Komeetfotografie

Waarneemactie 46P/Wirtanen

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Jaap van ‘t Leven
Oss, 20 oktober 2018

Nederlandse Kometen Vereniging

Comet
McNaught 2007

Vereniging ‘Werkgroep Astrofotografie’

Waarom moet U kometen fotograferen?

Wetenschappelijke doelen:

- Absolute helderheid / verloop magnitude
- Coma morfologie en “degree of condensation”
- Stofstaart – structuur en evolutie
- Gasstaart – structuur en evolutie
- Rotatie kern / nucleous →
- Fragmentatie
- Etc., etc.

Hale Bopp 26 Apr 97
Ti245 on CG11

Het zijn ook prachtige plaatjes!!!

C/1996 B2 Hyakutake 38min 300mm F/4, Hypered Fuji 800, 23 Mar 96

C/1995 O1 Hale-Bopp 8 min f/2.8 f=140mm, Hypered ISO800, 30 Mar 1997

Waarom Nu?

Waarneemactie periodieke komeet 46P/Wirtanen

- Gunstige verschijning na midden november 2018
  - Tussen 22:30 en 23:00 MET in zuiden.
  - 7 graden boven horizon op 16 november, klimt 1 graad per dag. Circumpolair vanaf 21 december 2018.
- Perihelium op 12 dec 2018 op 1.055 AE van de zon
- 0.078 AE van Aarde op 17 dec 2018 (=30x afstand Aarde-Maan)
- Verwachte visuele helderheid Mv = 3.8
- Diffuus object met grote coma ($\pm$ 1 graad)

Waarom Nu?

