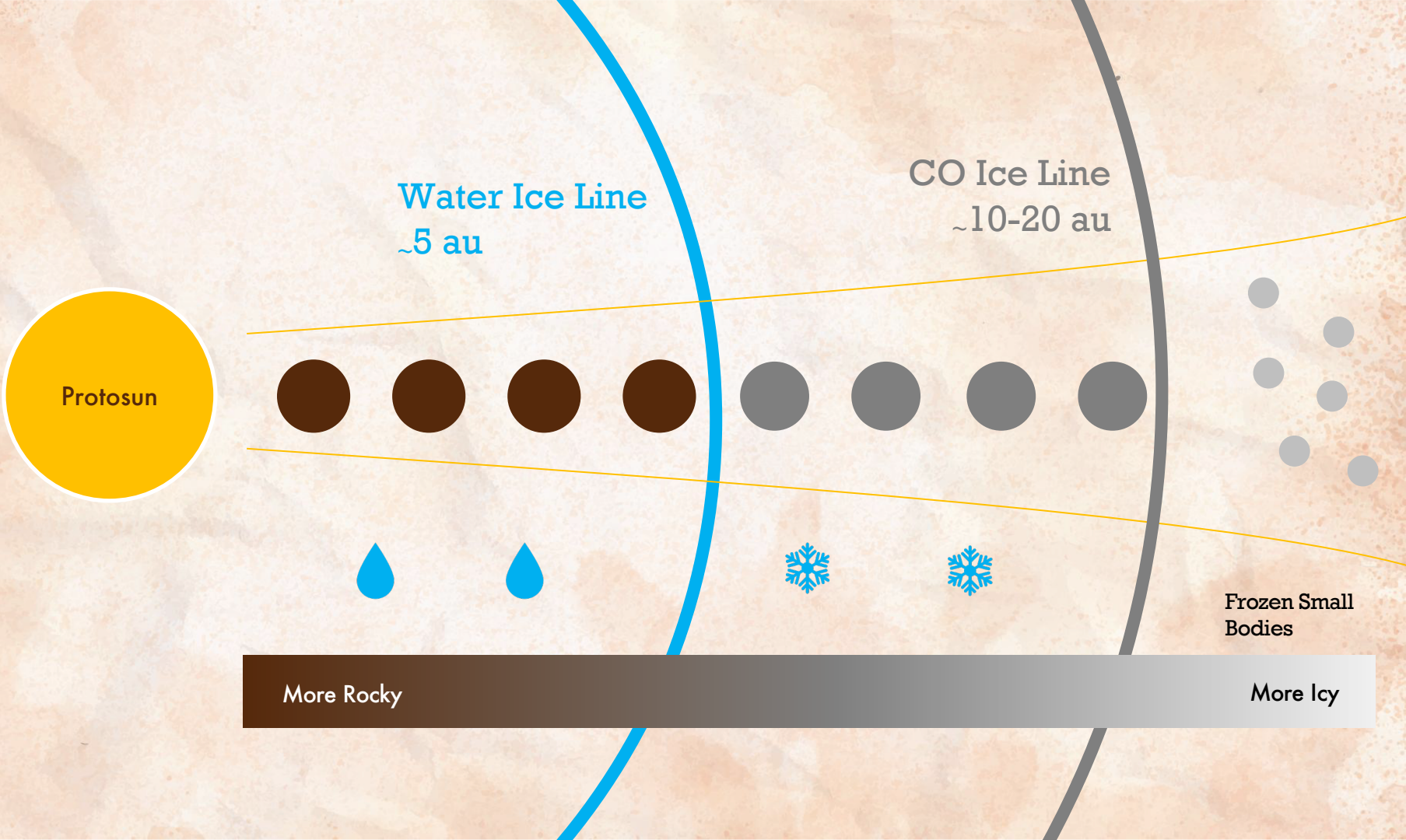
Scientific Seminar of the Astronomical Institute 26 Feb 2025

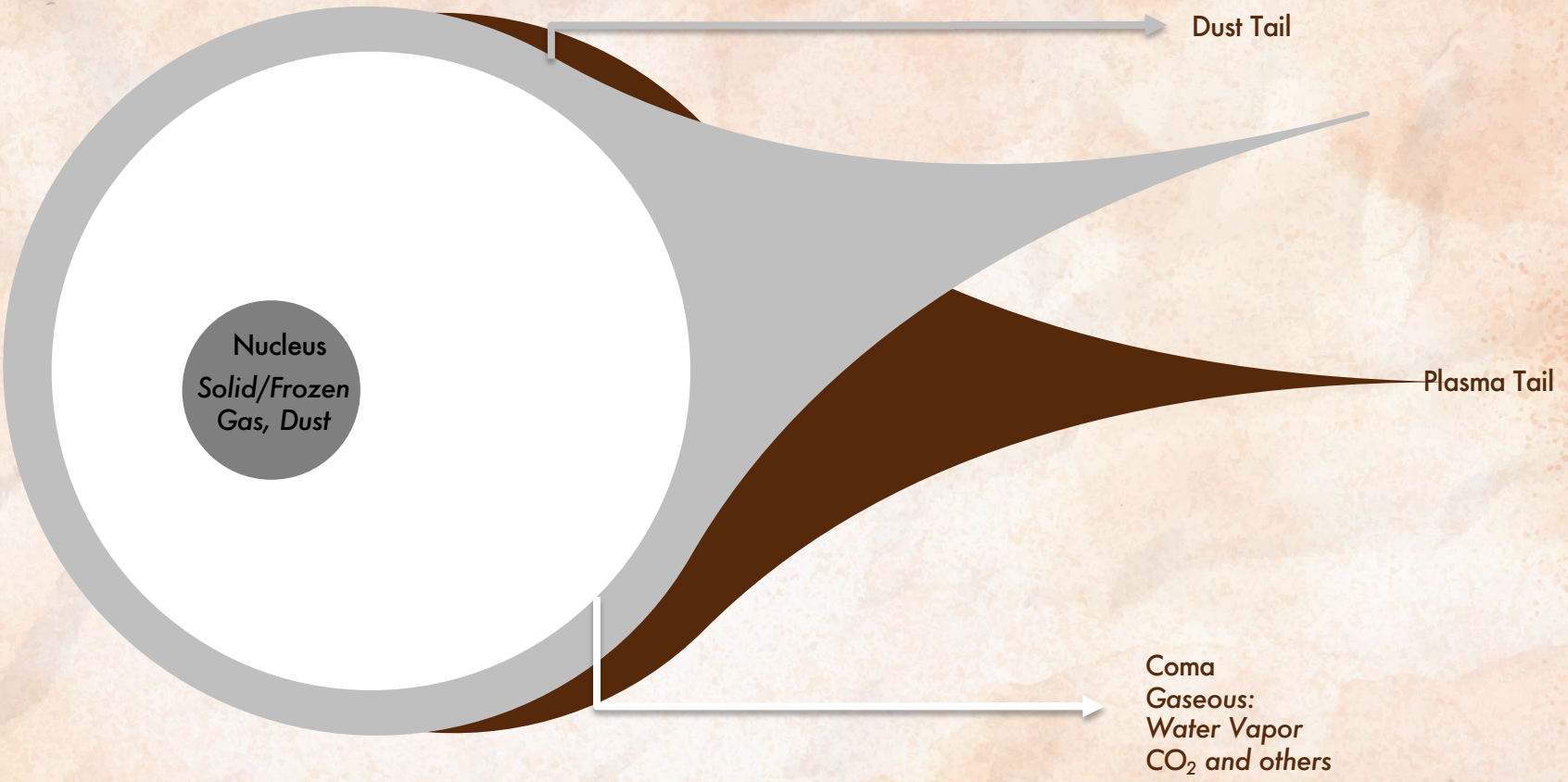
Cracking the Comet Cold Case

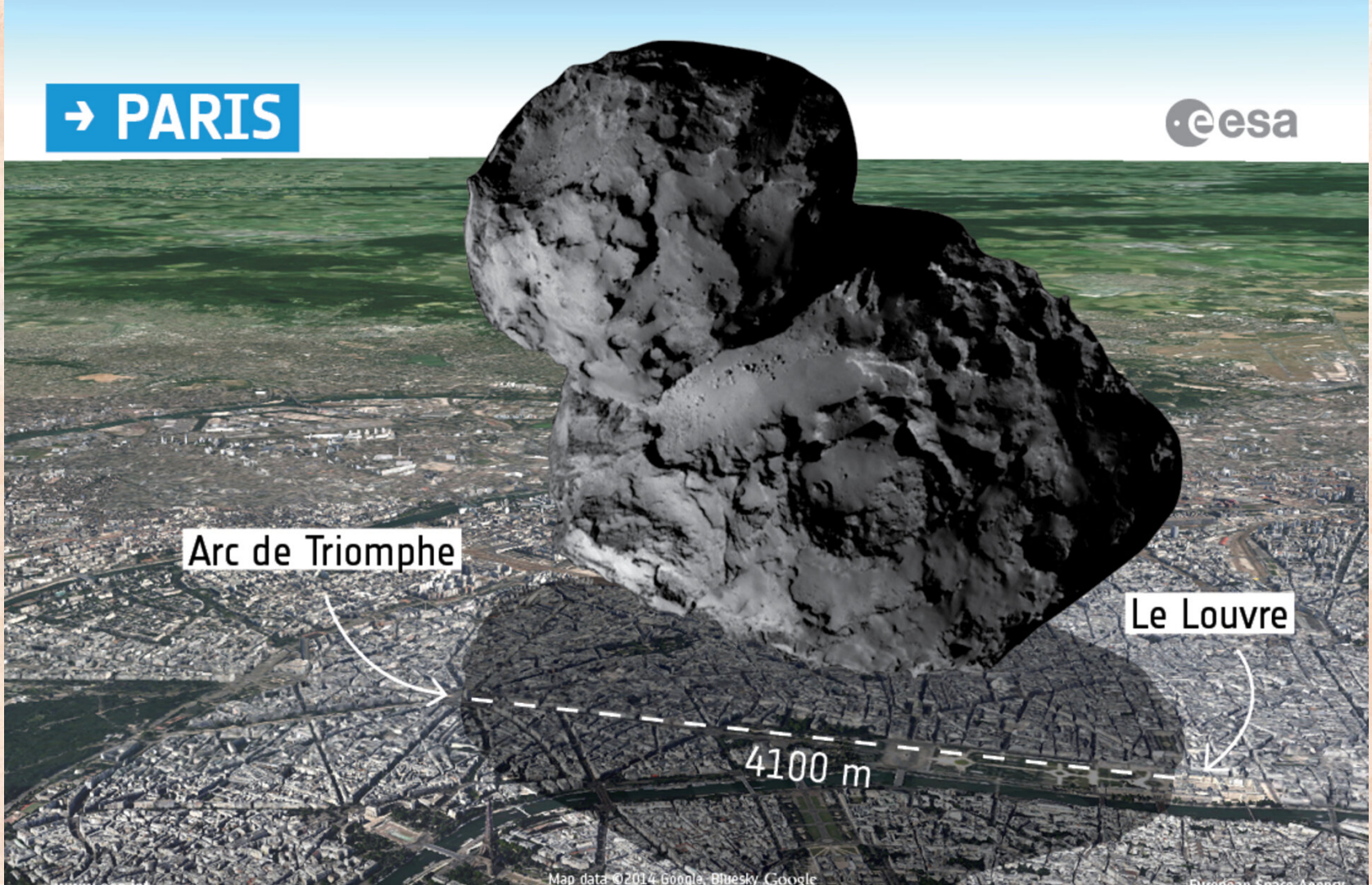
New results from blue comet C/1908 R1 (Morehouse)

S. E. Anderson[1, 2], P. Rousselot[2], E. Jehin[3], B. Noyelles[2], J. Manfroid[3], P. Hardy[4, 2] and V. Robert[5, 6]

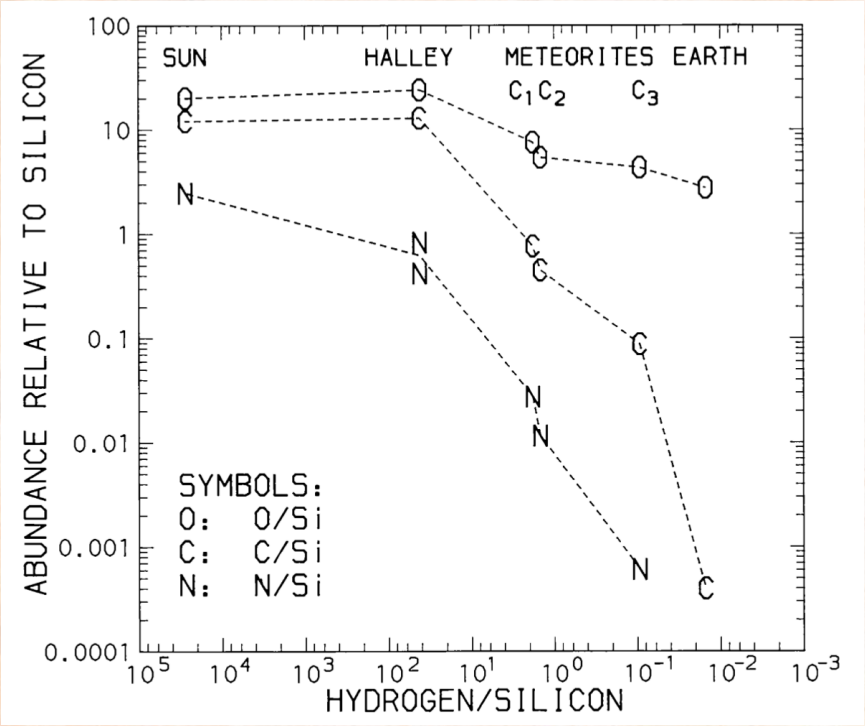
1 LAM, Laboratoire d'Astrophysique de Marseille, Aix Marseille University, 38 rue Frédéric Joliot-Curie, Marseille, 13013 France e-mail: sarah.anderson@lam.fr
2 Institut UTINAM UMR 6213 CNRS, Université de Franche-Comté, OSU THETA, BP 1615, 25010 Besançon Cedex, France
3 STAR Institute, Université de Liège, Allée du 6 Août 19c, 4000 Liège, Belgium
4 Laboratoire Interdisciplinaire Carnot de Bourgogne, UMR 6303 CNRS, Université de Bourgogne, 9 Av. A. Savary, BP47870, F-21078 Dijon Cedex, France
5 Institut Polytechnique des Sciences Avancées IPSA, 63 bis Boulevard de Brandebourg, 94200 Ivry-sur-Seine, France
6 IMCCE, Observatoire de Paris, PSL Research University, CNRS UMR 8028, Sorbonne Universités, UPMC, Univ. Lille 1, 77 avenue Denfert- Rochereau, 75014 Paris, France


Water Ice Line
~5 au
CO Ice Line
~10-20 au
Protosun
Frozen Small Bodies
More Rocky
More Icy


Dust Tail
Nucleus
Solid/Frozen
Gas, Dust
Plasma Tail
Coma
Gaseous:
Water Vapor
CO_2 and others


→ PARIS
esa
Arc de Triomphe
Le Louvre
4100 m
Map data ©2014 Google, Bluesky, Google

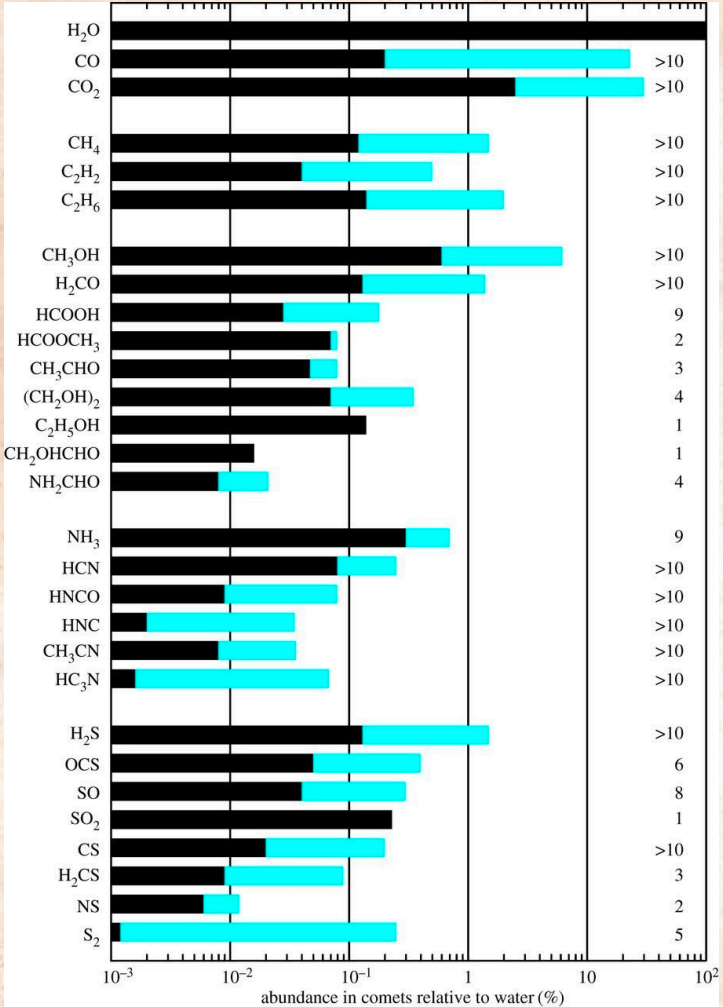
The Nitrogen Depletion in Comets



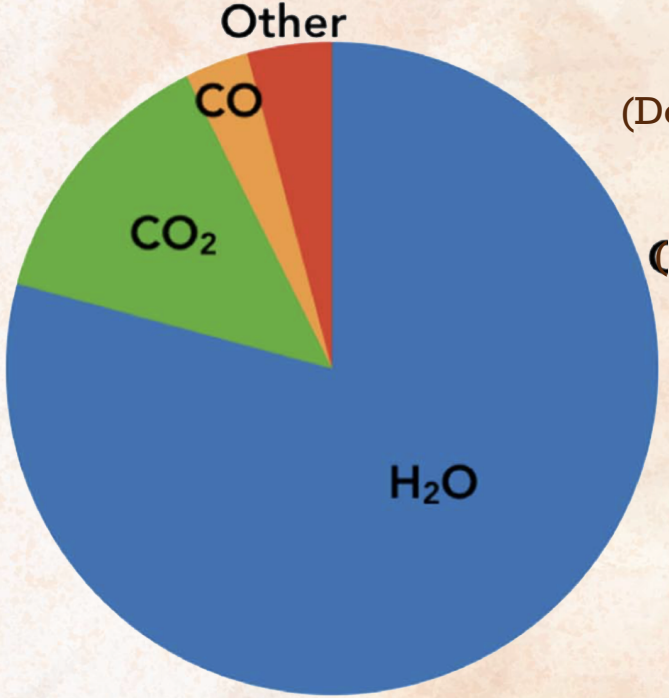
All of 1P/ Halley's light elements were found in the same relative abundance as in the Sun – except for nitrogen.

