E    Gem    8.9    79   21
2022 Jan 26   06 48   +28 00    3.557   2.643   154E    Gem    8.9    78   22
2022 Jan 31   06 44   +26 58    3.559   2.679   149E    Gem    9.0    77   23
2022 Feb 05   06 41   +25 57    3.562   2.722   143E    Gem    9.0    76   24
```

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

```
m1 =  4.6 + 5 log d +  9.0 log r [through T-600 days; T = date of perihelion]
m1 = -4.4 + 5 log d + 20.2 log r [T-600 days to T-0]
m1 =  1.2 + 5 log d + 10.0 log r [T-0 and onwards, assumed]
```



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 30.87  S  9.3 TK 20.3T10  77    3    6   0.2  310 ICQ XX GON05 Juan Jose Gonzalez Suarez
   2019L3  2021 12 29.49 xM  9.0 TK 25.0L 5  40    3.0  6            ICQ XX WYA   Chris Wyatt
   2019L3  2021 12 26.74  S  9.1 TI 29.8L 4  92    2.8  4/   4.0m315 ICQ XX HAR11 Christian Harder
   2019L3  2021 12 25.77  S  9.6 TI 29.8L 4  92    1.7  4/   7.0m310 ICQ XX HAR11 Christian Harder
   2019L3  2021 12 14.67 xM  9.5 TK 40.0L 4  59    3.2  6   10.0m287 ICQ XX WYA   Chris Wyatt
   2019L3  2021 12 13.66 xM  9.4 TK 40.0L 4  59    3.5  6    9.2m267 ICQ XX WYA   Chris Wyatt
   2019L3  2021 12 11.21  S  9.4 TK 10.0B    25    6    6            ICQ XX GON05 Juan Jose Gonzalez Suarez
   2019L3  2021 12 03.13  S  9.9 TK  7.0B 6  16    2.5               ICQ XX PIL01 Uwe Pilz
   2019L3  2021 12 03.07  S  9.5 TI 25.2L 4  78    3    4/   6.0m325 ICQ XX HAR11 Christian Harder
   2019L3  2021 12 02.96  S  9.6 TK 20.3T10  77    5    6   0.2  300 ICQ XX GON05 Juan Jose Gonzalez Suarez
   2019L3  2021 12 02.78  S  9.7 TI 29.8L 4  92    1.9  4/           ICQ XX HAR11 Christian Harder
   2019L3  2021 12 01.50  Z  9.2 U4  7.2R 5a300  11.0      0.14 329 ICQ xx HER02 Carl Hergenrother
```

Hanging out just one constellation over from 67P is C/2019 L3 (ATLAS). The two comets make a nice pair as both are around magnitude 9 and near maximum brightness. Unlike 67P which is now a few weeks after

perihelion, C/2019 L3 arrives at perihelion this month on the 9th. Though both comets are around 9th magnitude, ATLAS is intrinsically brighter as it is located much further from the Sun (3.55 au) and Earth (2.6 au) than 67P (1.5 au from the Sun and 0.5-0.6 au from Earth).

Several visual observations were reported by J. J. Gonzalez, Christian Harder, Uwe Pilz, and Chris Wyatt in December finding the comet between magnitude 9.0 and 9.9. The coma was reported as moderately condensed (DCs from 4.5 to 6) and between 1.7' and 6' in diameter. An image by Carl Hergenrother found a much larger coma with a diameter of 11'. Visual and imagers detected a tail up to 0.2 deg in length.

C/2019 L3 (ATLAS) is at opposition early in the month as it moves through Gemini. Its location near opposition and the ecliptic means it is observable from both hemispheres. Though its distance to the Sun changes very little this month, the comet should fade as it moves away from Earth (from 2.58 to 2.68 au). Orbit plane crossing happens on January 11 so imagers should be on the lookout for any sign of a dust trail.