Internationale Waarneemactie – University of Maryland

http://wirtanen.astro.umd.edu/

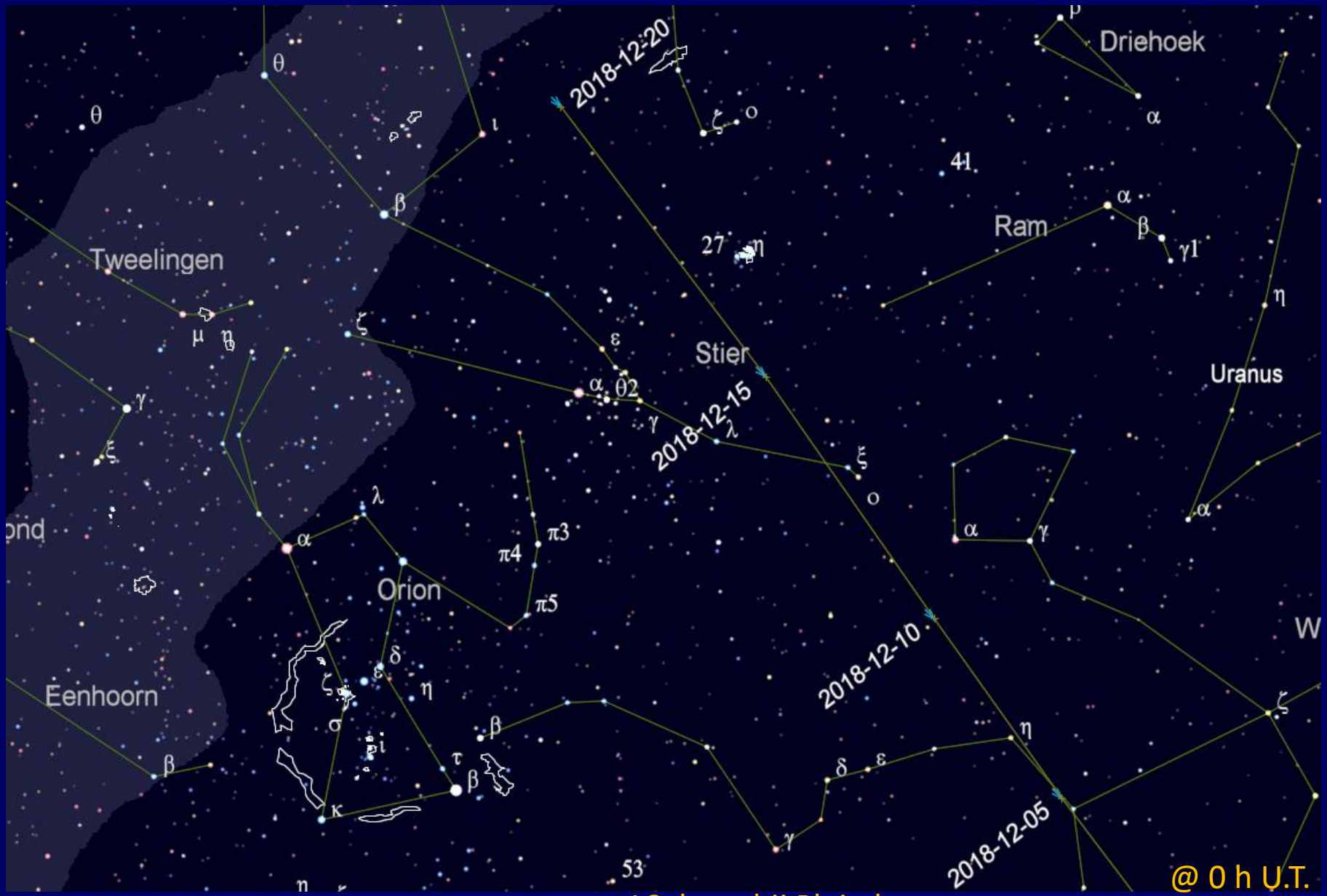
Data 46P/Wirtanen

- Carl Wittanen 17 jan 1948
- Lick Observatory
- ∅ 1.2 km
- Jupiter familie – Aphelium 5.13 AE
- P = 5.43 jaar
- Perihelium verkleint onder invloed van Jupiter
  - 1.625 → 1.256 AE in 1972
  - 1.256 → 1.085 AE in 1984
  - → Hyperactiviteit en uitbarstingen
- Mogelijk doel ruimtemissie