Geiss 1987, *Composition measurements and the history of cometary matter.*
Values from the mass spectrometer of the *Giotto* spacecraft.

Element	Atomic fraction	Weight fraction
Oxygen	30%	41%
Carbon	30%	30%
Hydrogen	30%	2.5%
Silicon	5.5%	13%
Iron	1.6%	7.5%
Magnesium	0.6%	1.3%



THE COMPOSITION OF COMETARY ICES



$CO/H_2O \sim 4 - 8\%$
(DelloRusso et al. 2016)

$N_2/CO \sim 0.1\%$
(Cochran et al. 2000)

Bockelée-Morvan and Biver, 2007

The N_2/CO ratio

$$\frac{N_2^+}{CO^+} = \frac{g_{CO^+}}{g_{N_2^+}} \frac{L_{N_2^+}}{L_{CO^+}}$$

'g' factors or 'excitation' factors of:
7.0×10^{-2} photons.sec^{-1}.mol^{-1} for the N_2^+ (0,0) band (Lutz et al. 1993)
3.55×10^{-3} photons sec^{-1}.mol^{-1} for the CO^+ (2,0) band (Magnani and A'Hearn 1986)

Comet	CO^+ (counts)	N_2^+ Upper Limit	N_2^+/CO^+ Upper Limit
deVico	718	2.7	3.0×10^{-4}
Hale-Bopp	1434	1.7	9.9×10^{-5}
Hale-Bopp	1306	1.0	6.5×10^{-5}

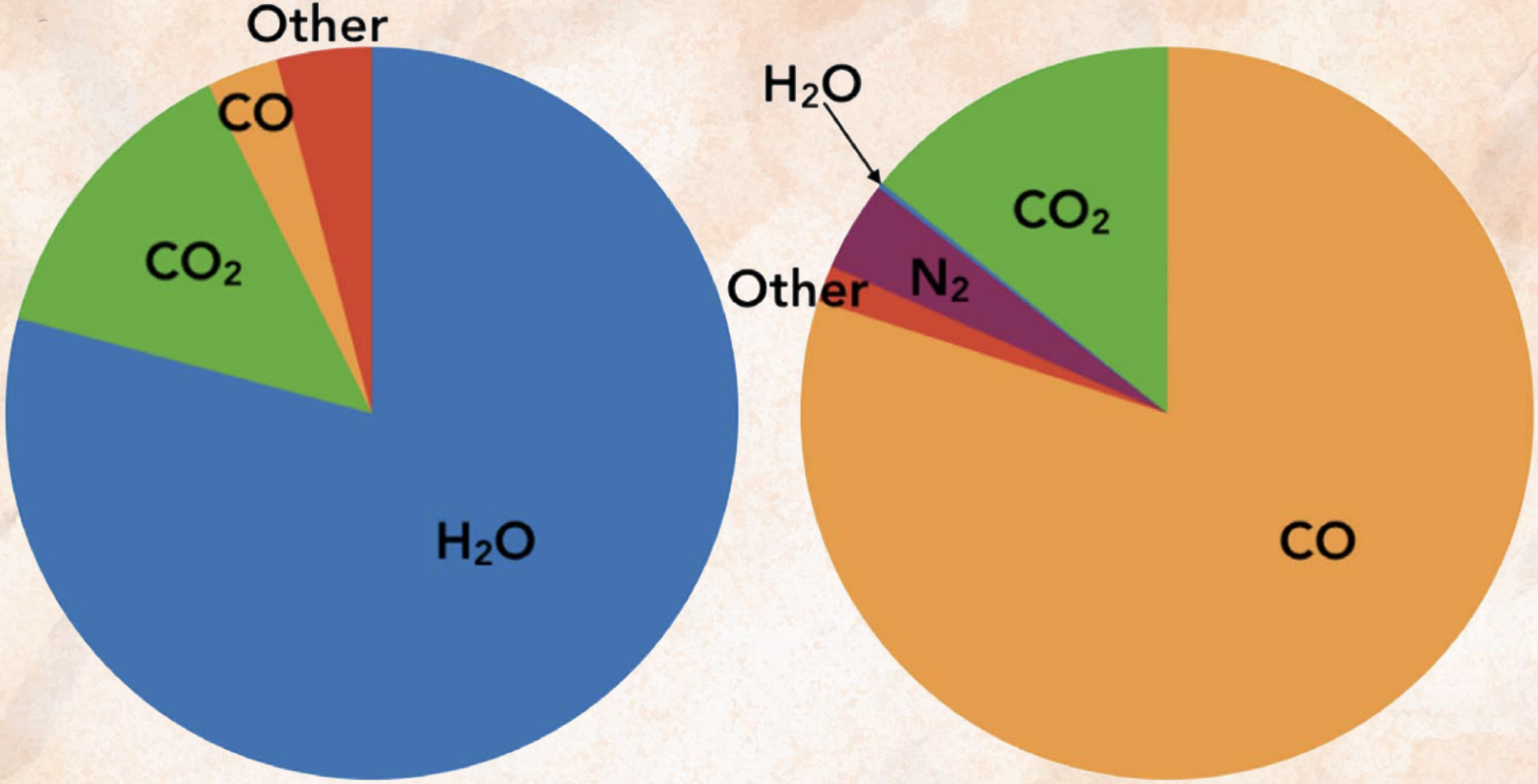
N_2^+ and CO^+ in Comets 122P/1995 S1 (deVico) and C/1995 O1 (Hale-Bopp)
Anita L. Cochran, William D. Cochran and Edwin S. Barker, 2000

Owen and Bar-Nun (1995) estimate this ratio should be in the order of 0.06

Context: Comet C/2016 R2 (PanSTARRS)

- **Remarkably depleted in water with an observed H_2O/CO ratio of only ~0.32% (McKay et al. 2019).**
- **Spectrum dominated by bands of CO+ as well as N_2+ : N_2/CO is estimated to be 0.09 (Anderson et al. 2022) — consequently blue!**
- **Dust poor with a Afρ ~ 750 cm (Opitom et al. 2019).**
- **Low CN production rate of only (3 ± 1) $\times 10^{24}$ mol/s (Opitom et al. 2019).**

Comet C/1908 R1 (Morehouse) as a C/2016 R2 (PanSTARRS)-like comet



Average Comet **C/2016 R2 (PanSTARRS)**

McKay et al. 2019


You Sparkle,
You shine
You are one
of a Kind!

visible en plein midi, à quelques degrés seulement du Soleil (comète Skjellerup, 1927).

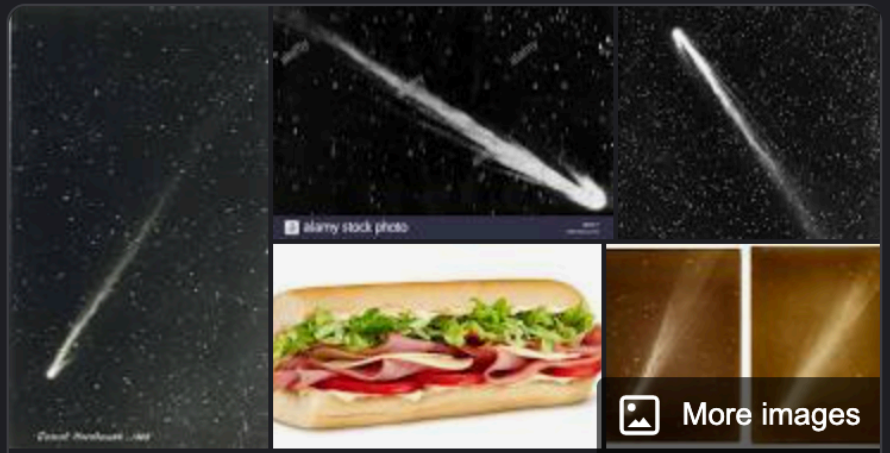
Enfin, dans la queue des comètes on rencontre des molécules d'oxyde de carbone ionisé CO^+ et d'azote ionisé N_2^+, cette ionisation (arrachement d'un électron) étant en liaison avec le mécanisme même de formation de la queue par expulsion violente des molécules issues de la tête sous l'action des radiations ultraviolettes du Soleil.

Bien des points restent cependant encore à élucider dans l'étude de ces astres étranges, dont on est en

Le Grand Larousse de L'Astronomie, 1948

Comet Designation	Old N_2/CO	Updated N_2/CO	Reference
C/1908 R1 (Morehouse)	≥0.06	≥0.085	Cochran et al. (2000)
C/1940 R2 (Cunningham)	≥0.04	≥0.057	Cochran et al. (2000)
C/1947 S1 (Bester)	0.05-0.09	0.071-0.125	Cochran et al. (2000)
C/1956 R1 (Arend-Roland)	>0.09	>0.125	Cochran et al. (2000)
C/1957 R1 (Mrkos)	0.02	0.028	Cochran et al. (2000)
C/1961 R1 (Humason)	0.02-0.03	0.028-0.043	Cochran et al. (2000)
C/1969 T1 (Tago-Sato-Kosaka)	≤0.03	≤0.043	Cochran et al. (2000)
C/1969 Y1 (Benett)	0.03	0.043	Cochran et al. (2000)
C/1973 E1 (Kohoutek)	0.07	0.100	Cochran et al. (2000)
C/1975 V1-A (West)	0.008	0.011	Cochran et al. (2000)
C/1986 P1 (Wilson)	0.07	0.100	Cochran et al. (2000)
C/1987 P1 (Bradfield)	0.02	0.028	Lutz et al. (1993)
C/2001 Q4 (NEAT)	<0.03	<0.043	Feldman (2015)
C/2002 VQ94 (LINEAR)	0.06	0.085	Korsun et al. (2014)
C/2016 R2 (PanSTARRS)	0.06	0.089	Opitom et al. (2019)
1P/Halley	0.005	0.007	Wyckoff et al. (1991)
29P/Schwassmann–Wachmann 1	0.01	0.014	Ivanova et al. (2016)
122P/de Vico	3×10^{-4}	4.2×10^{-4}	Cochran et al. (2000)
153P/Ikeya–Zhang	$< 5.4 \times 10^{-4}$	$< 7.5 \times 10^{-4}$	Bar-Nun et al. (2007)
C/1995 O1 (Hale–Bopp)	$< 6.5 \times 10^{-5} - < 9.9 \times 10^{-5}$	$< 9.2 \times 10^{-5} - < 1.4 \times 10^{-4}$	Cochran et al. (2000)

Blue Comet C/1908 R1 (Morehouse)



Comet Morehouse

Comet Morehouse was a bright, non-periodic comet discovered by US astronomer Daniel Walter Morehouse and first observed on September 1, 1908. It was unusual in the rapid variations seen in the structure of its tail. Wikipedia

Discoverer: Daniel Walter Morehouse

Last perihelion: December 26, 1908

HALLEYS COMET

+

COMET MOREHOUSE

=

COMET CANDY

Blue Comet C/1908 R1 (Morehouse)

- Observed from September to December 1908.
- Notable for rapid tail variations after becoming visible beyond 2 au (Chambers et al. 1909)
- Blueish color due to dominant ion emissions (blue, violet, and UV light) (Guillaume et al. 1908).
- Spectroscopic analysis of comet tails was rare at the time; second after Comet C/1907 L2.
- Absence of continuous spectrum in tail (Deslandres et al. 1908)
- Depletion of CN in the coma, Campbell et al. 1908})
- Detected bright bands at 4256 Å and 4279 Å, later identified as CO+ emissions (De la Baume Pluvinel et al 1911).
- First ever confirmed detection of N_2+ in a comet (Deslandres et al. 1909).

Three-pronged approach:

Dynamics

Do the two comets have similar dynamical histories?

Morphology

Did the two comets behave the same way when visiting the inner solar system?

Composition

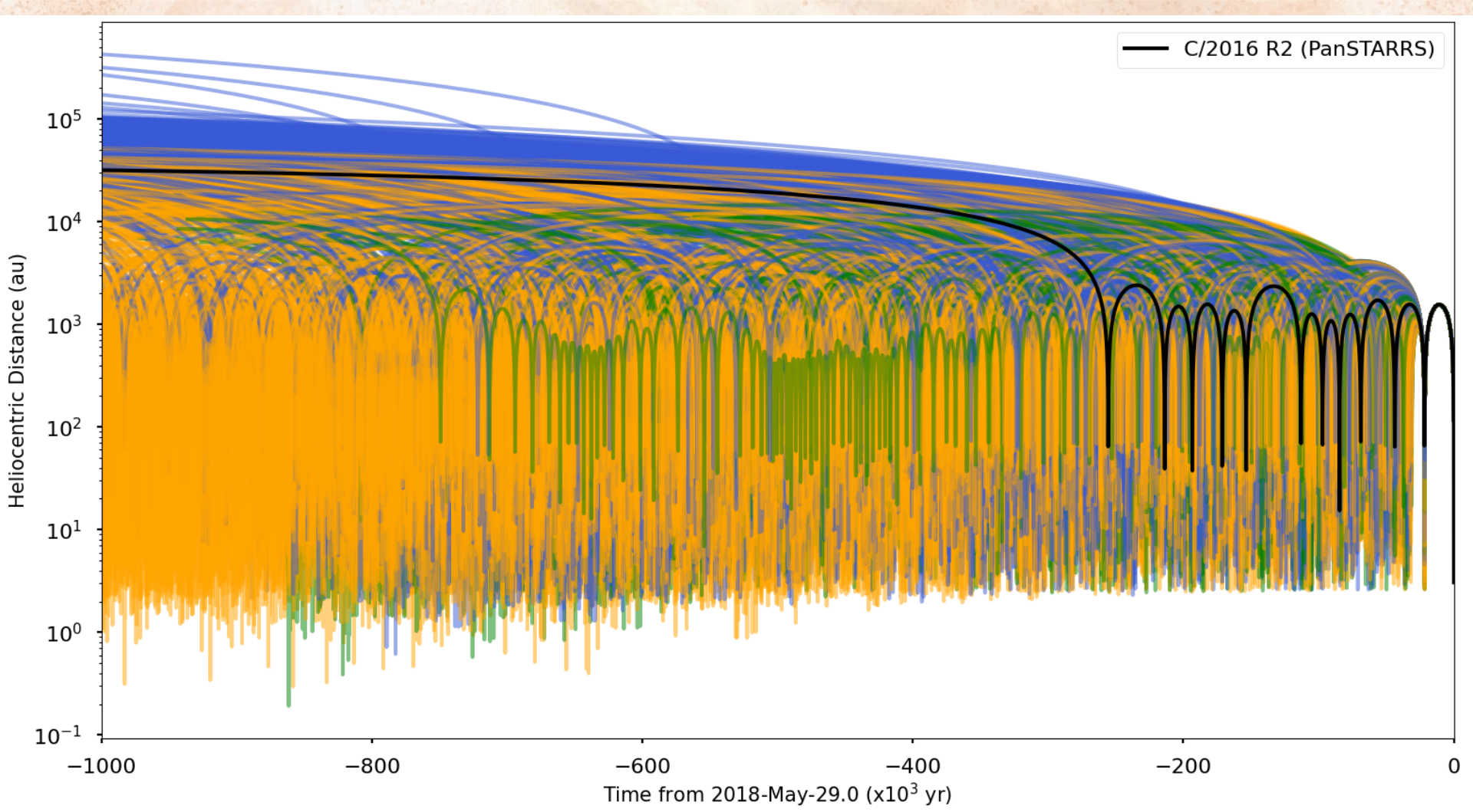
Do the two comets share their unique compositions?