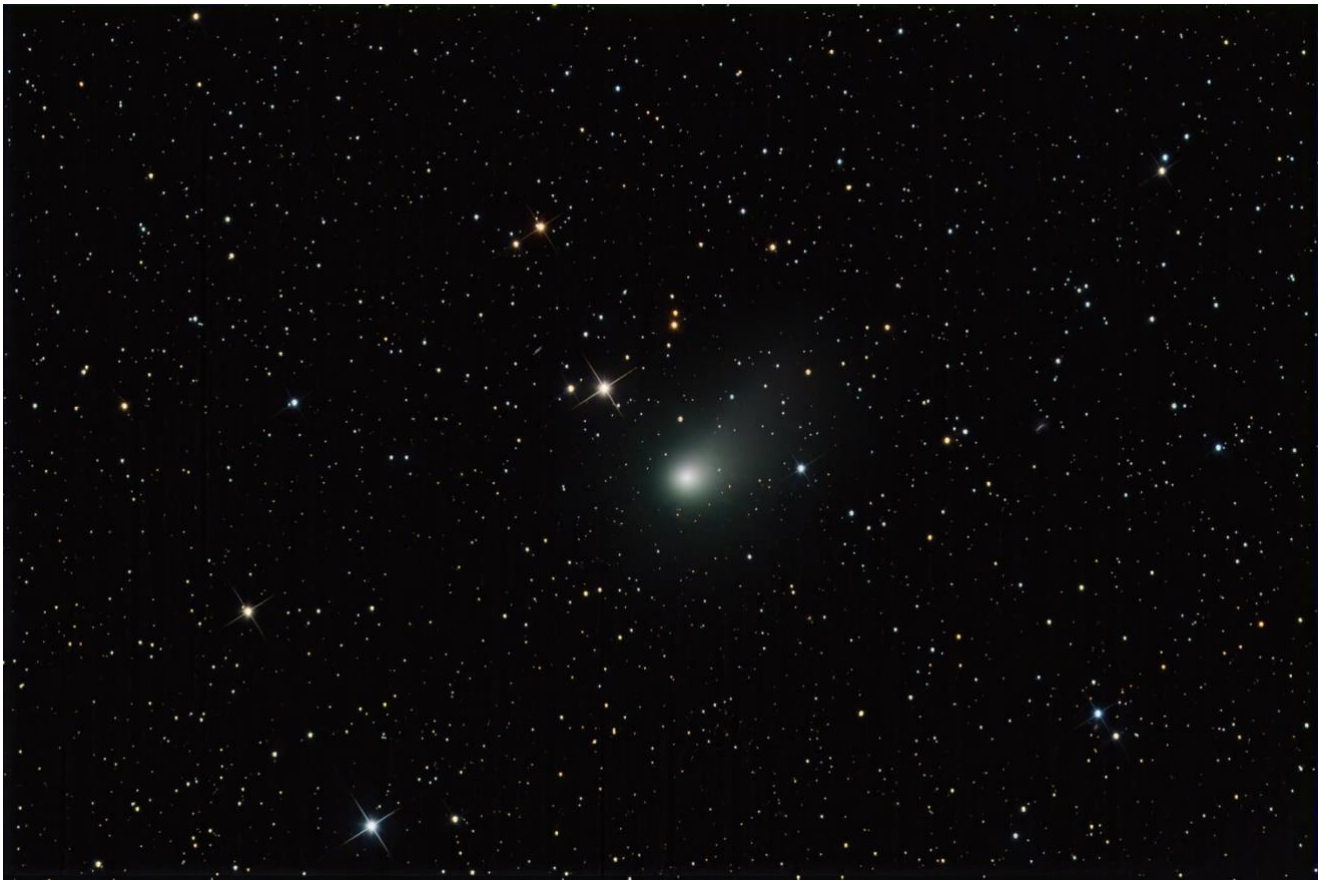


Figure 10 - C/2019 L3 (ATLAS) as imaged by Gregg Ruppel on 2021 December 11 with a ASA 10N f/3.7 astrograph and STL11000M camera. Image is a color composite LRGB of 20:20:20:20 minutes (80 min total).

Comets Between Magnitude 10 and 13

4P/Faye

Discovered visually on 1843 November 23 by the Herve Faye

Orbit (from MPEC 2021-Y10)

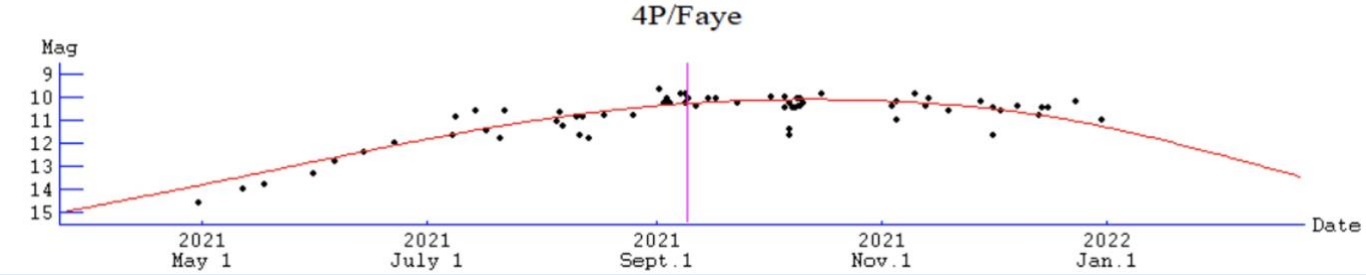
```
   4P/Faye
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2021 Sept. 8.84427 TT                                  Rudenko
q   1.6189095            (2000.0)            P              Q
n   0.13180036     Peri.  207.00487     +0.76775831     -0.63998070
a   3.8240626      Node   192.93064     +0.61015802     +0.74510050
e   0.5766519      Incl.    8.00832     +0.19558724     +0.18774972
P   7.48
From 5965 observations 1998 May 24-2021 Dec. 17, mean residual 0".9.
     Nongravitational parameters A1 = +0.57, A2 = -0.0280.
```

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
2022 Jan 01   06 32  +07 25    1.973    1.009    164E   Mon   11.3     57   43
2022 Jan 06   06 28  +07 43    2.000    1.040    162E   Mon   11.5     58   42
2022 Jan 11   06 25  +08 05    2.028    1.077    159E   Mon   11.7     58   42
2022 Jan 16   06 22  +08 30    2.056    1.120    155E   Mon   11.9     59   41
2022 Jan 21   06 20  +08 58    2.084    1.168    151E   Mon   12.1     59   41
2022 Jan 26   06 19  +09 28    2.113    1.221    146E   Ori   12.3     59   41
2022 Jan 31   06 18  +09 58    2.142    1.279    141E   Ori   12.5     60   40
2022 Feb 05   06 18  +10 29    2.171    1.341    137E   Ori   12.7     60   39
```

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

```
m1 = 5.9 + 5 log d + 18.3 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 12 14.69 xM 12.0 AQ 40.0L 4 108   1.4   6    4.5m297 ICQ XX WYA   Chris Wyatt
  4        2021 12 13.69 xM 12.3 AQ 40.0L 4 108   0.8   6    3.2m275 ICQ XX WYA   Chris Wyatt
  4        2021 12 03.22  S 10.8 TK 20.3T10 100   3     2/          ICQ XX GON05 Juan Jose Gonzalez Suarez
  4        2021 12 01.47  Z 11.7 U4  7.2R 5a360   2.2       0.06 283 ICQ xx HER02 Carl Hergenrother
```

Faye's 22nd observed return has reached its maximum brightness with the comet now weeks after perihelion (1.62 au on Sep. 8) and closest approach to Earth (0.94 au on Dec. 5). Faye should fade from around magnitude 11.5 to 13.0 this month as it moves through the evening constellations of Monoceros (Jan 1-23) and Orion (23-31).

6P/d'Arrest

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

Orbit (from MPEC 2021-Y10)

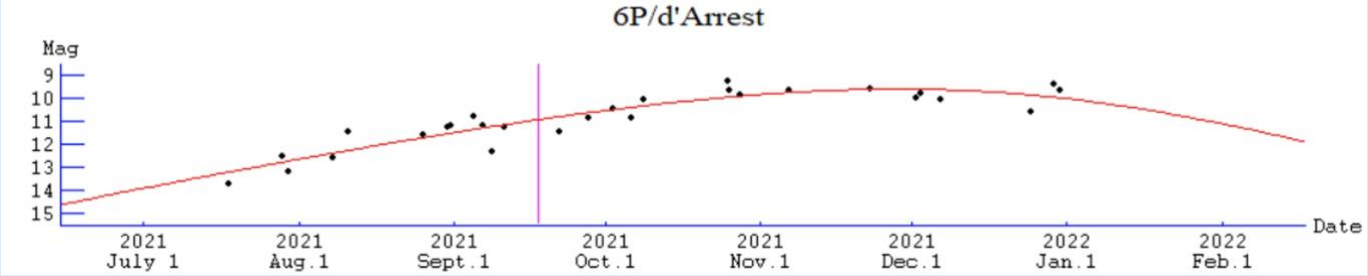
```
   6P/d'Arrest
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2021 Sept. 17.76117 TT                                  Rudenko
q   1.3545380            (2000.0)            P              Q
n   0.15067344     Peri.  178.08852     +0.73289133     +0.64399341
a   3.4976653      Node   138.93495     -0.62855292     +0.76434198
e   0.6127308      Incl.   19.51219     -0.26036806     -0.03246250
P   6.54
From 3261 observations 1987 Mar. 31-2021 Dec. 15, 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
2022 Jan 01  23 56  -19 27   1.785    1.827     71E    Cet   10.0    29   32
2022 Jan 06  00 08  -18 03   1.819    1.899     70E    Cet   10.2    30   30
2022 Jan 11  00 20  -16 39   1.853    1.971     68E    Cet   10.3    30   28
2022 Jan 16  00 31  -15 16   1.887    2.045     66E    Cet   10.5    30   27
2022 Jan 21  00 43  -13 54   1.921    2.120     64E    Cet   10.7    30   25
2022 Jan 26  00 54  -12 33   1.956    2.196     62E    Cet   10.9    30   24
2022 Jan 31  01 04  -11 13   1.991    2.272     61E    Cet   11.1    29   23
2022 Feb 05  01 15  -09 56   2.027    2.349     59E    Cet   11.3    29   22
```

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