73P/Schwassmann-Wachmann III „Outburst“ Cookbook Ti245 CCD + CG11- 25 Oct 95

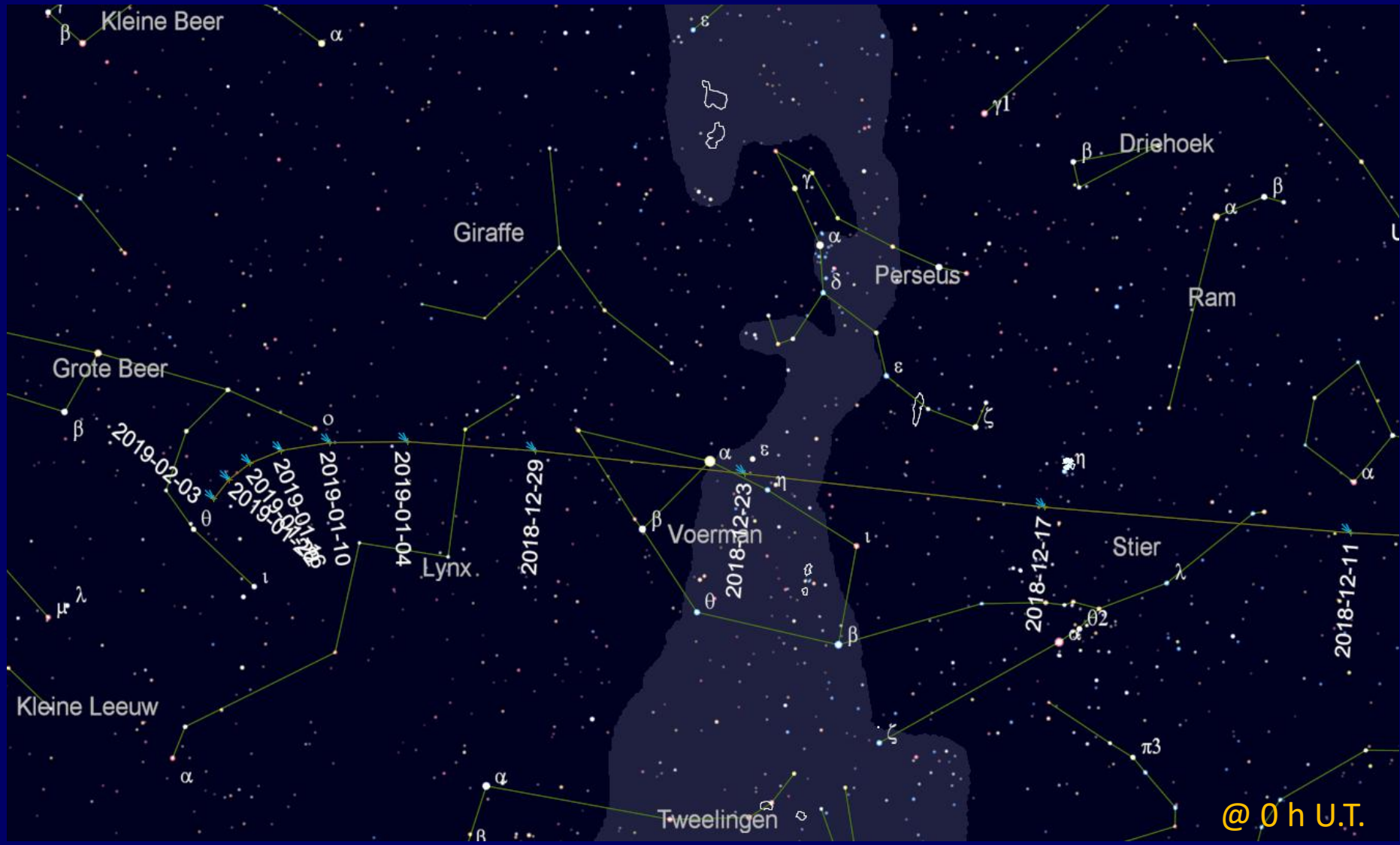
46P/Wirtanen in 2018

46P/Wirtanen in 2018



16 dec – bij Plejaden

46P/Wirtanen in 2018/19



16 jan – bij NGC 2685 S0-a

16 dec – bij Plejaden

Helderheidsverloop Kometen

Formule van Holetschek

$$m_1 = H_0 + 2.5 \times \left(\log \Delta^2 + \log r^n \right)$$

$H_0 \approx 9$ (absolute helderheid 46P/Wirtanen)

$n \approx 6$ (hellingsfactor 46P/Wirtanen)