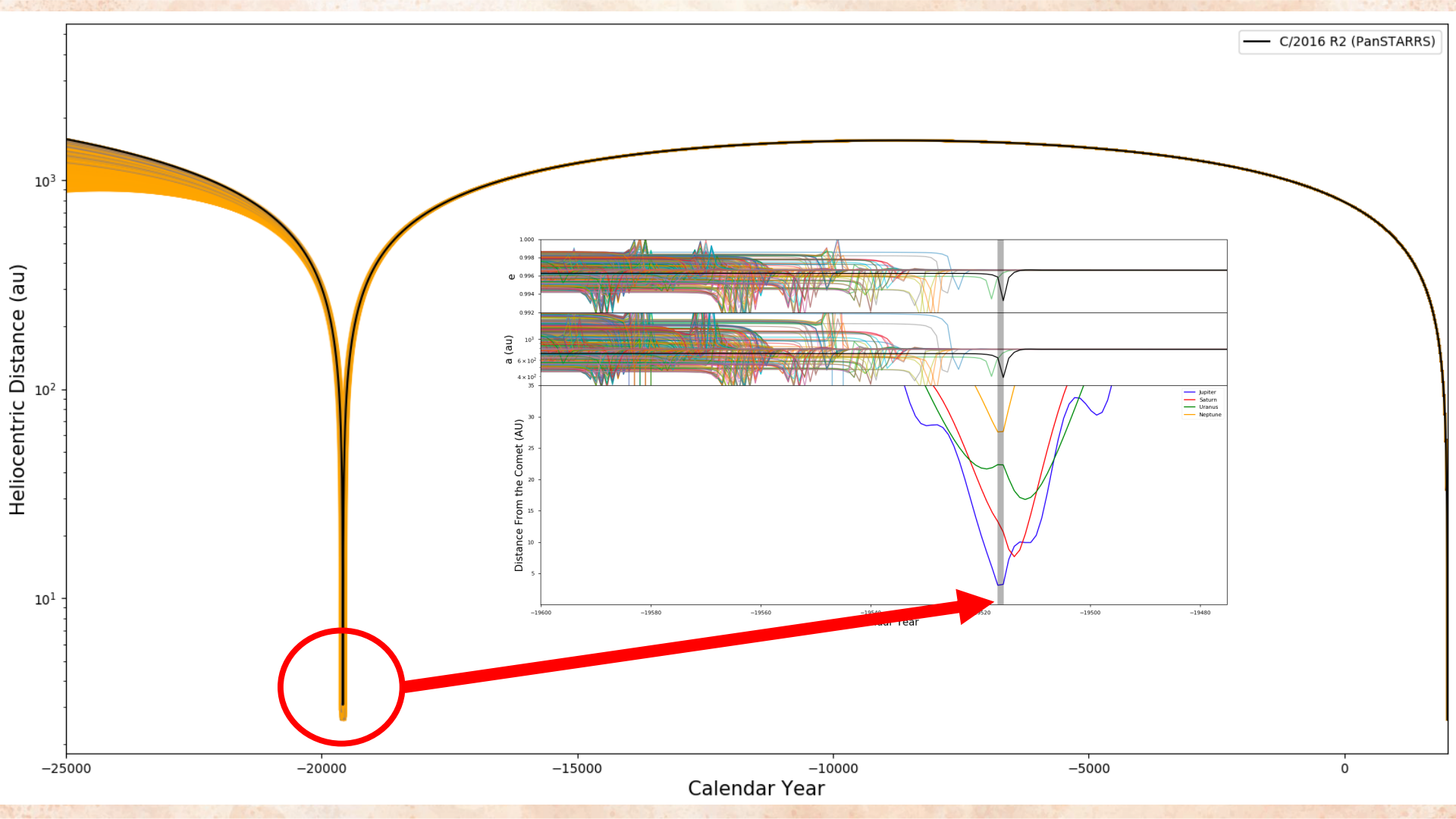
01 Dynamics

Do the two comets have similar dynamical histories?

Orbital Elements

Element	C/1908 R1 (Morehouse)	C/2016 R2 (PanSTARRS)
Date	1908-Oct-31.0	2018-May-29.0
e	1.0009 ± 0.0002	0.9963 ± 1.9501 x10^{-6}
a (au)	-1023.0389 ± 182.87	705.3500 ± 0.37245
q (au)	0.9454 ± 0.0001	2.6024 ± 1.1386 x10^{-6}
i (deg)	140.1738 ± 0.0008	58.2241 ± 8.7863 x10^{-6}
node (deg)	104.4586 ± 0.0006	80.5690 ± 6.748 x10^{-6}
Arg. of perihelion (deg)	171.5825 ± 0.0103	33.1919 ± 2.0025 x10^{-5}
Time of perihelion (TDB)	1908-Dec-26.2480 ± 0.0063	2018-May-09 ± 9.1186 x10^{-5}

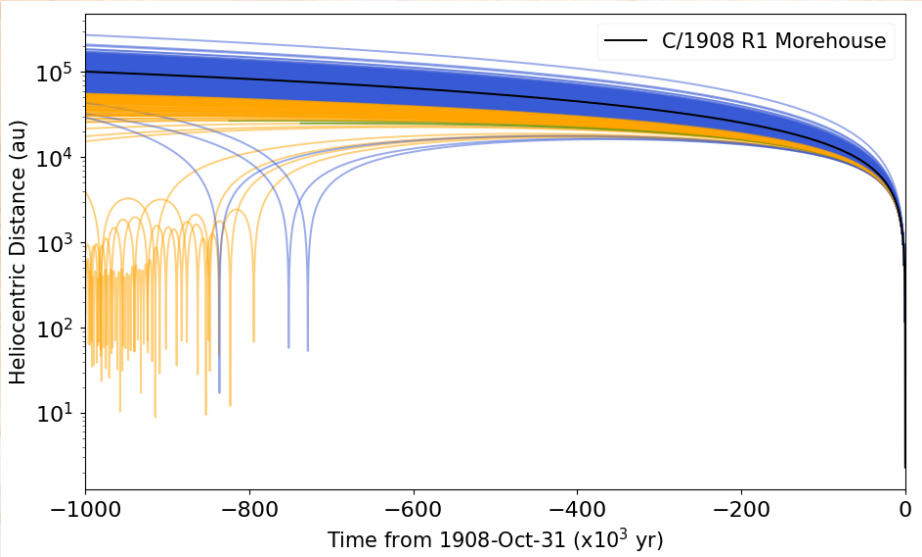

C/2016 R2 (PanSTARRS)
Heliocentric Distance (au)
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
−1000
−800
−600
−400
−200
0
Time from 2018-May-29.0 (x10^{3} yr)

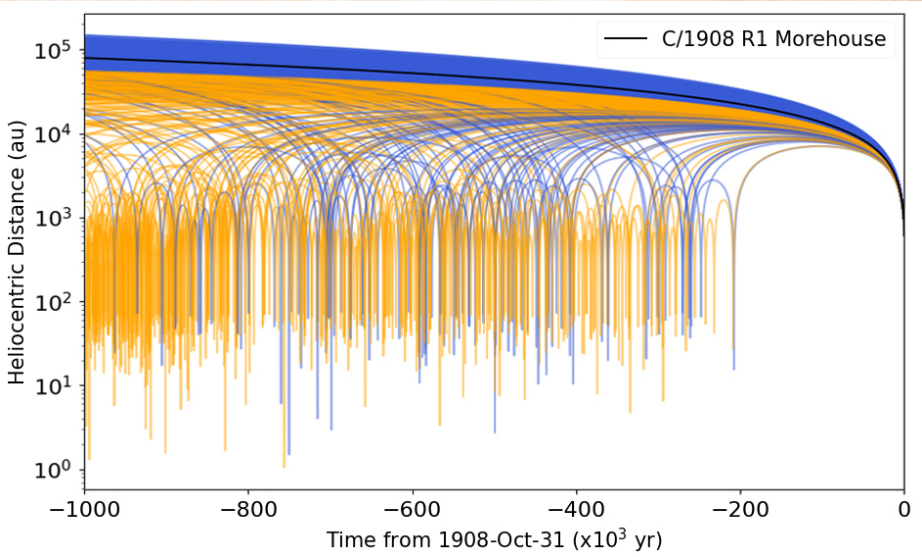

C/2016 R2 (PanSTARRS)
Heliocentric Distance (au)
10^3
10^2
10^1
−25000
−20000
−15000
−10000
−5000
0
Calendar Year
e
a (au)
Distance From the Comet (AU)
Jupiter
Saturn
Uranus
Neptune

Comets are like cats: they have tails, and they do precisely what they want to.

David H. Levi, *Comets*

Dynamical History





MERCURY Simulation
Av. eccentricity: 1.16

REBOUND Simulation
Av. eccentricity: 1.00

Despite the uncertainties, C/1908 R1 is clearly dynamically new.

Is it interstellar?

$$-\frac{GM_{\odot}}{2a}=\frac{1}{2}v_{\infty}^{2}$$

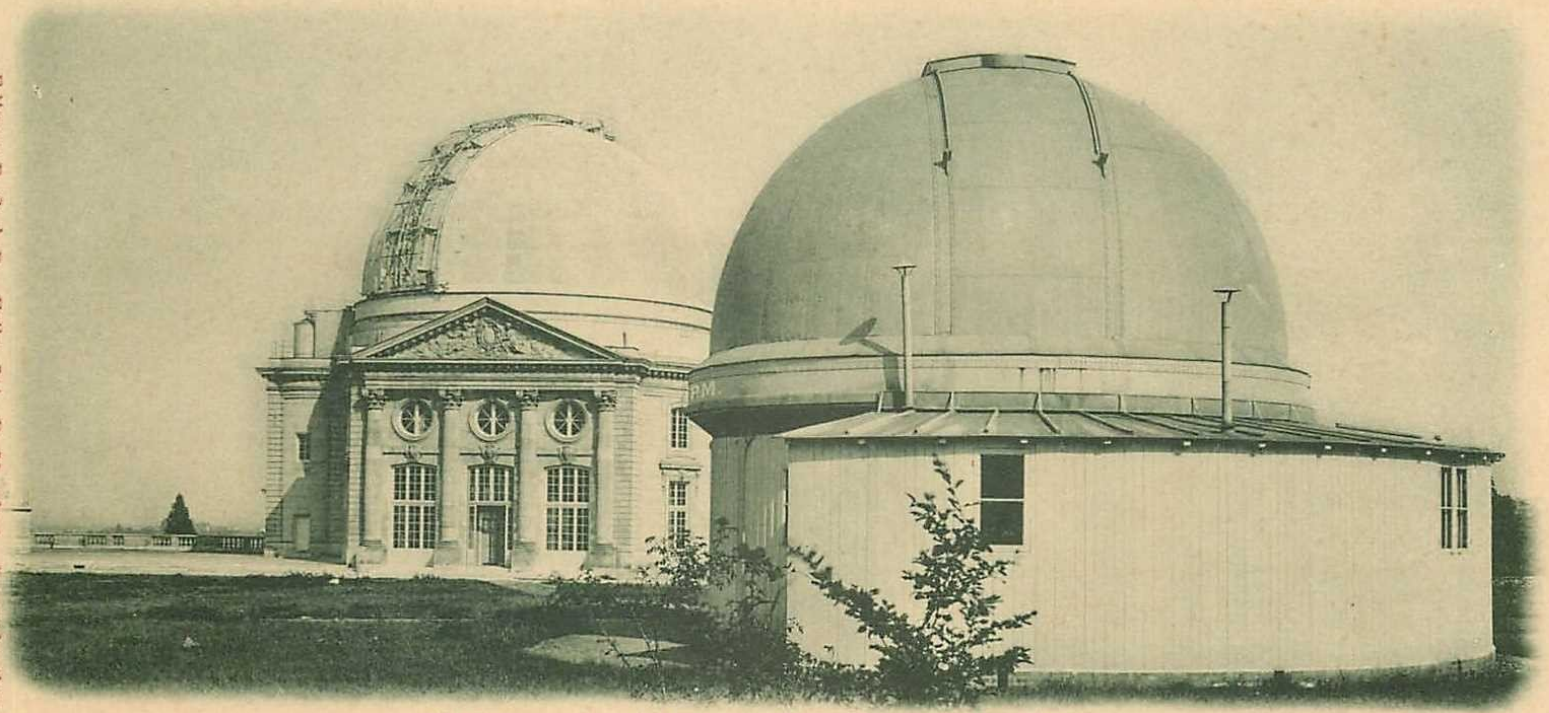
Where:

- *G* is the gravitational constant.
- $M_{\odot}$ is the mass of the Sun.
- a is the semi-major axis of the object's orbit.
- v_{∞} is the velocity of the object at infinity, also known as the hyperbolic excess velocity.

For C/1908 R1, v_{∞} = 0.9 km/s…significantly lower than the excess velocities of interstellar objects 1I/'Oumuamua (27 km/s) and 2I/Borisov (33 km/s).

02 Composition

Do the two comets share their unique compositions?



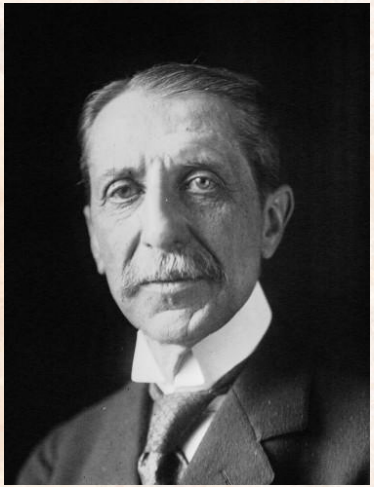
Château de Meudon, Façade sur la Forêt

Ancienne Résidence impériale et royale incendiée pendant la guerre de 1870-71, actuellement Observatoire

Meudon-Bellevue, le .....

Observing Teams

JUIVISY



Le **comte Aymar de La Baume Pluvinel**
(1860-1938)

Fernand Baldet
(1885-1964)

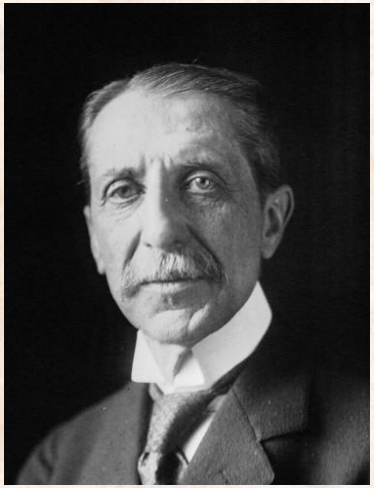
MEUDON

Henri Deslandres
(1853-1948)
Directeur de l'observatoire de Meudon (1907-1929)

Adrien Bernard
(~1880-?)

Observing Teams

JUIVISY



Le **comte Aymar de La Baume Pluvinel**
(1860-1938)

Fernand Baldet
(1885-1964)

MEUDON

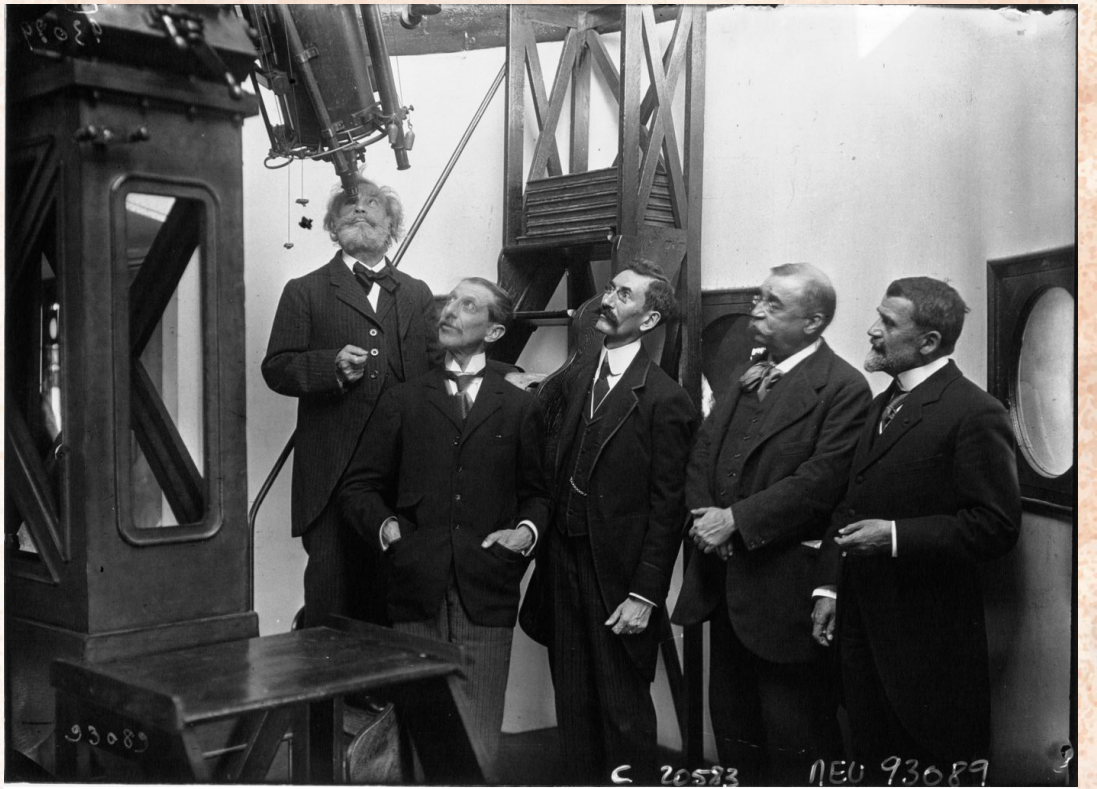
Henri Deslandres
(1853-1948)
Directeur de l'observatoire de Meudon (1907-1929)

Activités Astronome, espérantiste, physicien, astrophysicien

Adrien Bernard
(~1880-?)