```
m1 = 5.3 + 5 log d + 25.7 log r(t-95)
```



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
  6        2021 12 30.82  S 10.0 TK 20.3T10  77   6    2           ICQ XX GON05 Juan Jose Gonzalez Suarez
  6        2021 12 29.48 xS 10.4 TK 25.0L 5  40   6.5  3           ICQ XX WYA   Chris Wyatt
  6        2021 12 02.83  S 10.1 TK 20.3T10  77   6    2           ICQ XX GON05 Juan Jose Gonzalez Suarez
```

6P/d'Arrest is also past its perihelion [T = 2021 September 17 @ 1.35 au]. Due to an asymmetrical lightcurve, the comet peaked in brightness in December. Visual observations by Chris Wyatt and J. J. Gonzalez found the comet to be between magnitude 10.0 and 10.4. January should see the comet fade from around magnitude 10.0 to 11.1.

This month, 6P is an evening object moving through Cetus. Though better placed for southern observers, it is observable from both hemispheres. Like C/2019 L3, d'Arrest has an orbit plane crossing this month (on February 7).

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-Y10)

```
  29P/Schwassmann-Wachmann
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2019 Apr. 4.85534 TT                                  Rudenko
q   5.7713412            (2000.0)            P              Q
n   0.06636469     Peri.   49.81497     +0.99174163     -0.04468714
a   6.0419623      Node   312.38187     -0.02058557     +0.86971592
e   0.0447903      Incl.    9.36627     +0.12658896     +0.49152545
P  14.9
From 11913 observations 2018 June 18-2021 Dec. 16, 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
2022 Jan 01  04 21  +31 01   5.945   5.092   147E   Per  11-13    81   19
2022 Jan 06  04 20  +30 49   5.946   5.139   142E   Tau  11-13    81   19
2022 Jan 11  04 18  +30 38   5.947   5.192   136E   Tau  11-13    81   19
2022 Jan 16  04 17  +30 27   5.949   5.250   131E   Tau  11-13    81   19
2022 Jan 21  04 16  +30 17   5.950   5.313   126E   Tau  11-13    80   18
2022 Jan 26  04 15  +30 07   5.952   5.381   121E   Tau  11-13    80   18
2022 Jan 31  04 15  +29 57   5.953   5.452   116E   Tau  11-13    80   17
2022 Feb 05  04 15  +29 48   5.955   5.527   111E   Tau  11-13    80   16
```

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 30.86  S 10.5 TK 20.3T10  77   7    1/           ICQ XX GON05 Juan Jose Gonzalez Suarez
 29        2021 12 02.84  S 10.2 TK 20.3T10  77   6    2            ICQ XX GON05 Juan Jose Gonzalez Suarez
 29        2021 12 02.77  S 11.3 TI 29.8L 4 108   3    1            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 was especially active with multiple outbursts observed between September and November. While the high rate of outbursts seems to have ended, the comet is still relatively bright, for 29P that is, at magnitude 10.0 to 11.0. Perhaps due to its large distance of 5.95 au from the Sun, dust released from last year's outbursts have been slow to disperse with visual observers still reporting a large coma of 6-7' diameter. December coma diameters measured from images and submitted to COBS were as large as 11'.

29P is an evening object in Perseus (Jan 1-2) and Taurus (2-31) 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). Not to sound like a broken record, but imagers should also be on the lookout for any features due to an orbit plane crossing on February 1.

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-Y10)

```
  57P/du Toit-Neujmin-Delporte
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2021 Oct. 17.39698 TT                                Rudenko
q   1.7200345            (2000.0)            P             Q
n   0.15397449     Peri.  115.25495     +0.55935840     +0.82889123
a   3.4474941      Node   188.76829     -0.77729959     +0.52132110
e   0.5010769      Incl.    2.85132     -0.28796445     +0.20288822
P   6.40
From 1158 observations 2015 Feb. 18-2021 Dec. 15, 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
2022 Jan 01  21 35  -13 19   1.854   2.471    41E   Cap  11-13   19    2
2022 Jan 06  21 48  -12 20   1.871   2.518    39E   Cap  11-13   18    0
2022 Jan 11  22 00  -11 19   1.889   2.566    37E   Aqr  11-13   17    0
2022 Jan 16  22 13  -10 16   1.908   2.614    36E   Aqr  11-13   16    0
2022 Jan 21  22 25  -09 12   1.927   2.661    34E   Aqr  11-13   14    0
2022 Jan 26  22 37  -08 07   1.947   2.709    32E   Aqr  11-13   13    0
2022 Jan 31  22 48  -07 01   1.968   2.756    30E   Aqr  11-13   11    0
2022 Feb 05  23 00  -05 55   1.989   2.803    28E   Aqr  11-13    9    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
None
```

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 independently 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.

No observations of 57P were reported to the ALPO in December. There are four imaging observations on the COBS site, and all suggest the comet is holding steady around magnitude 12. 57P remains an evening object in Capricornus (Jan 1-10) and Aquarius (10-31) and should fade as it moves away from the Sun (1.85 to 1.97 au) and Earth (2.47 to 2.76 au).