Δ = afstand tot de aarde

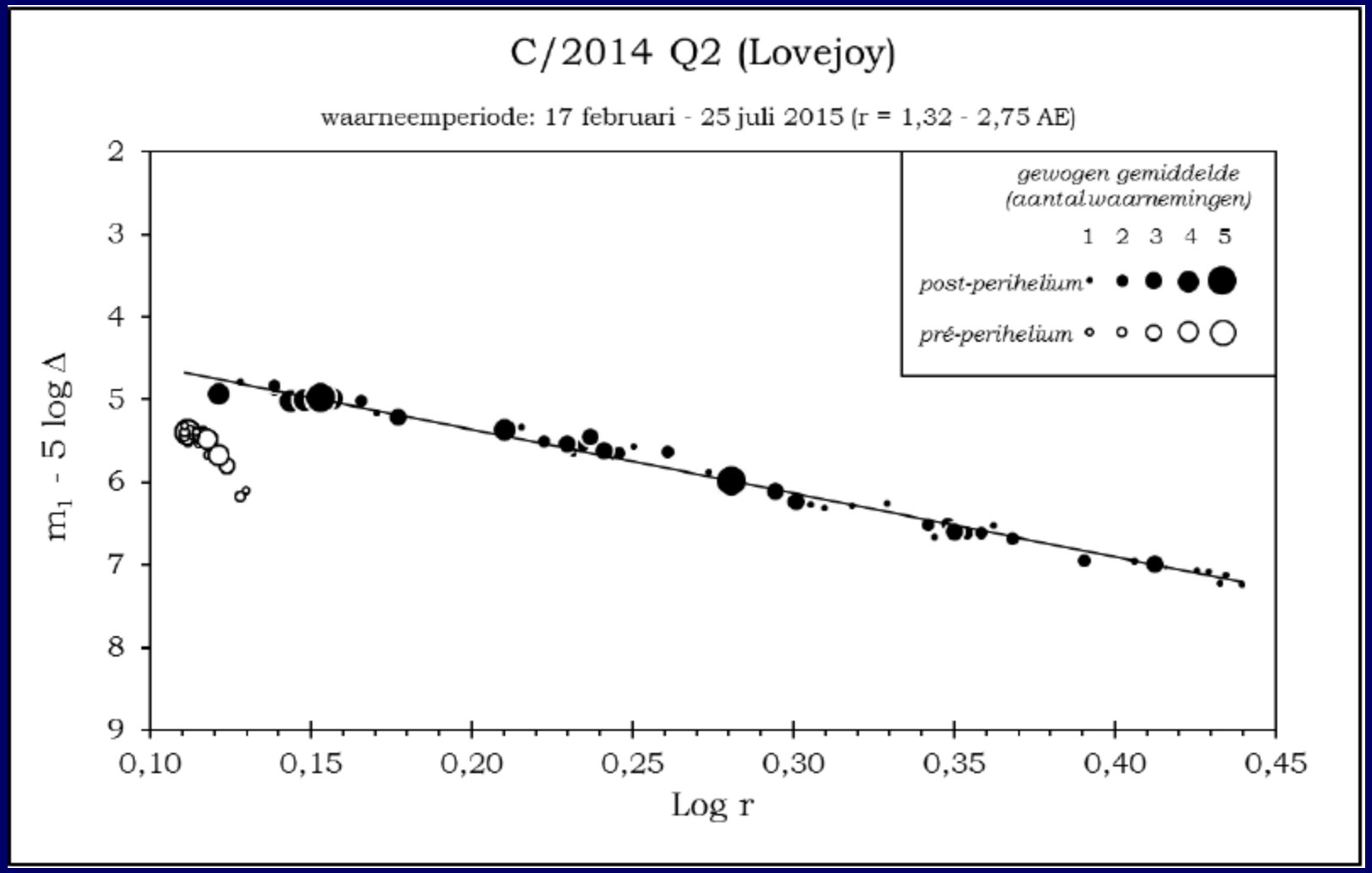
r = afstand tot de zon

H_0 en n veelal verschillend voor / na perihelium

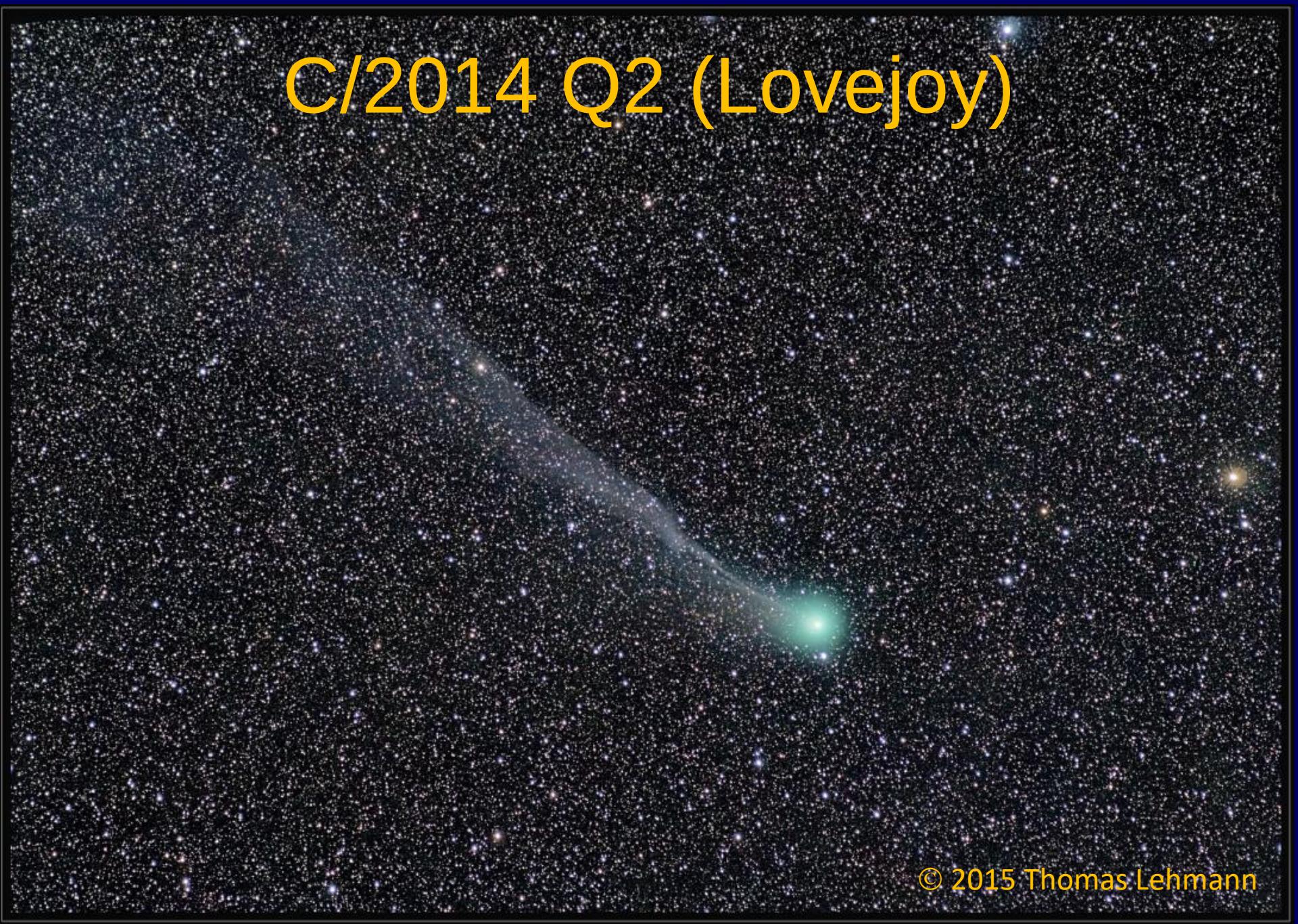
Grafiek : $m_1 - 5 \log \Delta = H_0 + 2.5n \log r$