BERNARD, Adrien

Ingénieur de l'École centrale des arts et manufactures (promotion 1888), il fut astronome volontaire à l'observatoire de Meudon de 1903 à 1912. Il accompagna Deslandres à Burgos (Espagne) lors de l'éclipse totale de Soleil du 30 août 1905. Il obtint en 1907 avec Deslandres les premiers spectres de la queue d'une comète. Il s'agissait de la comète **1907 IV Daniel**.



Source gallica.bnf.fr / Bibliothèque nationale de France

Mr Flammarion, Comte de la Baume Pluvinel, Bosler, Roland Bonaparte, Général Ferrié

Fernand Baldet, 1930

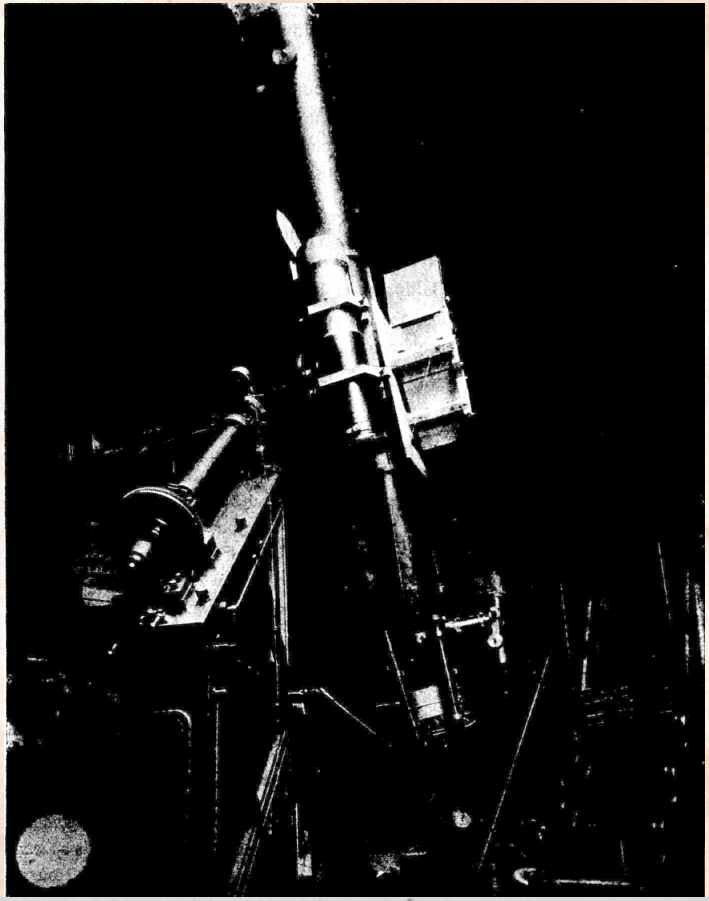
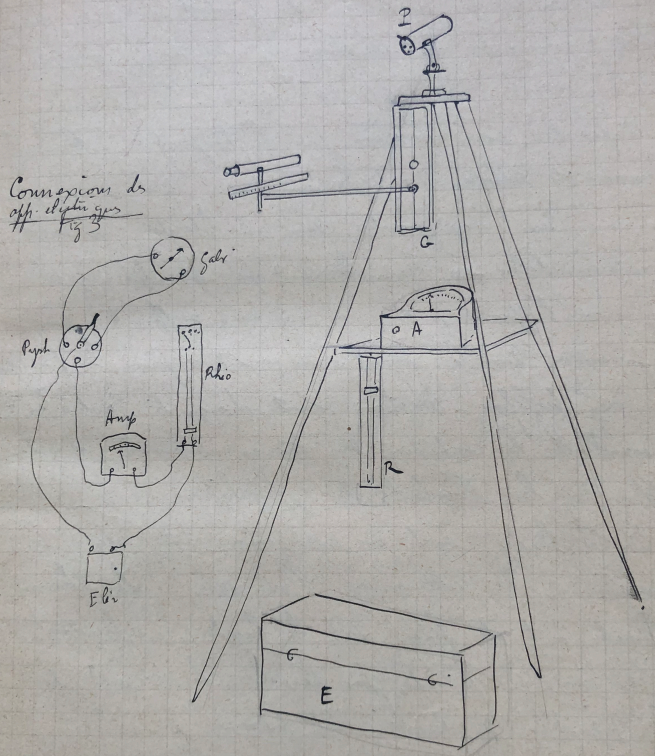


Fig. 11. — Instruments de photographie céleste et de spectroscopie montés sur l'équatorial de l'Observatoire de Juvisy. A droite, spectrographe avec prisme-objectif de 60°. (La lunette photographique à long foyer de Viennet est cachée par l'équatorial.)

Ensemble —

Fig 2.



133.

I 21 C. Photogr. Comète Morehouse 1908 c —
avec la ch. photogr. Zeiss. UV. — F/3.
Cirage 50,75
Plaque Lumière Σ.
Le noyau très nébuleux et fort intense, disparaît lorsque les fils du micromètre sont éclairés, même faiblement — Aussi, je n'ai pu suivre avec précision — La pose a été arrêtée par la lune qui se levait à
Commencement pose — 8h 17m 30s } Temps — 35 min.
Fin — 8h 52 30s }

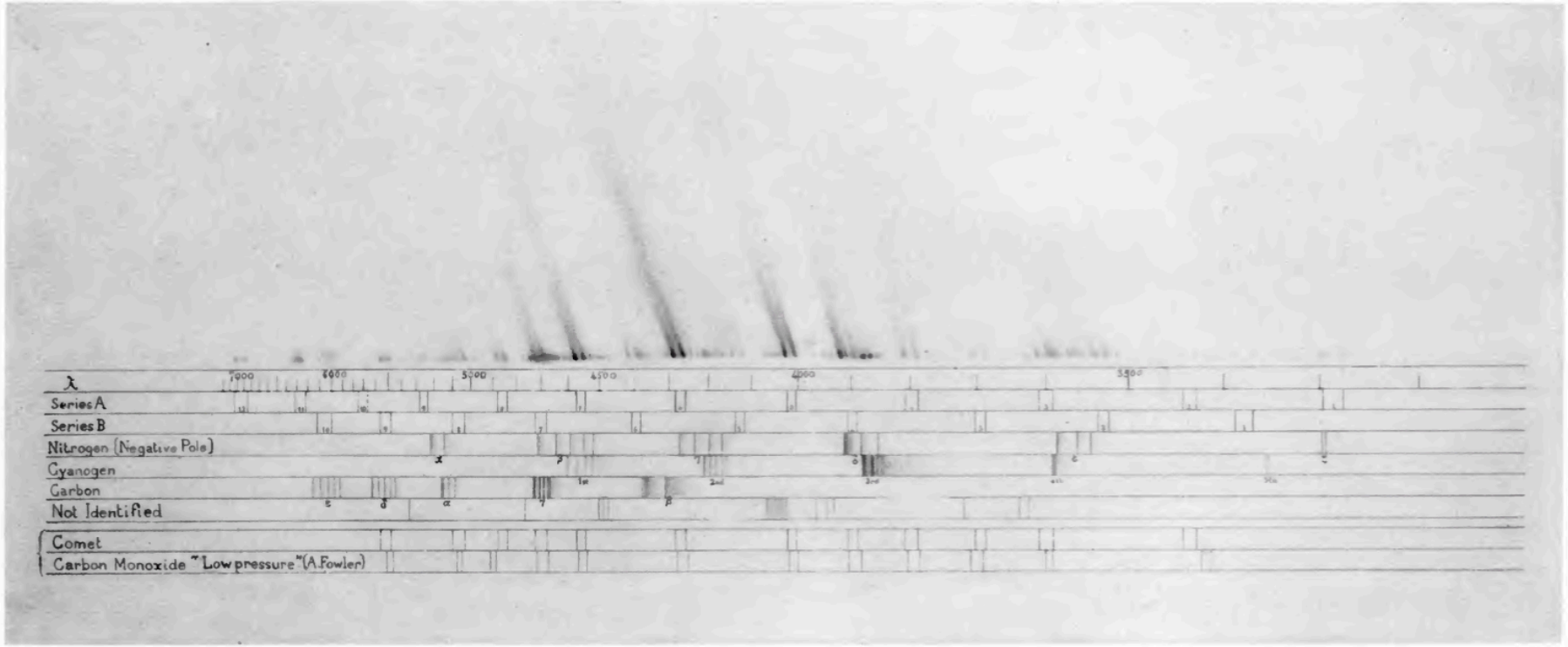
D Photogr — d° — avec la ch. ph. Apochr. Zeiss F/8,3.
Plaque lum. Σ. Cirage 28,0.
Commt pose 8h 17m 30s } Temps 35 minutes.
Fin 8h 52 30s }

Plates conserved in the library

Ref de Lot	Name of File	Date of Obs	Observatoire	Object	Observer	Size	Ref	Eposure Time	Comparison Star	Objective Prism
566	07_10_1908_Vega	7 October 1908	Juvisy	Vega	?		x	x	x	20°
566	07_10_1908_Vega_Bis	7 October 1908	Juvisy	Vega	?		x	x	x	20°
566	Morehouse-spectre03	13 October 1908	Juvisy	Vega	A.D.P. & F. B.	?	x	x	x	60°
413	Morehouse19081016	16 October 1908	Meudon	Morehouse	B & D	11 x 9	CRAS V147	14 min	x	61°
566	Morehouse Drawing 1	18 October 1908	Juvisy	Morehouse Comparison	A.D.P. & F. B.	A4	APJ 1911	3h57	Vega	60°
566	Morehouse Drawing 2	18 October 1908	Juvisy	Morehouse Comparison	A.D.P. & F. B.	A4	APJ 1911	3h57	Vega	60°
566	Morehouse Drawing 3	18 October 1908	Juvisy	Morehouse Comparison	A.D.P. & F. B.	A4	APJ 1911	3h57	Vega	60°
566	Morehouse13x18-01	18 October 1908	Juvisy	Morehouse	A.D.P. & F. B.	13 x 18	APJ 1911	3h57	Vega	60°
566	Morehouse13x18-02	18 October 1908	Juvisy	Morehouse Comparison	A.D.P. & F. B.	13 x 18	APJ 1911	3h57	Vega	60°
566	Morehouse13x18-03	18 October 1908	Juvisy	Morehouse	A.D.P. & F. B.	13 x 18	APJ 1911	3h57	Vega	60°
624	Morehouse1908IIIn14	19 October 1908	Juvisy	Morehouse	A.D.P. & F. B.	13 x 18	APJ 1911	5h56	x	60°
624	Morehouse1908IIIn17	23 October 1908	Juvisy	Morehouse	A.D.P. & F. B.	13 x 18	APJ 1911	0h21	x	60°
413	Morehouse19081028	28 October 1908	Meudon	Morehouse	B & D	11 x 9	CRAS V147	60 min	x	61°
566	Morehouse13x13-01	29 October 1908	Juvisy	Vega	A.D.P. & F. B. ?	13 x 13	x	x	x	Spar & Quartz
566	Morehouse13x13-02	29 October 1908	Juvisy	Vega	A.D.P. & F. B. ?	13 x 13	x	x	x	Spar & Quartz
566	29_10_1908	29 October 1908	Juvisy	Morehouse	A.D.P. & F. B. ?	11 x 9	Calames		Capella	Spar & Quartz
566	30_10_1908	30 October 1908	Juvisy	Morehouse	A.D.P. & F. B. ?	11 x 9	Calames		Capella	Spar & Quartz
413	Morehouse19081030	30 October 1908	Meudon	Morehouse	B & D	11 x 9	CRAS V147	"136" (1h36? ou 2h16?)	Delta Cygni	61°
566	Morehouse-spectre01	31 October 1908	Juvisy	Morehouse	A.D.P. & F. B.	11 x 9	Calames	7h01 (Over 2 nights)	Capella	Spar & Quartz
530	Morehouse1908IIIn26a	21 November 1908	Juvisy	Morehouse	A.D.P. & F. B.	13 x 18	APJ 1911	1h34	x	60°
413	Morehouse19081030	26 November 1908	Meudon	Morehouse	B & D	11 x 9	CRAS V147	33 min (ou 38?)	x	61°
530	Morehouse1908IIIn26b	26 November 1908	Juvisy	Morehouse	A.D.P. & F. B.	13 x 18	APJ 1911	1h43	x	60°
530	Morehouse1908IIIn26c	26 November 1908	Juvisy	Morehouse	A.D.P. & F. B.	13 x 18	APJ 1911	1h32	x	60°
530	Morehouse1908IIIn27	27 November 1908	Juvisy	Morehouse	A.D.P. & F. B.	13 x 18	APJ 1911	1h32	x	60°
413	Morehouse19081128n1	28 November 1908	Meudon	Morehouse	B & D	11 x 9	CRAS V147	1h17	Delta Cygni	61°
413	Morehouse19081128n2	28 November 1908	Meudon	Morehouse	B & D	11 x 9	CRAS V147	1h17	Delta Cygni	61°
413	Morehouse19081129n1	29 November 1908	Meudon	Morehouse	B & D	11 x 9	CRAS V147	1h09	x	61°
413	Morehouse19081129n2	29 November 1908	Meudon	Morehouse	B & D	11 x 9	CRAS V147	1h09	x	61°
566	Morehouse-spectre02	19 January 1909	Juvisy	Capella et Sirius	A.D.P. & F. B.	?	x	x	x	60°

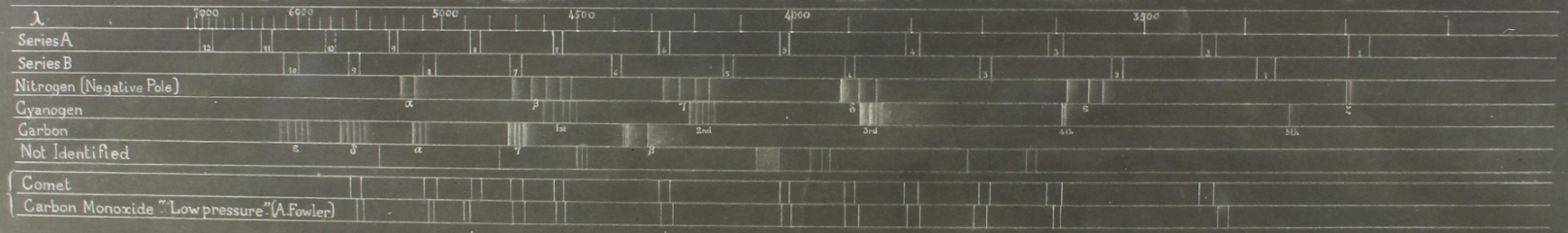

n° 18
Marchouse 1908 III

PLATE VII



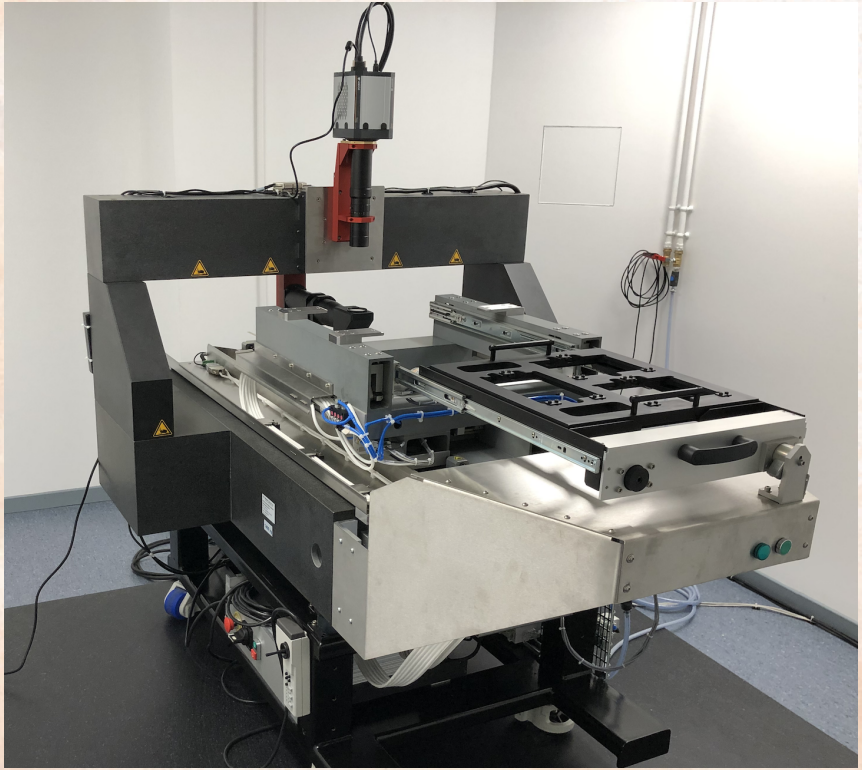
DRAWING FROM PHOTOGRAPH OF SPECTRUM OF COMET MOREHOUSE AND COMPARISON WITH THE SPECTRA OF DIFFERENT GASES