104P/Kowal

Photographically discovered on 1979 January 27 by Charles Kowal at Palomar Observatory
Previously visually discovered, but not confirmed, by Reverend Leo Boethin on 1973 January 11
Jupiter-family comet with orbital period of 5.7 years

Orbit (from Minor Planet Center, MPEC 2021-Y10)

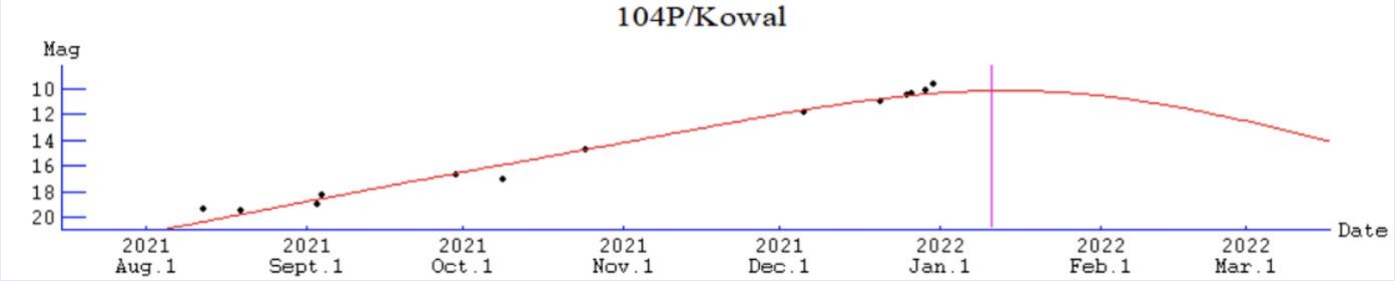
```
104P/Kowal
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2022 Jan. 11.62528 TT                                  Rudenko
q   1.0730776            (2000.0)            P              Q
n   0.17169933     Peri.  227.25288     +0.26948903     -0.96193141
a   3.2059517      Node   207.21206     +0.91001809     +0.26980953
e   0.6652858      Incl.    5.70122     +0.31502816     +0.04348312
P   5.74
From 515 observations 2016 Jan. 3-2021 Dec. 16, mean residual 0".8.
     Nongravitational parameters A1 = +1.62, A2 = -1.0625.
```

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

```
104P/Kowal                                                          Max El
                                                                     (deg)
    Date       R.A.    Decl.      r        d     Elong  Const  Mag   40N  40S
2022 Jan 01   00 06   -05 10    1.079    0.665     79E    Psc  10.3    43   25
2022 Jan 06   00 26   -03 56    1.073    0.653     79E    Psc  10.2    44   24
2022 Jan 11   00 46   -02 33    1.071    0.642     79E    Cet  10.2    45   24
2022 Jan 16   01 08   -01 03    1.073    0.633     80E    Cet  10.1    47   24
2022 Jan 21   01 31   +00 32    1.080    0.626     80E    Cet  10.2    48   25
2022 Jan 26   01 55   +02 13    1.090    0.623     82E    Cet  10.3    50   25
2022 Jan 31   02 20   +03 57    1.105    0.623     83E    Cet  10.5    51   26
2022 Feb 05   02 46   +05 40    1.123    0.628     85E    Cet  10.7    53   27
```

Comet Magnitude Formula (from ALPO and COBS data)

```
m1 = 10.2 + 5 log d + 30.6 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
104        2021 12 30.84  S  9.9 TK 20.3T10  77   7    3           ICQ XX GON05 Juan Jose Gonzalez Suarez
104        2021 12 29.47 xM 10.5 TK 25.0L 5  40   5.0  3/          ICQ XX WYA   Chris Wyatt
104        2021 12 26.72  S 10.8 TI 29.8L 4  92   2.5  2           ICQ XX HAR11 Christian Harder
104        2021 12 25.75  S 10.9 TI 29.8L 4  92   3    2           ICQ XX HAR11 Christian Harder
```

Short-period comet 104P/Kowal was discovered on 1979 January 27, 28, and 29 at 17th magnitude by Charles Kowal on photographic plates taken with the 1.2-m Schmidt on Mount Palomar. 104P was one of 6 periodic comets discovered by Kowal. In addition to 104P, he also found 95P/Chiron, 99P/Kowal, 134P/Kowal-Vavrova, 143P/Kowal-Mrkos, and 158P/Kowal-LINEAR.

The story of 104P didn't start with Kowal's discovery. Reverend Leo Boethin was a missionary living near Bangued in the Philippines who regularly hunted for comets visually with a 0.2-m reflector. Between 1965 and

1973, he reported 3 comet discoveries which were subsequently lost due to slow communications between the Philippines and the Central Bureau of Astronomical Telegrams (CBAT) (the organization responsible for announcing comet discoveries) in Cambridge, Massachusetts. As a result, none of these discoveries were confirmed by others. Boethin would eventually find success with the discovery of 85D/Boethin in 1975.

In 2003, former ALPO Comets Section Coordinator Gary Kronk and CBAT/MPC Director Brian Marsden found that one of Boethin's unconfirmed comets was an early sighting of 104P/Kowal. Boethin found the comet to be around magnitude 9.5 on 1973 January 11 and 12, but considerably fainter at magnitude 13 by the night of the 14th [IAUC 8255]. Based on Boethin's report and the fact that it was "discovered" ~5 months after its 1972 perihelion, it is likely the comet had experienced a major outburst.

Following its 1979 discovery apparition, 104P would pass unseen at its 1985 return. In November 1991, Masao Ishikawa would serendipitously rediscover the comet at 14th magnitude with a 0.16-m hyperboloid astrograph [IAUC 5406]. Since 1991, it was also seen at returns in 1998, 2004, and 2016 (though missed in 2010). This makes 2022, its 7th observed return.

The perihelion distance of 104P has decreased in a step like pattern since its original sighting in 1973 from 1.53 to its current 1.07 au due to series of close approaches to Jupiter. Another approach to 0.62 au of Jupiter in 2031 will result in yet another decrease, this time to a perihelion at 0.98 au at its 2033 return. The current return will see 104P's smallest observed distance to Earth at 0.64 au. Even closer approaches are possible during the remainder of the century in 2039 (0.40 au), 2049 (0.25 au), 2060 (0.07 au), 2071 (0.39 au), 2082 (0.59 au), and 2093 (0.31 au). As a result, 104P may become a routine small telescope object in the future.