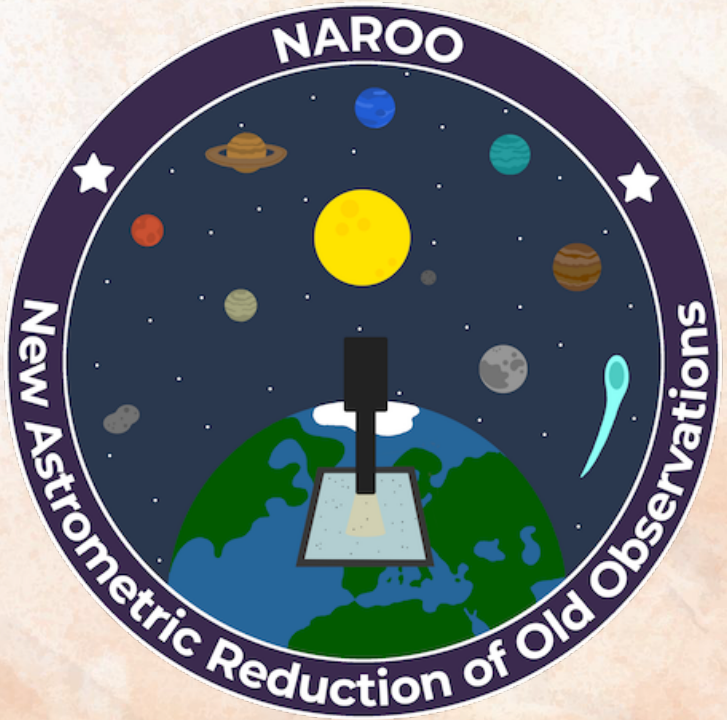
Drawing of the Spectrum of Comet Morehouse



[1] Comparison with Spectra of different gases.

NAROO Project



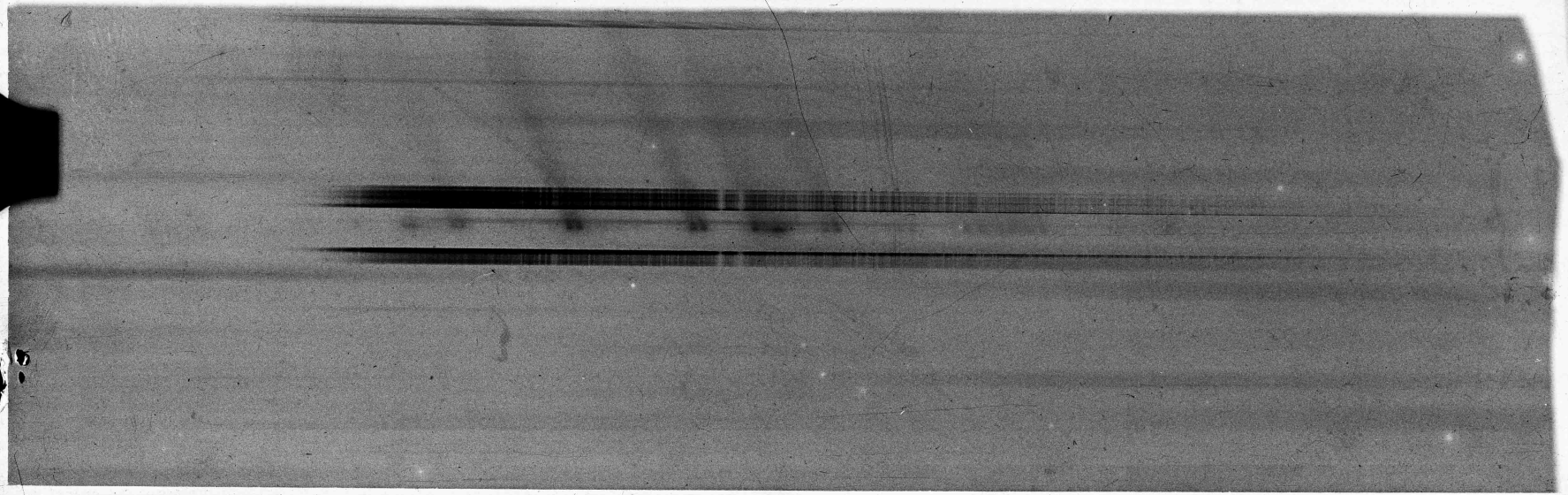


Plates used in this study:

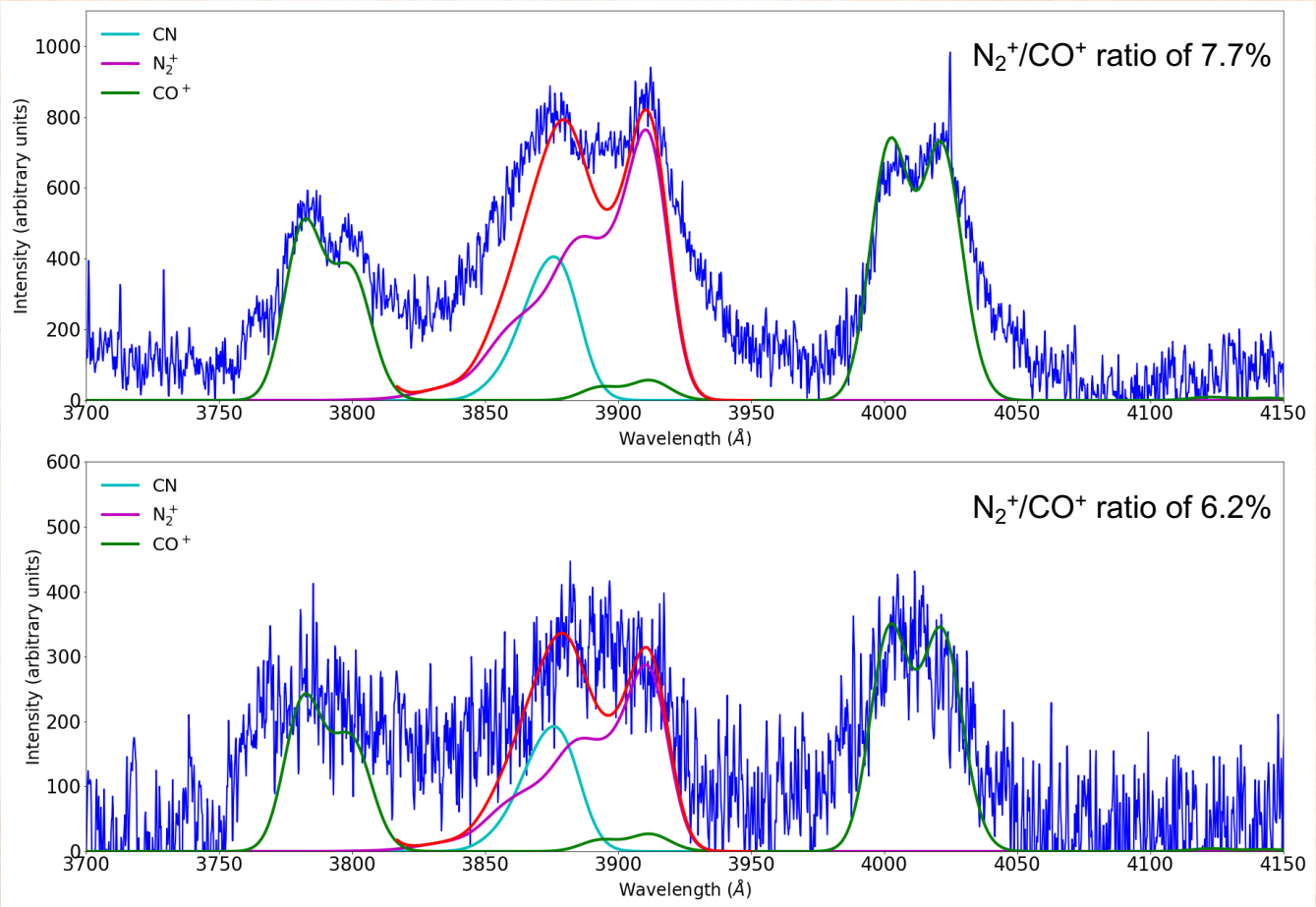
Date	*Observer*	*Exposure time*	r_h	Δ
1908 October 18	De La Baume Pluvinel & Baldet (Juvisy)	3h57	1.50 au	1.04 au
1908 October 30	Deslandres & Bernard (Meudon)	1h36	1.36 au	1.12 au
1908 October 31 1908 November 1	De La Baume Pluvinel & Baldet	7h01	1.35 au	1.13 au
1908 November 28	Deslandres & Bernard	1h17	1.01 au	1.58 au

1908 Octobre 31 . 6^h12 à 11^h10
Nov. 1 . 6.27 à $8^h.30$
} Durée 7^h1^m. Comète Morehouse 1908 c

Prisme obj. de spath et quartz - Plaque Lumière violette - Spectres de comparaison : Capella.



October 31-November 1 1908



Nucleus Region

Tail Region

Dust Production & CN

No *Afρ of Q*(CN) due to the lack of absolute flux calibration of the spectra as the exposure time of the reference stars was not given.

- The observed solar continuum was described as weak, but without flux calibration, we cannot quantify it.
- Weak solar continuum usually indicates a low dust content, as it is not sufficient to scatter the Visible-UV part of the continuous spectrum (also observed in C/2016 R2).
- This also prevents us from quantifying the CN production rate.

Comparison comet: **C/2012 K1 (PanSTARRS)**.

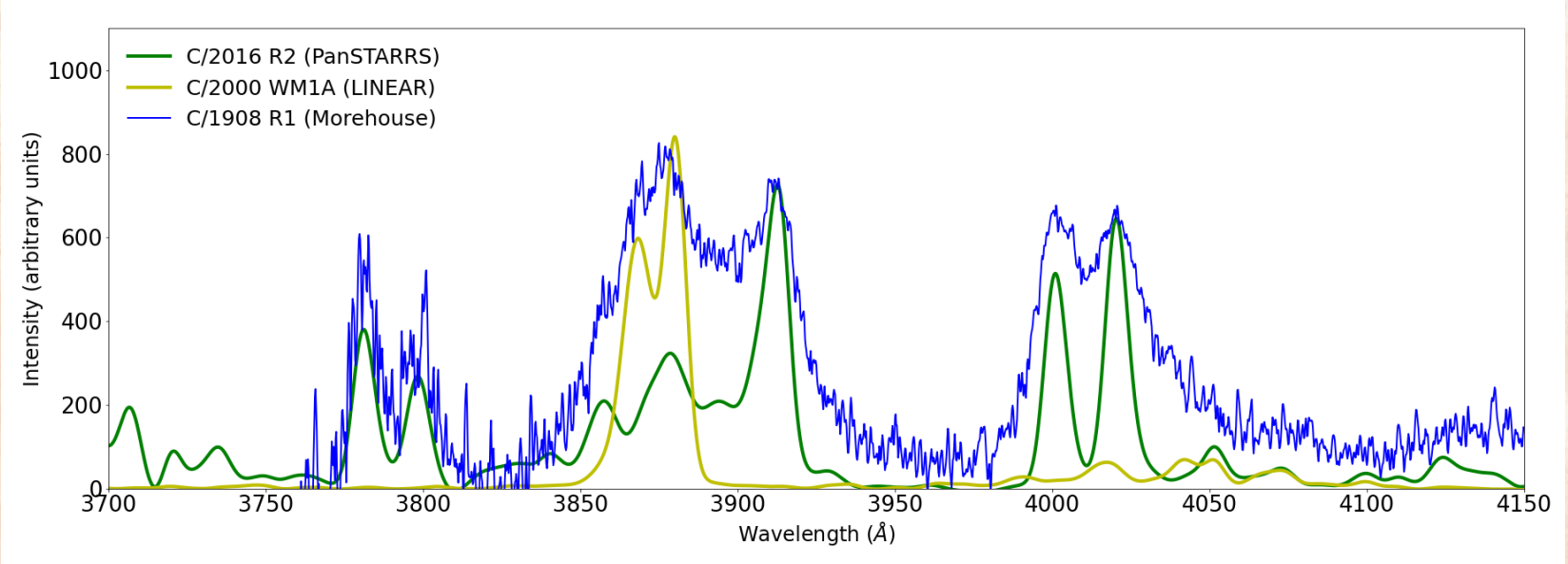
- TRAPPIST measurements for C/2012 K1 give an *Afρ* value of roughly 4×10^3 cm (Jehin+2011).
- By extrapolation, C/1908 R1 *Afρ* could be around 4×10^4 cm, assuming comparable magnitudes and contributions from dust and gas emissions.
- C/2012 K1 may not be the best comparison to C/1908 R1, since total magnitude may have been less representative of a dust coma and rather a CO^+ dominated one.
- **An *Afρ* upper limit of 10^4 cm.**

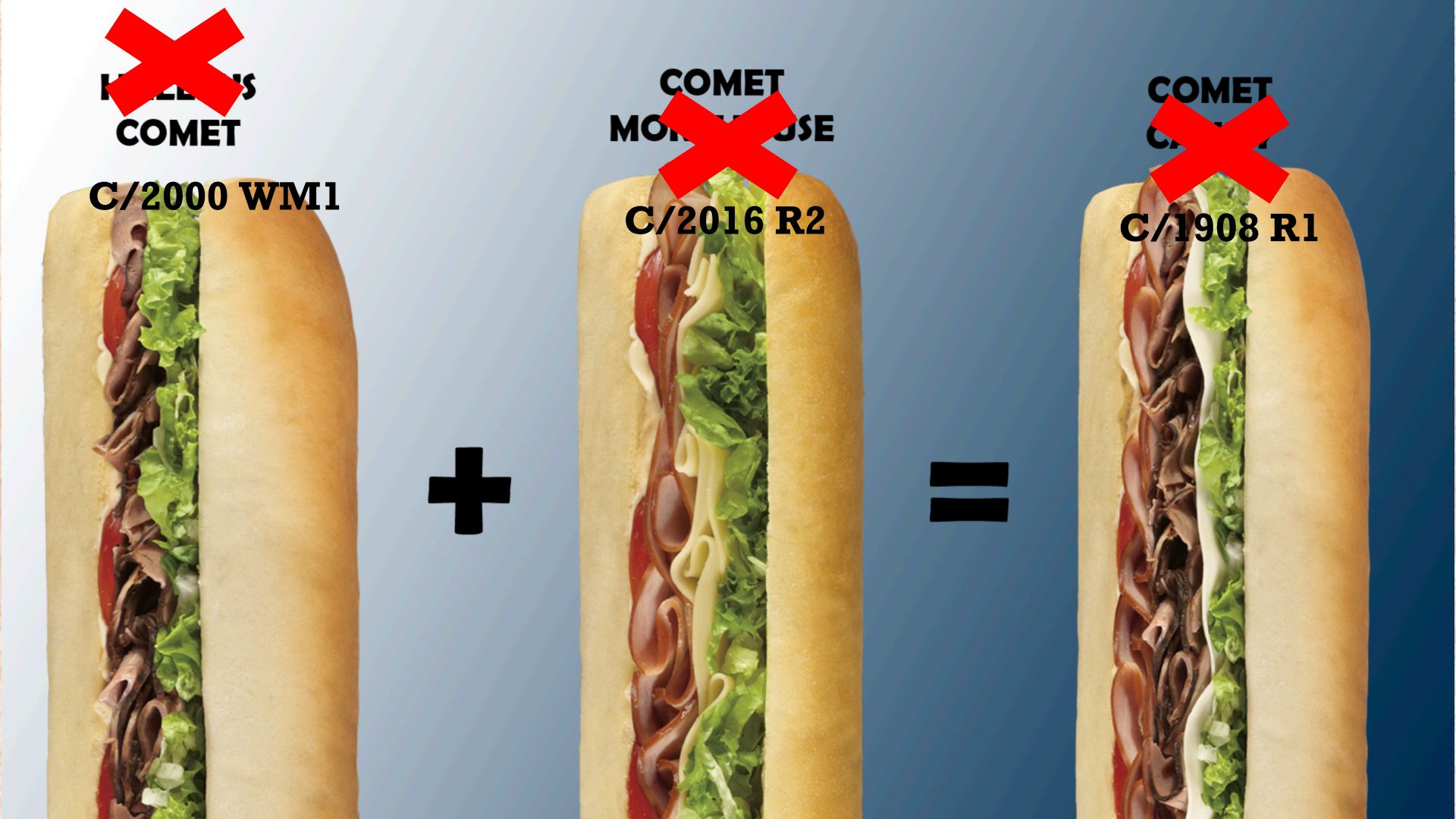
We NEED to find the reference star exposure time!