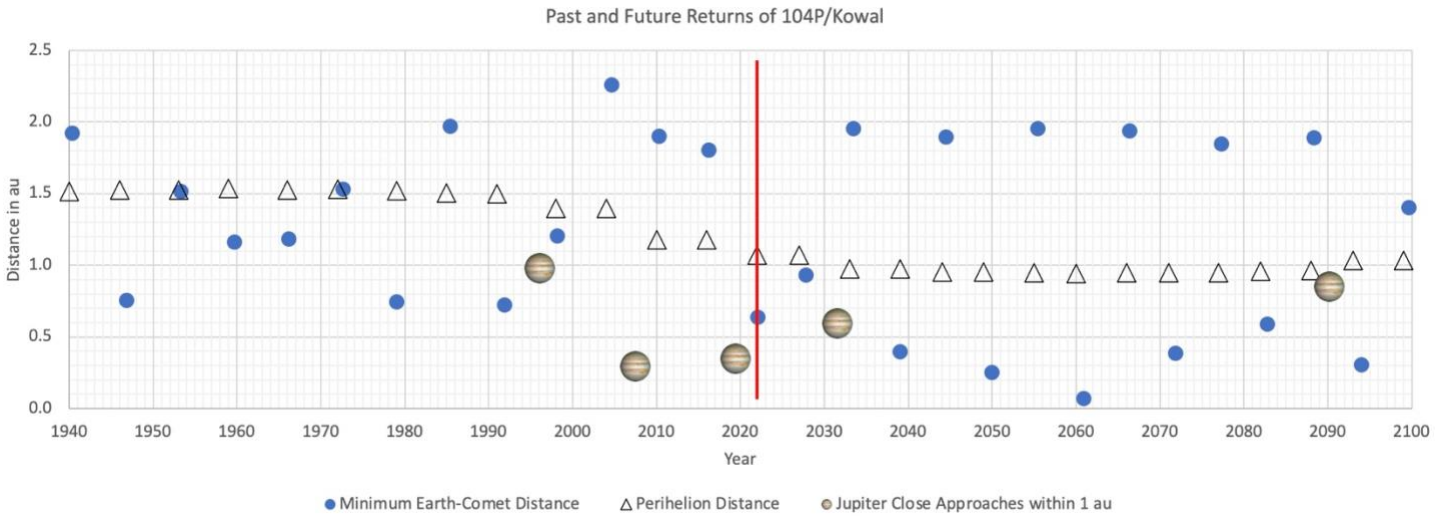


Figure 11 - Orbital evolution of 104P/Kowal. Red vertical line highlights the current apparition. Ephemeris data from JPL Horizons.

As recently as late October, CCD photometry submitted to the COBS site placed 104P at 16-17th magnitude. Since then, the comet has rapidly brightened with visual observations from the end of December by Chris Wyatt and Christian Harder placing Kowal between magnitude 10.5 and 10.9. With perihelion on 2022 January 11, the comet should start the month near its peak brightness between magnitude 10.0 and 10.5. It is an evening object and well placed for observation from both hemispheres in Pisces (Jan 1-6) and Cetus (6-31).

104P and 19P will approach to within 7.7 deg of each other on January 16. Both comets will have numerous photo opportunities with NGC and IC galaxies throughout the month. In some cases, both comets will pass extremely close to the same galaxies though on different dates (for example, 104P passes within 12' of the galaxies NGC 426, 429, 430 & IC 1643 while 19P passes ~30' from the same group two nights later.) See an expanded list of close comet-galaxy pairings in the Comet Calendar section of this report.

C/2017 K2 (PANSTARRS)

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

Orbit (from MPEC 2021-Y10)

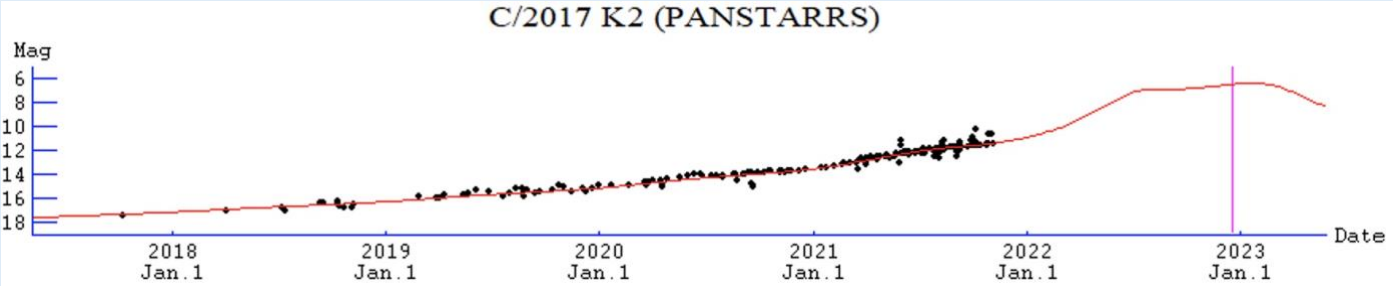
```
    C/2017 K2 (PANSTARRS)
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2022 Dec. 19.6921 TT                                  Rudenko
q   1.797116             (2000.0)            P             Q
z  -0.000389       Peri.  236.1933      +0.0182544      +0.0492546
 +/-0.0000008      Node    88.2367      -0.1810169      +0.9824432
e   1.000700       Incl.   87.5589      -0.9833106      -0.1799429
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
2022 Jan 01  17 57  +13 17   4.396   5.127     38M   Oph   10.9    14    0
2022 Jan 06  18 01  +12 56   4.351   5.072     38M   Oph   10.9    17    0
2022 Jan 11  18 05  +12 37   4.306   5.013     40M   Oph   10.8    20    0
2022 Jan 16  18 09  +12 20   4.261   4.948     41M   Oph   10.8    23    0
2022 Jan 21  18 13  +12 06   4.217   4.879     43M   Oph   10.7    25    0
2022 Jan 26  18 17  +11 53   4.172   4.806     45M   Oph   10.6    27    0
2022 Jan 31  18 21  +11 43   4.127   4.728     47M   Oph   10.6    30    0
2022 Feb 05  18 25  +11 35   4.082   4.646     49M   Oph   10.5    32    0
```

Comet Magnitude Formula (from ALPO and COBS data)

```
m1 =  2.7 + 5 log d + 7.3 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
None
```

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 having only passed through solar conjunction last month. Being located north of the Sun, it remains invisible to southern hemisphere observers until next month. Northern observers with a clear and dark northern horizon should be able to watch K2 brighten from around magnitude 10.9 to 10.6 this month in the morning sky.

C/2019 T4 (ATLAS)

Discovered 2019 October 9 by the ATLAS survey
Dynamically old long-period comet

Orbit (from MPEC 2021-Y10)

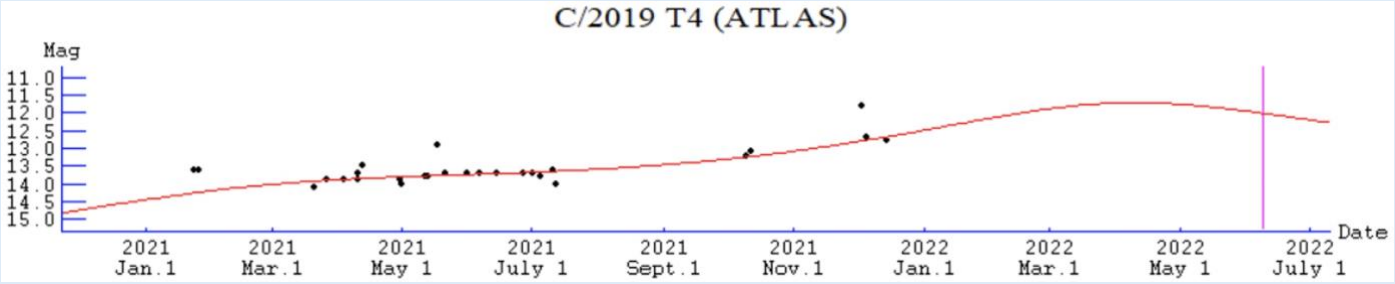
```
    C/2019 T4 (ATLAS)
Epoch 2022 Jan. 21.0 TT = JDT 2459600.5
T 2022 June  9.1704 TT                                  Rudenko
q   4.242379              (2000.0)            P             Q
z  +0.000975       Peri.  351.2060      -0.9599190      +0.0561616
 +/-0.0000010      Node   199.9403      -0.1820578      -0.8698296
e   0.995864       Incl.   53.6260      -0.2130974      +0.4901452
1/a(orig) = +0.000621 AU**-1, 1/a(fut) = +0.000960 AU**-1.
```

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

```
C/2019 T4 (ATLAS)                                                    Max El
                                                                      (deg)
    Date      R.A.   Decl.     r       d    Elong  Const  Mag    40N  40S
2022 Jan 01  12 00  -29 28   4.443   4.374    87M   Hya  12.5     20   55
2022 Jan 06  12 02  -29 36   4.431   4.291    91M   Hya  12.4     20   60
2022 Jan 11  12 04  -29 40   4.420   4.208    95M   Hya  12.4     20   64
2022 Jan 16  12 06  -29 42   4.408   4.126   100M   Hya  12.3     20   69
2022 Jan 21  12 07  -29 40   4.397   4.045   104M   Hya  12.3     20   74
2022 Jan 26  12 07  -29 35   4.386   3.966   108M   Hya  12.2     20   78
2022 Jan 31  12 08  -29 26   4.376   3.889   113M   Hya  12.2     20   79
2022 Feb 05  12 08  -29 13   4.366   3.814   118M   Hya  12.1     21   79
```

Comet Magnitude Formula (from ALPO and COBS data)

```
m1 =  2.1 + 5 log d + 11.1 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
   2019T4  2021 12 14.71 xM 13.4 AQ 40.0L 4 108   0.7  5/          ICQ XX WYA   Chris Wyatt
   2019T4  2021 12 03.24  S 12.1 AQ 20.3T10 133   2    3           ICQ XX GON05 J J Gonzalez
```

C/2019 T4 (ATLAS) was discovered on 2019 October 6 at 19th magnitude with the "Asteroid Terrestrial-Impact Last Alert System" (ATLAS) 0.5-m reflector at Haleakala, Hawaii. At discovery, T4 was 8.6 au from the Sun.

Perihelion is in a few months on 2022 June 9 at a still distant 4.24 au. Visual observers Chris Wyatt and J. J. Gonzalez recently found ATLAS at magnitude 12.1 (Gonzalez on Dec. 3 with a 0.2-m) and 13.4 (Wyatt on Dec. 14 with a 0.4-m). With perihelion a few months way, this long-period comet should continue to slowly brighten. January finds it brightening to around magnitude 12 in the morning sky in Hydra. It will be visible from both hemispheres. Peak brightness should occur around opposition in April at 11th magnitude.

New Discoveries, Recoveries and Other Comets News

New Comet Discoveries

P/2021 W1 = P/2008 WZ96 (LINEAR) – E. Schwab of Egelsbach, Germany, recovered comet P/2008 WZ96 in images taken on two nights with the 0.8-m f/3 Schmidt telescope at Calar Alto. The recovery was part of a program conducted by Schwab with D. Koschny, M. Micheli, and E. Petrescu. When recovered on the nights of 2021 November 30 and December 1, the comet was 19th magnitude which is fainter than at its discovery apparition in 2008 when it reached 17th magnitude. With an orbital period of 6.5 years, this is the comet's 3rd return since (and including) the discovery apparition. It was missed at its last perihelion in 2015. Perihelion was on 2021 August 26 at 1.85 au. This comet is still awaiting a number. [CBET 5078]

P/2021 R8 (Sheppard) – Scott Sheppard discovered this faint 21st magnitude comet on 2021 September 8 with the Japanese 8.2-m Subaru Telescope on Mauna Kea. Other observations were subsequently found in Pan-STARRS data taken on 6 nights between August and October 2021. P/2021 W8 is a short-period comet with an orbital period of 5.24 years and perihelion on 2021 October 7 at 2.13 au. The comet is now fading. [CBET 5079, MPEC 2021-X149]