Dust Production & CN

We can estimate the CN production by comparing it to another comet at a similar distance.

- Comparison comet: **C/2000 WM1**
- The CN and C2 intensities line up perfectly: not depleted compared to other comets.
- Could Comet R2 have had the same CN production if it had only come a little closer to the sun?




COMET
C/2000 WM1
COMET
C/2016 R2
COMET
C/1908 R1

What about water?

We have no measurements of OH as the spectrum does not go so far into the blue, so no estimation of H_2O.

Spectre de la comète Morehouse (1908 *c*).

Int.	λ	Description	Identification
1	7027	Tête	Non identifiée.
1	6848	Tête	Non identifiée.
3	6254	Tête avec queue	C 3e gr. nég. 6245-6196 (C, + 2).
2	6024	Tête diffuse, large	C I, 6191-5958.
1	6020	Tête avec queue	C 3e gr. nég. 6021-5976 (B, + 3) (?).
2	5900	Tête avec queue	C 3e gr. nég. 5906-5862 (D, o).
1	5563	Tête avec trace de queue	C II, 5635-5470.
1	5482	Tête avec trace de queue	C 3e gr. nég. 5504-5467 (B, + 2).
1	5369	Tête très faible	Non identifiée.
1	5260	Tête avec queue	C 3e gr. nég. 5248-5214 (C, o) (?).

We would also expect to see bright H_2O^+ (0–8–0) bands at 6183–6216 Å, but these are not noted in their table.

- We could not identify the usual brightest bands of H_2O^+ at 620 and 590 nm.
- Baldet (1926) reported a non-identified band at 7027 Å which could correspond to the H_2O^+ (0,6,0) band, but this region is also very rich in NH_2.
- Baldet specified it was found in the head of the comet, which favors NH_2.
- Two other non-identified bands at 5369 Å and 4987 Å also correspond to NH_2-rich regions. (NH_2 was not identified in comets in 1926.)

What about water?

IF the comet was typical, we can use the Jorda relation to determine its water production from its magnitude:

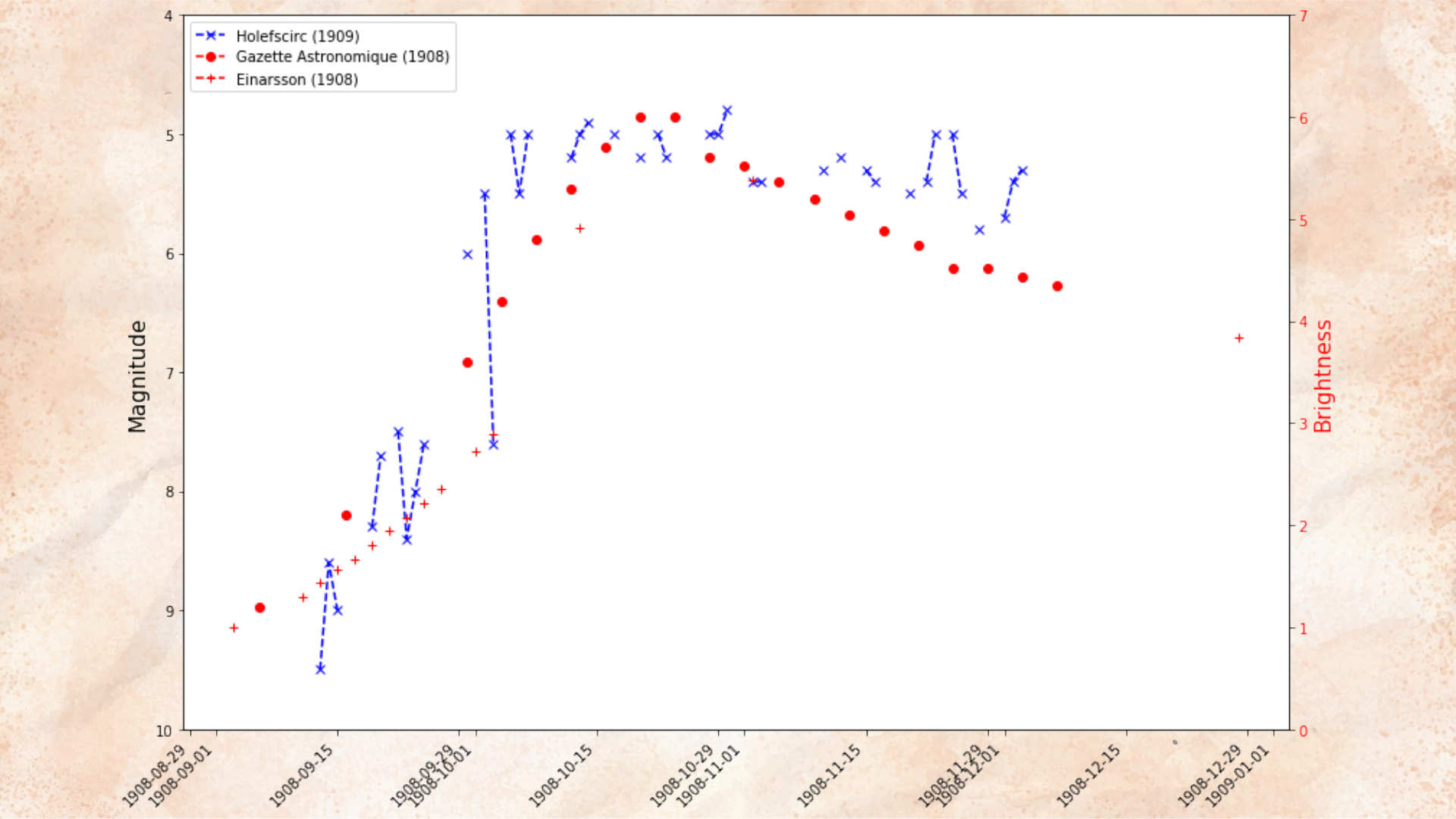
$$\log Q[H_2O] = 30.76 - 0.25mH$$

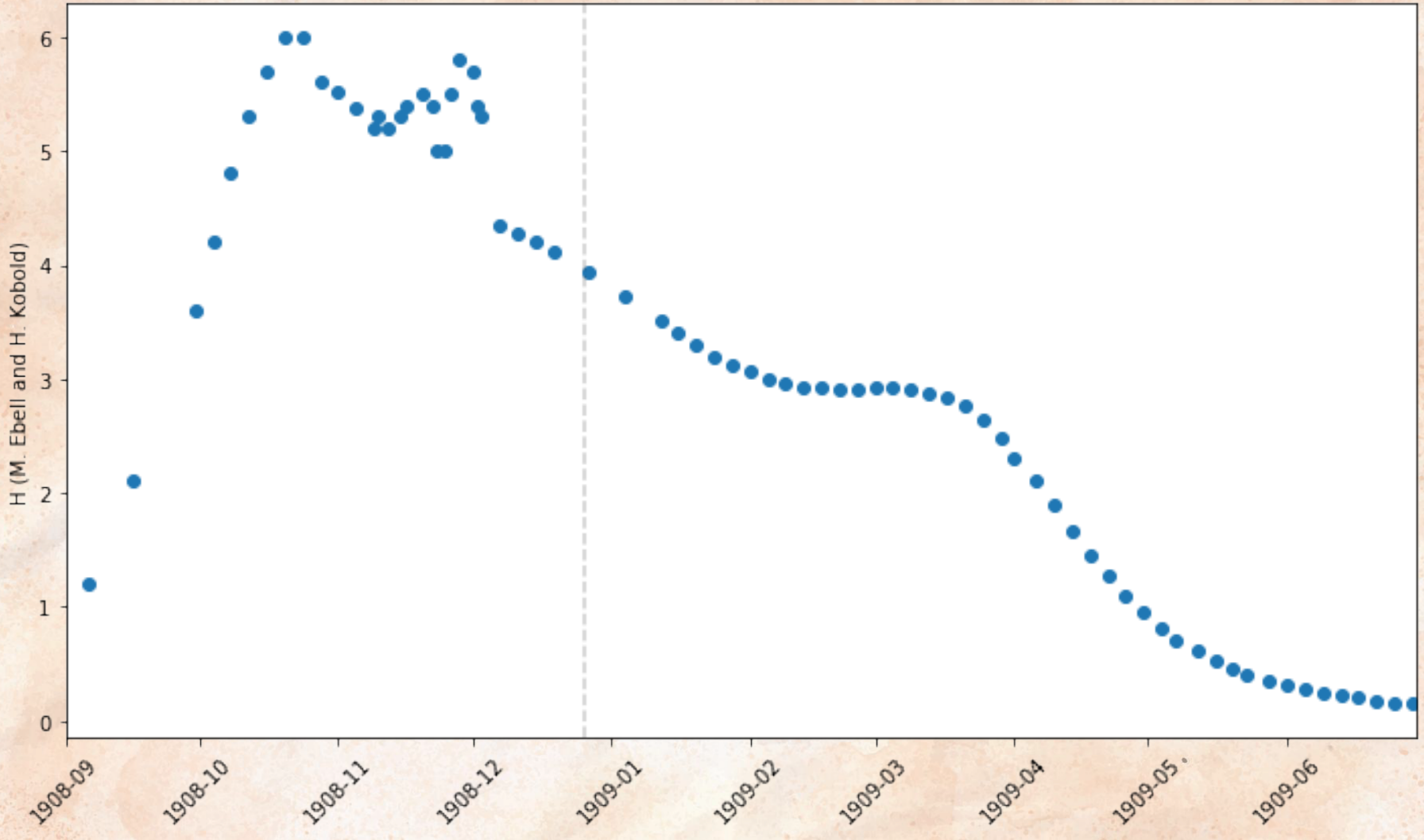
Which would give us a $\boldsymbol{Q[H_2O] = 10^{29.5}}$ **mol/s.**

But bias in water production for C/2016 R2 due to its large heliocentric distance, with its perihelion at 2.7 au, when the sublimation efficiency of H_2O is less than at 1.1-1.4 au; C/1908 R1 has a perihelion of 0.9 au.

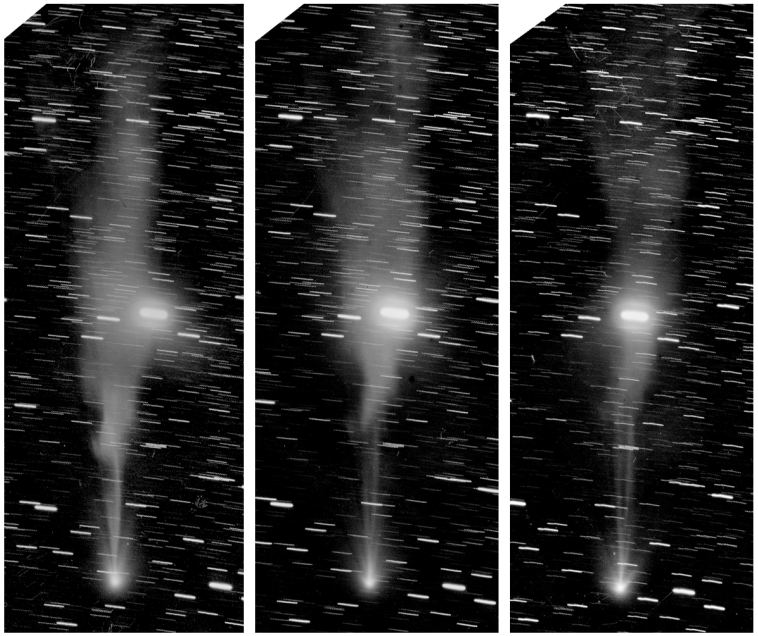
03 Morphology

Did the two comets behave the same way when visiting the inner solar system?


Holefscirc (1909)
Gazette Astronomique (1908)
Einarsson (1908)
Magnitude
Brightness
4
5
6
7
8
9
10
0
1
2
3
4
5
6
7
1908-08-29
1908-09-01
1908-09-15
1908-09-29
1908-10-01
1908-10-15
1908-10-29
1908-11-01
1908-11-15
1908-11-29
1908-12-01
1908-12-15
1908-12-29
1909-01-01


H (M. Ebell and H. Kobold)
0
1
2
3
4
5
6
1908-09
1908-10
1908-11
1908-12
1909-01
1909-02
1909-03
1909-04
1909-05
1909-06

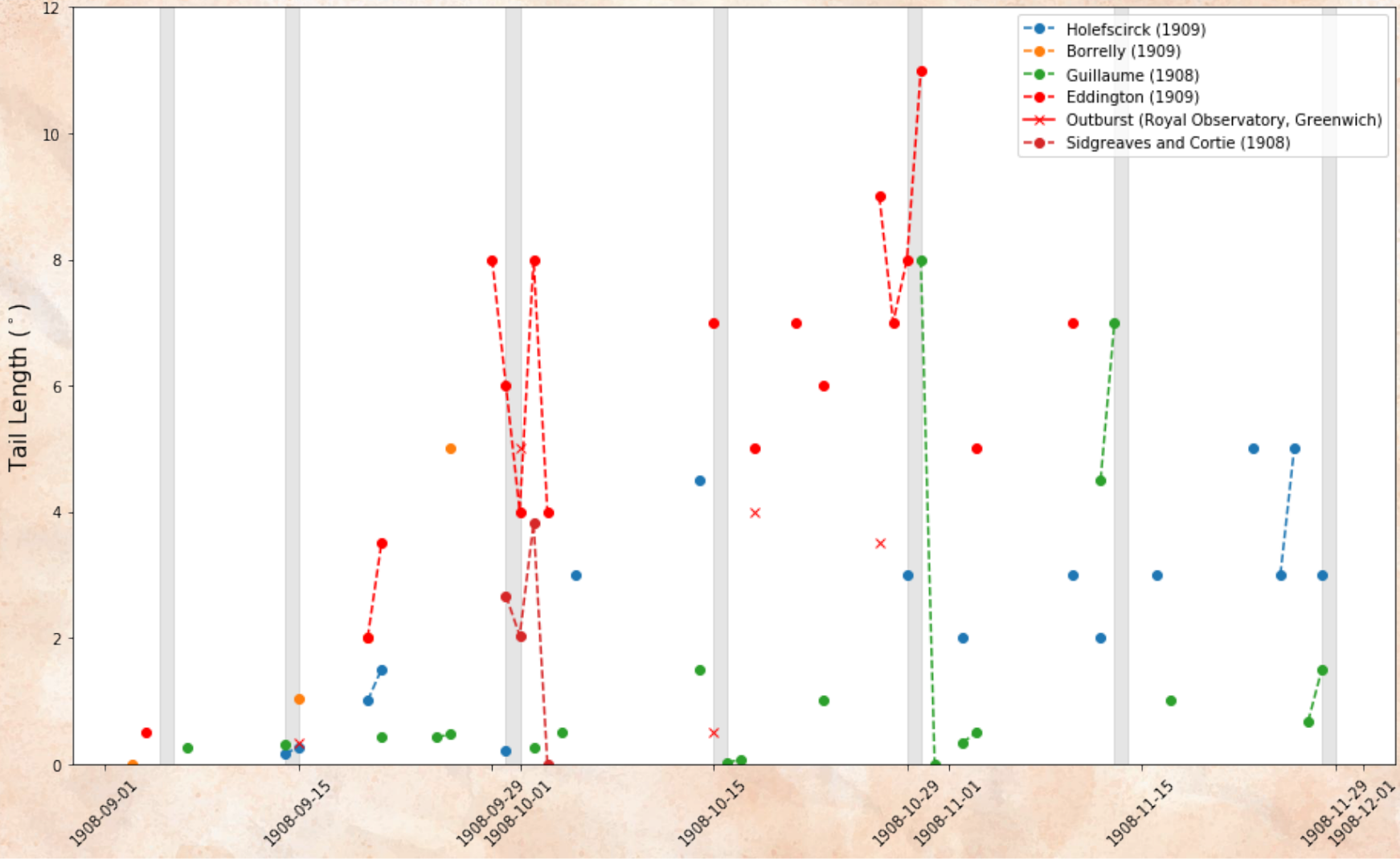
Comet Morehouse (C/1908 R1)
Tail Disconnection Event
1908 October 1-2



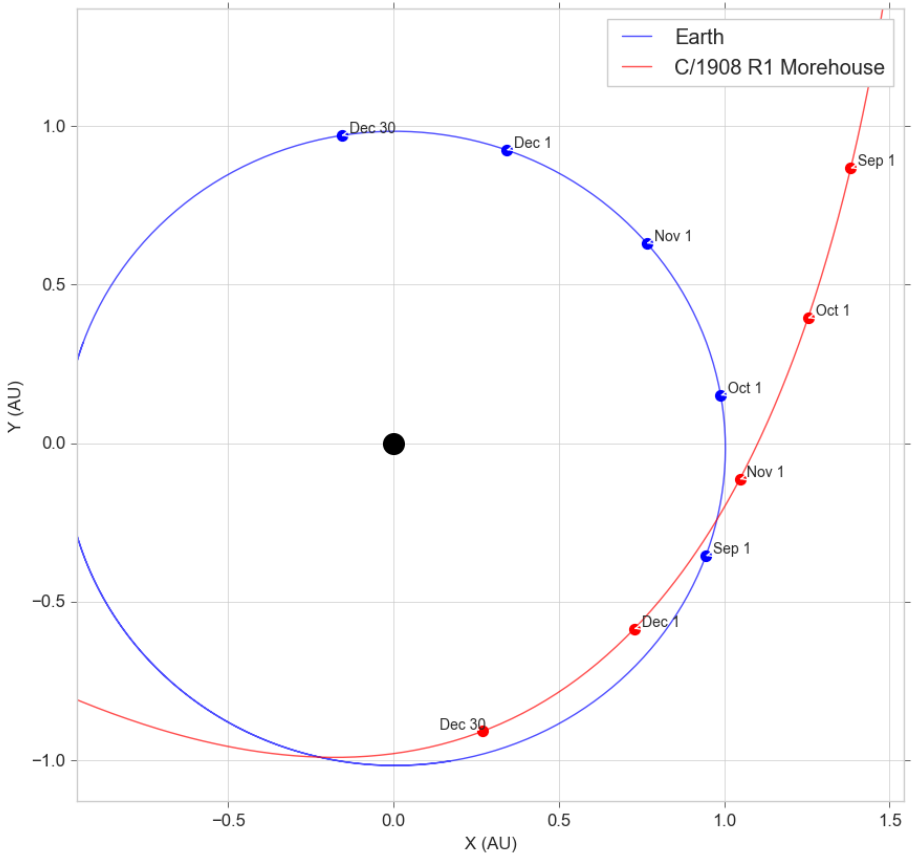
20:19Z 22:39Z 00:59Z

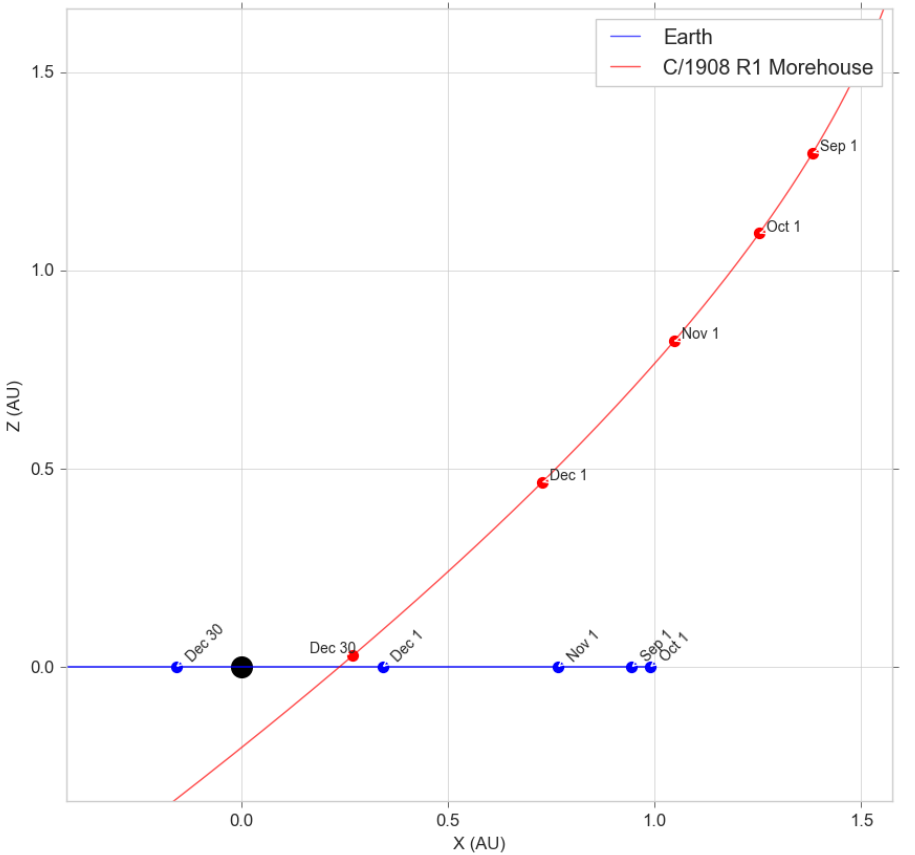
Series of 7200s exposures on blue-sensitive emulsion, taken with the Heidelberg-Königstuhl Observatory's 16" Bruce Double Astrograph.

Credit: August Kopff


Holefscirck (1909)
Borrelly (1909)
Guillaume (1908)
Eddington (1909)
Outburst (Royal Observatory, Greenwich)
Sidgreaves and Cortie (1908)
Tail Length (°)
0
2
4
6
8
10
12
1908-09-01
1908-09-15
1908-09-29
1908-10-01
1908-10-15
1908-10-29
1908-11-01
1908-11-15
1908-11-29
1908-12-01

Comet C/1908 R1 (Morehouse) as a C/2016 R2 (PanSTARRS)-like comet





THE AURORA BOREALIS AND MOREHOUSE'S COMET.

To the Editor of the SCIENTIFIC AMERICAN:

Prof. S. A. Mitchell's article on the peculiar behavior of Morehouse's comet is very interesting. We might well hope that a study of this comet will give us a much more definite and comprehensive conception of the significance of cometary and allied phenomena. Apparently the greatest change occurred during the night of September 30. Now it was on the evening of September 29 that there occurred such a display of the aurora borealis that you have but to inquire of any man in the northern part of the United States (who happened to be outdoors that evening) from Maine to Washington, to be assured of its wonderful activity, and to realize that it is very rarely that we witness displays that can compare with this.

In a letter from Mr. Sidgraves (Stonyhurst College Observatory) which appeared in Nature October 29, he tells of a magnetic disturbance which coincides in time with this aurora. It seems to be universally granted that the aurora and magnetic disturbances are closely related, also that both may be referred to solar influence. Mr. Sidgraves has shown that the coincidence in the time of happening of the aurora and magnetic disturbance was almost exact. It seems that the violent change in the comet and the terrestrial maanifestations can also be made to coincide in time of happening after suitable deductions have been made, and therefore prove that they were acting under the same influence. Now it was suspected a long time ago that there was a strong affinity between the aurora and comet's tails; this is a unique opportunity for confirming that suspicion.

WILFRID GRIFFIN.
Pittsfield, Mass.,
January 14, 1909.
Scientific American

One of the features of Lew Dockstader and his company of ministrel entertainers this season will be a unique stage effect entitled "Afloat in the Open Polar Sea," in which the polar regions are shown together with great moving icebergs and the glorious scintillating aurora borealis or northern lights. This masterpiece of stagecraft is the result of years of thought on the part of several experts and is accomplished in a noved manner. The open water is shown and great cakes of floating ice which move about in the most natural manner possible. The scene alone cost more than $5,000 and occupies less than two minutes of time in being shown. The effect is patented and protected in this country and Europe. Lew Dockstader and his merry company will be seen at the Boyd next Thursday; matinee and night.

GREAT SUN SPOT FOUND 2,500,000 MILES SQUARE

Remarkable Aurora Borealis is Discovered With Temperature of 60,000 Degrees Heat.

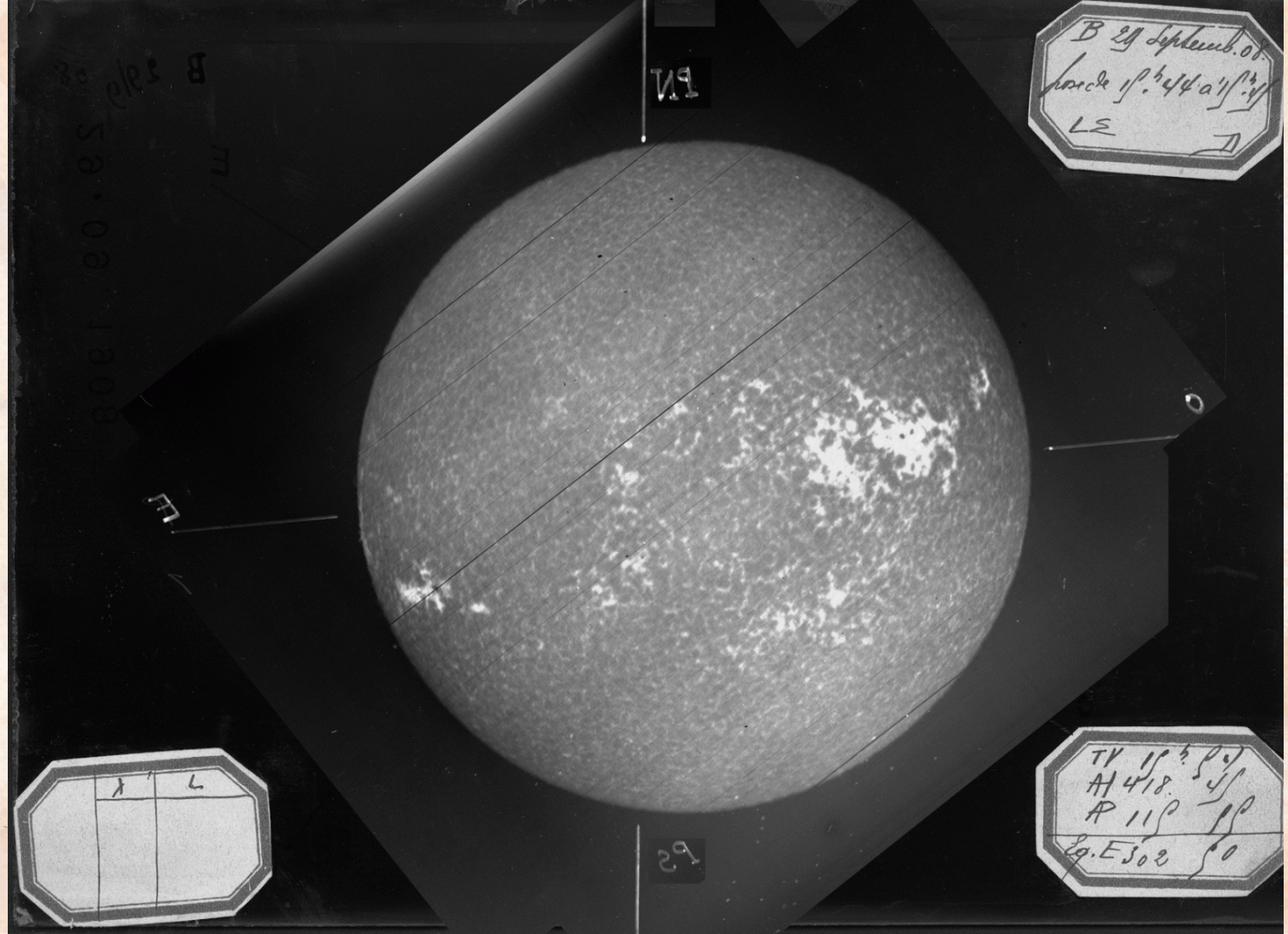
(By Associated Press.)

PITTSBURG, Pa., Sept. 12.—Attracted by probably the most remarkable aurora borealis ever witnessed in this section of the country, Dr. John A. Braschear, the well known scientist and astronomer, last night made a measurement of an immense sun spot he had just photographed.

This spot covers 2,500,000 square miles of the surface of the sun and has a temperature estimated at sixty thousand degrees above zero. The aurora borealis flashed in brilliant shafts to the north. The display lasted nearly six hours.

Dr. Brashear believes there is a close connection between the auroraborealis and sun spots.

"I expect we shall hear of magnetic disturbances due to these sun spots," said Dr. Brashear.



OBSERVATIONS OF THE AURORA, MADE AT THE YERKES OBSERVATORY, 1902–1909

By E. E. BARNARD

In the *Astrophysical Journal*, **16**, 135–144, October 1902, I have given my observations of the aurora at the Yerkes Observatory in the years 1897–1902. I have continued these observations, but not with the closeness of the previous records. I have not failed, however, to record every aurora that I have seen.

September 12. Mr. Lee reports that there was a large aurora after midnight last night (the 11th) through a very dense sky and nearly full moonlight. It was bright in the north with streamers and with fluctuating bright clouds overhead. It must have been a very large aurora, as the sky was too thick to see anything except the brightest stars. It appears to have been most active from 12^h to 13^h. There had been no aurora as late as 10 o'clock that night.

September 28. Mr. Sullivan reports that during a short period of clear sky at $14^h\ 30^m$ there was a brilliant aurora with some streamers.

September 29. $7^h\ 10^m$: Brilliant aurora seen through breaks in clouds, all over the north, northeast, and northwest. Some effort at streamers. $11^h\ 10^m$: The aurora had been very active with streamers and fluctuating patches of light. At about $8^h\ 30^m$ it was very brilliant. The sky in the north looked like daylight. The illumination extended a great distance east and west and the whole northern sky as high as the pole was bright, but there was not much activity. It got less bright and broke up into patches and became very active with streamers that reached higher than the pole. If any arch existed it was lost in the broken clouds which covered the sky more or less all the time. Patches or areas of light would ascend to great altitudes and then die out. At this time ($11^h\ 10^m$) the light had almost died out, but there were some streamers. The sky was pretty well covered with clouds. $12^h\ 0^m$: Some streamers and broken masses. Clouds. $13^h\ 0^m$: Less bright. Clouds.

September 30. Cloudy until 10^h. The clouds, disappearing, revealed a strong auroral glow. There was also a very small segment of an arch at the north by east horizon, which was not more than 1° high. The aurora was not active. By $10^h\ 30^m$ the arch had gone, but the glow continued. At 14^h there was some activity but no arch—only the glow and a few broad sheets of light shooting up from the horizon. The sky was very luminous all night—not haze, but like moonlight. I could read my watch in the Bruce dome at $14^h\ 0^m$ without artificial light.

October 12. $7^h\ 0^m$: Auroral glow began in low north—not there before this time. It got brighter rapidly and at $7^h\ 30^m$ was quite strong in moonlight and appeared to be forming an arch. $8^h\ 50^m$: Very active. Arch low and unfinished. Bright rays were moving rapidly to the left. It was conspicuous in spite of moonlight. $10^h\ 15^m$: It was apparently dead and had been so for half an hour or more.

October 30. Nothing in early part of night—had looked for aurora at moonset. First saw it at $13^h\ 20^m$. Not visible half an hour earlier. Very bright arch, almost like daylight. Then a dark under part came up, the whole rising slowly. At $14^h\ 0^m$ the arch was $6°\pm$ high and intensely bright. It soon broke and several streamers appeared. At $14^h\ 9^m$ the dark part disappeared and short streamers were visible all along the arch. These all moved to the right (east)—even those at the west end of the arch. $14^h\ 20^m$: Quiet—had faded much. $14^h\ 30^m$: Brighter with a great region of diffused light low in northwest. $15^h\ 0^m$: Arch formed again very bright but very low. Not active—dark below. $16^h\ 5^m$: Very bright again—active but no long streamers. The illumination was very wide east and west. $16^h\ 15^m$: Short streamers all along the arch. $16^h\ 45^m$: Still bright and active. There were no long streamers, only short ones and diffused masses of light moving east along the dark arch. The dark part would form very low, then rise to twice or more the original height. The light at times was so bright that it cast a shadow. Though the brightest aurora in a long time this was not a specially active one.

04 The Press

THIS BABY SMOKES AND DRINKS

Cleeland, O., Sept. 22.—Louis Tomazin, Polish baby, 30 months old, smokes cigars like a man. Louis also likes a glass of beer three times a day. He doesn't like candy.

Louis is a black-eyed boy of more than average intelligence. He is strong and vigorous and plays with older boys. He can count up to 5 and talks as plainly as boys much older.

He is a great favorite with patrons of his father's saloon and grocery. His father's customers buy him all his cigars and drinks.