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 T	FL	POW	COMA Dia	COMA DC	TAIL LENG	TAIL PA	ICQ CODE	Observer Name
C/2021 A1 (Leonard)												
2021A1	2022 01 03.07 aM	4.8	TK	5.0B		10	4	7			ICQ xx	HER02 Carl Hergenrother
2021A1	2022 01 02.45 xM	5.1	TK	7.0B		15	7.0	6/	2.2	094	ICQ XX	WYA Christopher Wyatt
2021A1	2022 01 02.46 xM	4.8	TK	0.0E			20.0	5/	1.0	094	ICQ XX	WYA Christopher Wyatt
2021A1	2022 01 02.07 aM	4.7	TK	5.0B		10	5	6			ICQ xx	HER02 Carl Hergenrother
2021A1	2022 01 01.45 xM	4.7	TK	7.0B		15	7.0	6/	3.6	095	ICQ XX	WYA Christopher Wyatt
2021A1	2022 01 01.45 xM	4.4	TK	0.0E			18.0	6	1.2	095	ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 31.44 xM	4.9	TK	7.0B		15	6.5	6	3.2	092	ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 31.44 xM	4.7	TK	0.0E			20.0	5/	1.0	092	ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 30.76 S	4.8	TK	10.0B		25	6	7			ICQ XX	GON05 Juan Jose Gonzalez Suarez
2021A1	2021 12 30.44 xM	4.8	TK	7.0B		15	8	6/	2.4	90	ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 30.06 V	5.4	TK	5.0R	4		5				ICQ xx	OLAaa Michael Olason
2021A1	2021 12 29.44 xM	5.3	TK	7.0B		15	7.0	6	8.5	090	ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 29.44 xM	4.8	TK	0.0E			17.0	3/	1.0	090	ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 28.44 xM	4.5	TK	7.0B		15	10	6	9.0	90	ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 27.99 M	4.8	TK	9.0R	5	28	10	7	0.5	90	ICQ XX	SOU01 Willian Souza
2021A1	2021 12 27.98 M	4.7	TK	9.0R	5	16	10	7	0.5	90	ICQ XX	SOU01 Willian Souza
2021A1	2021 12 27.96 M	4.6	TK	4.2B		10	8	7	0.2	90	ICQ XX	SOU01 Willian Souza
2021A1	2021 12 27.06 V	3.9	TK	2.5R	4		8		>2.0	94	ICQ xx	OLAaa Michael Olason
2021A1	2021 12 26.98 B	4.0	TK	5.0B		7	8	6		90	ICQ XX	SOU01 Willian Souza
2021A1	2021 12 26.97 B	4.2	TK	7.0B		15	10	7	0.2	90	ICQ XX	SOU01 Willian Souza
2021A1	2021 12 25.43 xM	3.7	TK	0.0E			20.0	4	1.5	090	ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 25.44 xM	4.3	TK	7.0B		15	10.7	5/	2.6	088	ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 24.07 V	4.5	TK	5.0R	4		7		>1.0	94	ICQ xx	OLAaa Michael Olason
2021A1	2021 12 23.43 sM	4.6	TK	0.0E			20.0	4			ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 23.44 sM	5.0	TK	7.0B		15	8.0	6	2.5	090	ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 23.08 V	4.7	TK	5.0R	4		6		>1.0	94	ICQ xx	OLAaa Michael Olason
2021A1	2021 12 22.75 S	4.5	TK	10.0B		25	6	7	0.6	80	ICQ XX	GON05 Juan Jose Gonzalez Suarez
2021A1	2021 12 22.72 I	5.3:	TK	15.6R	8	30	10	3	25.0m	95	ICQ XX	DECaa Michel Deconinck
2021A1	2021 12 21.96 B	5.0	TK	7.0B		15	10	5	0.2	90	ICQ XX	SOU01 Willian Souza
2021A1	2021 12 21.72 I	4.8	TK	15.6R	8	30	5	3	25.0m	95	ICQ XX	DECaa Michel Deconinck
2021A1	2021 12 21.07 aM	3.7	TK	5.0B		10	6	6	0.3	85	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 21.07 Z	3.2	U4	7.2R	5a	210	18.2		>1.2	90	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 21.06 V	3.4	TK	5.0R	4		11		>1.0	94	ICQ xx	OLAaa Michael Olason
2021A1	2021 12 20.93 B	3.0	TK	7.0B		15	10	8	0.2	90	ICQ XX	SOU01 Willian Souza
2021A1	2021 12 20.72 I	3.8	TK	15.6R	8	30	5	6	12.0m		ICQ XX	DECaa Michel Deconinck
2021A1	2021 12 20.06 aM	3.5	TK	5.0B		10	6	7	0.25	80	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 20.06 V	4.2	TK	5.0R	4		11		>1.2	92	ICQ xx	OLAaa Michael Olason
2021A1	2021 12 20.05 Z	4.0	U4	7.2R	5a	45	12.5		0.6	85	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 19.72 I	5.5	-	15.6R	8	30		4/			ICQ XX	DECaa Michel Deconinck
2021A1	2021 12 19.06 aM	4.0	TK	5.0B		10	7	5	0.25	80	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 19.05 Z	3.7	U4	7.2R	5a	140	12.5		0.35	87	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 19.05 V	4.1	TK	5.0R	4		11		>0.4	89	ICQ xx	OLAaa Michael Olason
2021A1	2021 12 19.03 M	4.8	TK	5.0B	4	20	7	5			MAN04	MAN04 Luis Alberto Mansilla
2021A1	2021 12 18.71 E	4.7	TK	15.6R	8	30	10	3	15.0m	90	ICQ XX	DECaa Michel Deconinck
2021A1	2021 12 18.06 V	4.8	TK	5.0R	4		11				ICQ xx	OLAaa Michael Olason
2021A1	2021 12 17.75 S	4.3	TK	5.0B		10	5	7			ICQ XX	GON05 Juan Jose Gonzalez Suarez
2021A1	2021 12 17.43 &S	4.9	TK	7.0B		15	14	3			ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 17.41 &M	5.0	TK	25.0L	5	40	16	6	16.0m	90	ICQ XX	WYA Christopher Wyatt
2021A1	2021 12 17.06 V	4.3	TK	5.0R	4		12		>1.0	82	ICQ xx	OLAaa Michael Olason
2021A1	2021 12 17.06 M	4.1	TK	5.0B		10	5	4			ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 17.05 Z	4.3	U4	7.2R	5a	130	10.6		0.12	75	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 16.75 S	3.4	TK	5.0B		10	7	6			ICQ XX	GON05 Juan Jose Gonzalez Suarez
2021A1	2021 12 16.73 E	4.0:	TK	15.6R	8	30	5	5	30.0m	290	ICQ XX	DECaa Michel Deconinck
2021A1	2021 12 16.05 V	3.7	TK	5.0R	4		13				ICQ xx	OLAaa Michael Olason
2021A1	2021 12 15.75 S	3.3	TK	5.0B		10	7	6/			ICQ XX	GON05 Juan Jose Gonzalez Suarez
2021A1	2021 12 15.06 V	3.2	TK	5.0R	4		11				ICQ xx	OLAaa Michael Olason
2021A1	2021 12 11.54 M	4.8	TK	5.0B		10	7	5	0.7	330	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 11.24 S	4.9	TK	5.0B		10	16	6/	1.7	330	ICQ XX	GON05 Juan Jose Gonzalez Suarez
2021A1	2021 12 11.25 I	4.7	TK	0.0E			12	7			ICQ XX	GON05 Juan Jose Gonzalez Suarez
2021A1	2021 12 09.53 Z	5.4	U4	7.2R	5a	840	28.9		>1.4	327	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 09.50 M	5.0	TK	5.0B		10	12	5	1.5	320	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 09.19 I	5.3	TK	12.6B	5	40	12	3/	1.2	315	ICQ XX	DECaa Michel Deconinck
2021A1	2021 12 06.53 Z	5.7	U4	7.2R	5C	480	30.7		>1.35	321	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 06.47 M	6.0	TK	5.0B		10	10	6	1.0	320	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 05.53 Z	6.0	U4	7.2R	5C	000	28.1		>1.5	321	ICQ xx	HER02 Carl Hergenrother
2021A1	2021 12 05.51 GS	6.0	AC	5.0B		7 & 3	3				ICQ XX	AGUaa Salvador Aguirre
2021A1	2021 12 05.47 M	6.3	TK	5.0B		10	7	5/	0.5	320	ICQ xx	HER02 Carl Hergenrother