Acustomer bought Louis a glass of beer and a stogie the other day. Louis took two swallows of the beer and set the glass down.

"I'm not well, today," said he. "Gim-me a cigar."

The cigar was lighted. Louis put it in one corner of his mouth and walked over to a chair.

"This is a pretty good one," said Louis as he sat down and crossed his arms over his breast. "I like a light cigar best."

The baby puffed hard at the cigar and blew the smoke high up into the air. Then he flicked the ashes several times. He smoked until the cigar was a little stub. Then he threw it away.

The lad doesn't like cigarets. He says they are nasty. The boys used to fool Louis by buying chocolate cigars and telling him they were real cigars. Louis knows the difference now at sight.

The lad has been smoking three months. His mother says he is healthier now than before he smoked.

BABY LOUIS TAKES A SMOKE.

DRILL AT HERNDON

FIGHTING FOREST FIRES

BY WALDON FAWCETT

Battling with a Forest Fire

Fire all Around

Forest Fire in California

Hot Work

Fighting with Shovels

THE calendar year of 1908 is likely to become memorable as the most disastrous 12 months in history in point of the destructiveness of forest fires in the United States. It is estimated that in ordinary years the average annual loss through forest fires in this country is not less than $50,000,000, but great as is this havoc under what might be termed normal conditions, it appears almost insignificant by comparison with the record-breaking waste of the present period, when the aggregate loss will probably amount to several times the usual $50,000,000. For a considerable interval this autumn, when the forest fires have been at their height, the flames were doing damage to the amount of $1,000,000 a day.

The principal cause of this epidemic of forest fires has been found, of course, in the drouth which has been general throughout the country; but there have been other adverse conditions which have contributed to the menacing situation. Indeed, as an expert on forestry recently pointed out, it has seemed as though every imaginable unfavorable condition has been present this year to help along the deadly and destructive work. Deadly—because, in addition to the loss of property, there has been an appalling loss of life in connection with this year's fires.

Even in an ordinary year it is estimated that not less than 65 lives are included in the toll exacted by forest fires during the 12 months, and this year in the case of the human sacrifice, as with the loss of material things, the average has been greatly exceeded. Moreover, there will be a sequel to this year's fires that will not appear in connection with any of the statistics of loss at first hand from forest fires. As readers of the newspapers have had good cause to realize, the fires this year have not been confined, as is often the case, largely to the densely wooded and sparsely populated areas, but have invaded many populous districts, laying waste towns of considerable size and driving great numbers of people from their homes. As a result of the suffering and exposure thus entailed, there will probably be much invalidism and many deaths that, not being immediately attributable to the forest fires, will not be included in the statistics that will constitute the chronicle of this year's fire record.

Another unusual feature of the forest fires of 1908 is found in the wide range of territory visited by the flames. In the Maine woods and in the Adirondacks of Northern New York; throughout the State of Pennsylvania; in Michigan, Minnesota and Wisconsin and other territory adjacent to the Great Lakes the forest fires have been raging simultaneously, and even on the Pacific Coast the menace has been present, threatening among other things the destruction of one of the finest groves of the prized big trees. Moreover, the forest fires this year have been unusually difficult to conquer, and in many instances the owners of magnificent private forests or hunting preserves provided with the best private fire-fighting systems have found themselves unable to cope with the rapidly traveling flames and have been obliged to appeal to nearby municipalities for aid.

The recent forest fires have had their severity emphasized by reason of the fact that during the three or four years prior to the present one the annual loss from forest fires has been unusually small, thanks to favorable climatic conditions. However, this season's unparalleled record has given the country an unpleasant object lesson as to what may happen any year and has aroused everybody concerned to a realization of the need of some better system of fighting and preventing this immense yearly loss. Not only have private individuals and corporations owning timber lands been stirred to action by the spectacle of the past few weeks, but the United States government has inaugurated a country-wide campaign that it is believed will point a way to prevent many forest fires and to control those that, despite precautions, gain a start.

As a first step the national government has had one of the most efficient employes of its forest service, Mr. Raymond W. Pullman, traveling over the burned areas in the Northwest and elsewhere, and not only gathering detailed statistics that will be of value in urging congressional action on the subject, but also taking notes as to the physical characteristics of the fires and all details that might lead to a better understanding of this destructive element and the best means to circumvent it.

At the same time the national authorities have detailed an expert on forestry, Mr. Paul G. Redington, to make an investigation of the whole broad subject of forest fires and to devise ways and means for an improvement of conditions in future. In speaking of the line of action to be taken by the government in enlisting co-operation for the common cause Forester Redington said recently: "What is wanted is organized effort on the part of the government, the states, corporations and individuals. There should be adequate fire laws in every state where any forests are located. These laws should provide for the appointment of fire wardens, who should have authority and the power to enforce such, and to call upon the services of citizens in fighting forest fires which occur. The law should provide for a penalty to be imposed upon any man who refuses to give his services in time of need."

It is realized that the railroads through their spark-emitting locomotives constitute one of the chief sources of forest fires and consequently one of the first moves which has been made by Uncle Sam in the present undertaking was to invite the railroads to make common cause with the federal government against the forest fire menace. Within the past few weeks there have been prepared articles of agreement for a co-operative working arrangement between the government and those railroads whose lines traverse the national forests of the West and this is believed to be but a beginning of a better understanding between some of the parties most concerned.

Without the unselfish aid of corporations the United States government will have up-hill work in its crusade against the forest fire menace and in discussing the other day what these private interests can do to assist Forester Redington said: "Railroads whose rights of way run through forests should be required to keep the right of way clear of all debris and inflammable material, should equip their engines with adequate spark arresters and should adopt oil for fuel in forest regions if such change will tend to the more ample protection of the forests. Railroads should also furnish patrolmen who, traveling on "speeders," can follow the trains as they traverse the woodland districts and extinguish any small fires that may be started ere the flames have gained sufficient headway to be really dangerous. Nor is it only the railroads who can help in this big task. Lumber companies should see to it that their sawmills, located within the forest, are equipped with devices that will prevent the scattering of sparks and should keep the areas surrounding their mills free from debris.

When it comes down to systematic methods of fighting forest fires, the subject does not, chappily, present a wholly unexplored field. For some years past the United States government has been rapidly developing an efficient patrol and fire-fighting system on its own forests, and, inasmuch as Uncle Sam now controls about one-fourth of the forest area in the United States, it can be seen that the national authorities have had an excellent practice ground on which to try out their theories on a large scale. The realization brought by the forest fires of 1908 of the crying need for organized effort in fighting forest fires throughout the entire country, comes just at a time when the government has its own system practically perfected, and there is no doubt that this will be used as a model that will be copied by state and county authorities, corporations and private individuals, who are owners of extensive timber lands.

Under the forest patrol system maintained by the United States government on its own land a ranger or guard travels on foot or on horseback over the district of which he has charge at regular intervals and keeps a careful lookout for any fires that may have started since his preceding patrol. This nomadic fire warden makes especially frequent trips along the wagon roads trails or other frequented routes of travel through the forest and not only keeps his eyes open for incipient fires, but cautions all persons who may be traveling through the forest to be sure that any fires that they may light are fully extinguished before the campground is abandoned.

The arteries of travel through the forest are also extensively posted or placarded with printed notices warning hunters, campers and the traveling public in general against the dangers of starting fires except when absolutely necessary, or abandoning a camp site while the embers of the camp fire are still aglow. Not only do the forest rangers, or government patrolmen, pace their "beats" through the forest, but every now and then each of these guards climbs to commanding elevations or lookout points within his district to survey the whole situation and, if the existence of a fire is discovered, the ranger either puts it out himself, if he is able, or, if the flames are too formidable for his unaided effort, he summons the assistance of other rangers. A complete system of telephonic communication throughout Uncle Sam's forests enables the rallying of a good-sized fire-fighting force at short notice. Finally, these very busy rangers follow railroad trains—if their districts be traversed by the steel-tracked highways—and extinguish the innumerable small fires that constantly originate from locomotive sparks.

WALDON FAWCETT.

Paris Has New River Subway.

Paris will operate this winter a new subway which tunnels under the River Seine from the Place de la Concorde to the Chamber of Deputies, where the lawmakers of France sit in council, and where presidents are elected for the French republic. It is to be a part of the new Metropolitan Subway Line, and this line is expected to be opened in the spring and will connect Montmartre with the Porte de Versailles. The other metropolitan lines are forced to take to open bridges when they come to cross the Seine River, so that this tunnel will be an entirely new thing for Parisians. There are to be two distinct tunnels—one for northbound and the other for southbound trains.

Both tunnels will be under the river and lie side by side, but will have absolutely no connection. While running parallel the two tunnels are several hundred feet apart. They are so arranged, however, that one tunnel could be used as a single track line to handle passengers and trains in case the other should be temporarily disabled.

"HUGE COMET CAUSES OUR DISCOMFORT."--BUSBY

Editor Courier: A great West Indian storm is coming soon. It will be followed by colder weather and frost. I told the people through the Courier that we would have no frost up to Sept. 23. Was I not right?

The hot weather of the past month is due to a great comet I discovered. Its tail is near to our earth. It is my belief that the smoky appearance of the atmosphere and the great heat are due to this wandering stranger, which is traveling through space faster than any express train. Forest fires never could make such heat and smoke.

Next summer it will be possible to see this comet with the naked eye. It will be as bright as the comet of 1860. I hate to say it, but it means war and pestilence. The one in 1860 brought on the great war between the North and the South, and sanguinary struggle followed.

I believe this wandering stranger of the starry heavens is the same comet and that the smoke, the heat and the drought in places are due to its appearance.

Disprove it if you can.

JOHN C. BUSBY, Weather Prophet.

Independence, Sept, 21, 1908.

month.

COMING END OF WORLD

Halley's Comet May Snuff Out Life on the Earth

Berkeley, Cal., Feb. 9.—"If the astronomers are right in their estimations of the amount of cyanogen gas in the tail of Halley's comet, and if that body's vapors do envelop the earth, we may have a chance to feel the sensations of the bugs and insects which are killed by the use of this deadly

To Escape the Comet, Hire Submarine Boat

Deadly cyanogen gas does not travel through the water. So to escape the comet hire a submarine boat, fill it with three days' edibles and drinkables, and go under water to-morrow. The deeper the spot the better.

Stay under for three days, not even poking your nose above for one moment. At the end of that time, if nothing happens to your submarine, the cyanogen gas in the world will have spent itself.

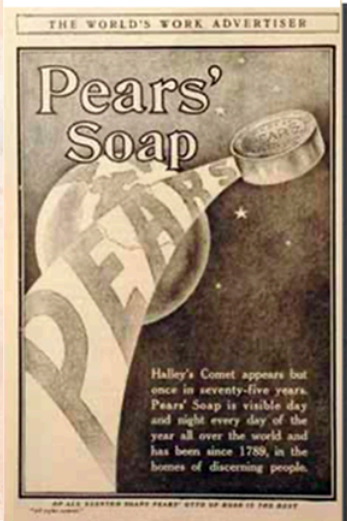
Then, if all the people in the world have perished under the deadly gas, you can claim the world for your own.

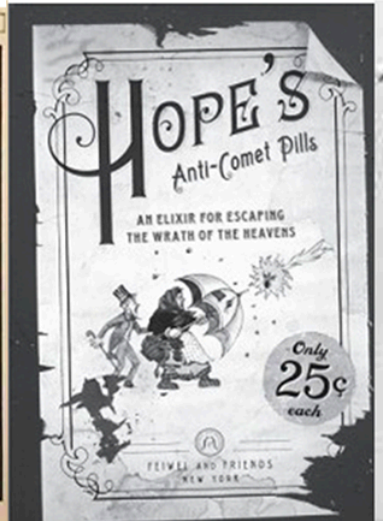
If they are not dead—perhaps you can stand the laugh.

THE PROTECTION OF COMET PILLS.

New York, May 16.—Whatever the comet may do to this old earth, the negroes of Port Au Prince, Hayti, are prepared. They are confident they will go unscathed, because they are well packed with comet pills.

Officers of the Hamburg-American liner Allegheny, in from Port Au Prince today, said that all the negro stevedores, servants, laborers, merchants, beggars, and thieves are rushing pell mell to the hut of a shrewd old voodoo doctor just outside the city, who is selling comet pills as fast as he can make them.





05 Conclusions

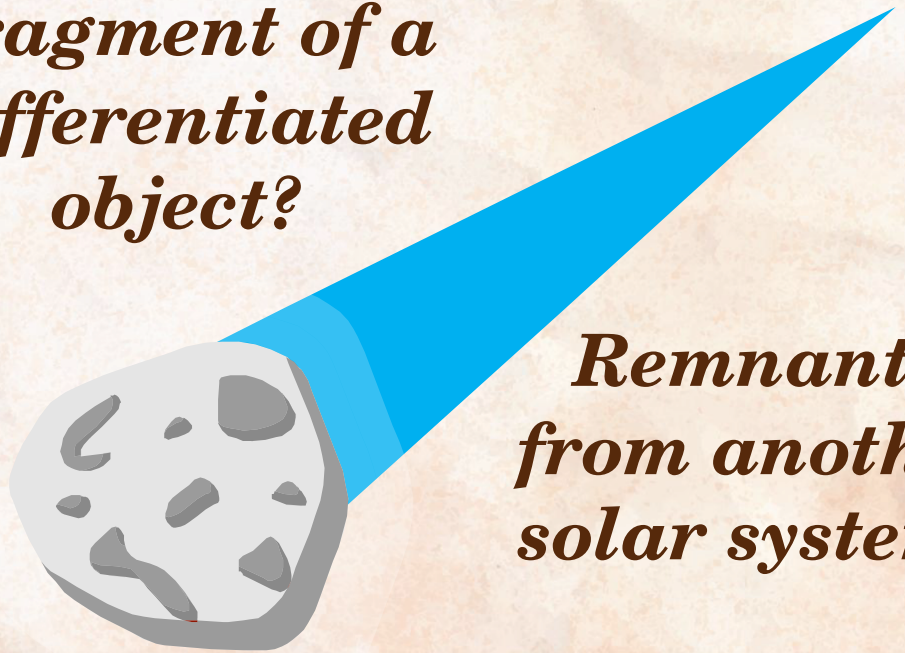
So, is C/1908 R1 Morehouse a C/2016 R2 PanSTARRS-like comet?

C/2016 R2 (PanSTARRS)		*C/1908 R1 (Morehouse)*
Nearly Parabolic	✓	**Nearly Parabolic**
High N_2/CO ratio – 0.09	✓	0.07
Dust-poor - Afρ ~ 750 cm	✓	Very Weak
H_2O-poor - H_2O/CO < 0.32%		Not found
CN-poor – Q(CN) = 3×10^{24} mol/s	✗	**Not** depleted

But what ARE they?

Fragment of a differentiated object?

Formed in unique formation zones?



Remnants from another solar system?

Je ne voudrais pas terminer cette étude sans résumer ce que je viens de dire, afin de répondre, en deux mots, à cette question : Quels sont les corps qui composent les comètes ?

Il y a une douzaine d'années, la réponse aurait été simple : je vous aurais dit que toutes les comètes ont sensiblement la même composition, qu'elles contiennent, d'une part, un gaz hydrocarboné et du cyanogène portés à une température assez élevée pour être lumineux, et, d'autre part, des particules solides également incandescentes pouvant se volatiliser à l'approche du Soleil et réfléchissant la lumière solaire.

Mais aujourd'hui que la méthode photographique nous a permis d'étendre nos investigations sur une plus grande étendue du spectre, la constitution des comètes nous apparaît comme étant beaucoup plus complexe. Tout d'abord les comètes n'ont pas toutes la même composition, et, lorsque nos connaissances seront plus avancées, nous serons sans doute conduits à classer les comètes en diverses catégories suivant leur type spectral, comme nous le faisons pour les étoiles. Il y a des comètes essentiellement gazeuses et bleues, comme la comète Morehouse, et il y a des comètes jaunes où dominent des particules solides, comme la comète de Johannesburg. Quant à la nature des gaz contenus dans les comètes, nous pouvons affirmer que

Mais les astronomes sont loin d'avoir dit leur dérnier mot sur la composition des comètes, et il nous faut souhaiter l'apparition dans le ciel de quelques comètes brillantes pour nous permettre d'aller plus avant dans l'étude de la constitution de ces astres étranges. Vous voyez donc que si les comètes ne répandent plus la terreur, comme autrefois, elles sont encore aujourd'hui remplies de mystère.

A. DE LA BAUME PLUVINEL.

But astronomers are far from having said their last word on the composition of comets, and we must hope for the appearance in the sky of some brilliant comets to allow us to go further in the study of the constitution of these strange bodies. **So, you see that if comets no longer spread terror, as in the past, they are still filled with mystery today.**

Aymar de La Baume Pluvinel

Comet C/1908 R1 (Morehouse) as a C/2016 R2 (PanSTARRS)-like comet

Thanks!

Let's talk comets!

Sarah.Anderson@lam.fr