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   2021A1  2021 12 03.25  S  6.4 TK  5.0B    10  12    5   2.4  310 ICQ XX GON05 Juan Jose Gonzalez Suarez
   2021A1  2021 12 03.06  S  7.0 TI 10.0L 4  36   5    4   14.0m320 ICQ XX HAR11 Christian Harder
   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 02.19  S  7.1 TK  5.0B 4   7   4    5/  0.28 328        PIL01 Uwe Pilz
   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
C/2019 T4 (ATLAS)
   2019T4  2021 12 14.71 xM 13.4 AQ 40.0L 4 108   0.7  5/           ICQ XX WYA   Chris Wyatt
   2019T4  2021 12 03.24  S 12.1 AQ 20.3T10 133   2.0  3            ICQ XX GON05 Juan Jose Gonzalez Suarez
C/2019 L3 (ATLAS)
   2019L3  2021 12 29.49 xM  9.0 TK 25.0L 5  40   3.0  6            ICQ XX WYA   Chris Wyatt
   2019L3  2021 12 26.74  S  9.1 TI 29.8L 4  92   2.8  4/   4.0m315 ICQ XX HAR11 Christian Harder
   2019L3  2021 12 25.77  S  9.6 TI 29.8L 4  92   1.7  4/   7.0m310 ICQ XX HAR11 Christian Harder
   2019L3  2021 12 14.67 xM  9.5 TK 40.0L 4  59   3.2  6   10.0m287 ICQ XX WYA   Chris Wyatt
   2019L3  2021 12 13.66 xM  9.4 TK 40.0L 4  59   3.5  6    9.2m267 ICQ XX WYA   Chris Wyatt
   2019L3  2021 12 11.21  S  9.4 TK 10.0B    25   6    6            ICQ XX GON05 Juan Jose Gonzalez Suarez
   2019L3  2021 12 03.13  S  9.9 TK  7.0B 6  16   2.5                      PIL01 Uwe Pilz
   2019L3  2021 12 03.07  S  9.5 TI 25.2L 4  78   3    4/   6.0m325 ICQ XX HAR11 Christian Harder
   2019L3  2021 12 02.96  S  9.6 TK 20.3T10  77   5    6   0.2  300 ICQ XX GON05 Juan Jose Gonzalez Suarez
   2019L3  2021 12 02.78  S  9.7 TI 29.8L 4  92   1.9  4/           ICQ XX HAR11 Christian Harder
   2019L3  2021 12 01.50  Z  9.2 U4  7.2R 5a300  11.0      0.14 329 ICQ xx HER02 Carl Hergenrother
104P/Kowal
104        2021 12 30.84  S  9.9 TK 20.3T10  77   7    3            ICQ XX GON05 Juan Jose Gonzalez Suarez
104        2021 12 29.47 xM 10.5 TK 25.0L 5  40   5.0  3/           ICQ XX WYA   Chris Wyatt
104        2021 12 26.72  S 10.8 TI 29.8L 4  92   2.5  2            ICQ XX HAR11 Christian Harder
104        2021 12 25.75  S 10.9 TI 29.8L 4  92   3    2            ICQ XX HAR11 Christian Harder
67P/Churyumov- Gerasimenko
 67        2021 12 25.79  S  9.6 TI 29.8L 4  92   3.5  3/           ICQ XX HAR11 Christian Harder
 67        2021 12 14.68 xM  9.6 TK 40.0L 4  59   3.2  6   15.5m274 ICQ XX WYA   Chris Wyatt
 67        2021 12 13.67 xM 10.2 TK 40.0L 4  59   2.1  6   11.2m279 ICQ XX WYA   Chris Wyatt
 67        2021 12 11.19  S  8.3 TK 10.0B    25   8    5   0.5  290 ICQ XX GON05 Juan Jose Gonzalez Suarez
 67        2021 12 03.13  S  7.4 TK  5.0B 4   7   6    5                PIL01 Uwe Pilz
 67        2021 12 03.05  S  8.8 TI 25.2L 4  68   3.3  4   14.0m280 ICQ XX HAR11 Christian Harder
 67        2021 12 03.00  S  8.4 TK 10.0B    25   7    5/  0.6  290 ICQ XX GON05 Juan Jose Gonzalez Suarez
 67        2021 12 02.98  S  9.0 TK 20.3T10  77   4    5   0.4  290 ICQ XX GON05 Juan Jose Gonzalez Suarez
 67        2021 12 01.49  Z  8.5 U4  7.2R 5a300  13.2     >0.7  329 ICQ xx HER02 Carl Hergenrother
29P/Schwassmann-Wachmann
 29        2021 12 30.86  S 10.5 TK 20.3T10  77   7    1/           ICQ XX GON05 Juan Jose Gonzalez Suarez
 29        2021 12 02.84  S 10.2 TK 20.3T10  77   6    2            ICQ XX GON05 Juan Jose Gonzalez Suarez
 29        2021 12 02.77  S 11.3 TI 29.8L 4 108   3    1            ICQ XX HAR11 Christian Harder
19P/Borrelly
 19        2022 01 03.08  S  9.3 TK 12.5B    30   3    5            ICQ xx HER02 Carl Hergenrother
 19        2021 12 31.45 xM  9.5 TK  7.0B    15   9.5  5/           ICQ XX WYA   Chris Wyatt
 19        2021 12 30.83  S  9.1 TK 20.3T10  77   5    4            ICQ XX GON05 Juan Jose Gonzalez Suarez
 19        2021 12 29.47 xM  9.0 TK 25.0L 5  40   7.5  4/           ICQ XX WYA   Chris Wyatt
 19        2021 12 26.72  S  9.6 TI 29.8L 4  79   2.2  3/           ICQ XX HAR11 Christian Harder
 19        2021 12 25.72  S  9.3 TI 29.8L 4  79   3.5  3/           ICQ XX HAR11 Christian Harder
 19        2021 12 02.82  S  9.8 TK 20.3T10  77   6    3/           ICQ XX GON05 Juan Jose Gonzalez Suarez
6P/d'Arrest
  6        2021 12 30.82  S 10.0 TK 20.3T10  77   6    2            ICQ XX GON05 Juan Jose Gonzalez Suarez
  6        2021 12 29.48 xS 10.4 TK 25.0L 5  40   6.5  3            ICQ XX WYA   Chris Wyatt
  6        2021 12 25.74  S[ -   TI 29.8L   132                     ICQ XX HAR11 Christian Harder
  6        2021 12 02.83  S 10.1 TK 20.3T10  77   6    2            ICQ XX GON05 Juan Jose Gonzalez Suarez
4P/Faye
  4        2021 12 14.69 xM 12.0 AQ 40.0L 4 108   1.4  6    4.5m297 ICQ XX WYA   Chris Wyatt
  4        2021 12 13.69 xM 12.3 AQ 40.0L 4 108   0.8  6    3.2m275 ICQ XX WYA   Chris Wyatt
  4        2021 12 03.22  S 10.8 TK 20.3T10 100   3    2/           ICQ XX GON05 Juan Jose Gonzalez Suarez
  4        2021 12 01.47  Z 11.7 U4  7.2R 5a360   2.2      0.06 283 ICQ xx HER02 Carl Hergenrother
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