Heliocentrische helderheid

Helderheidsverloop C/2014 Q2 (Lovejoy)



C/2014 Q2 (Lovejoy)



Comet C/2014 Q2 (Lovejoy) - 2015-02-13, 18:53 UT, field size 5.7°x4.0°

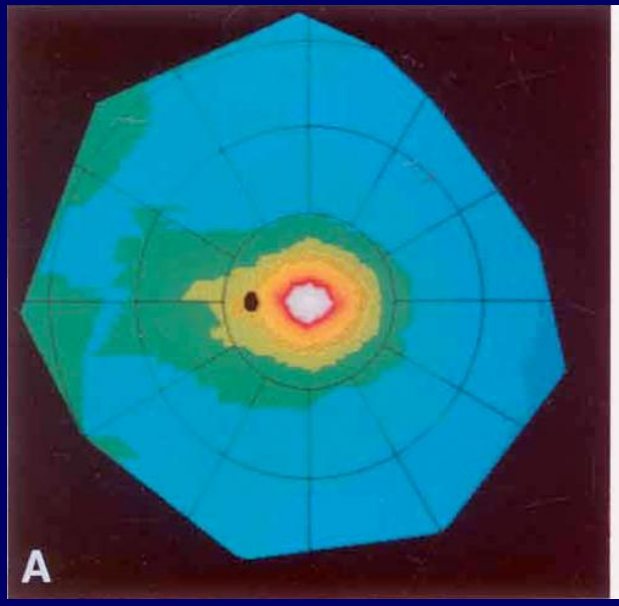
© 2015, Thomas Lehmann

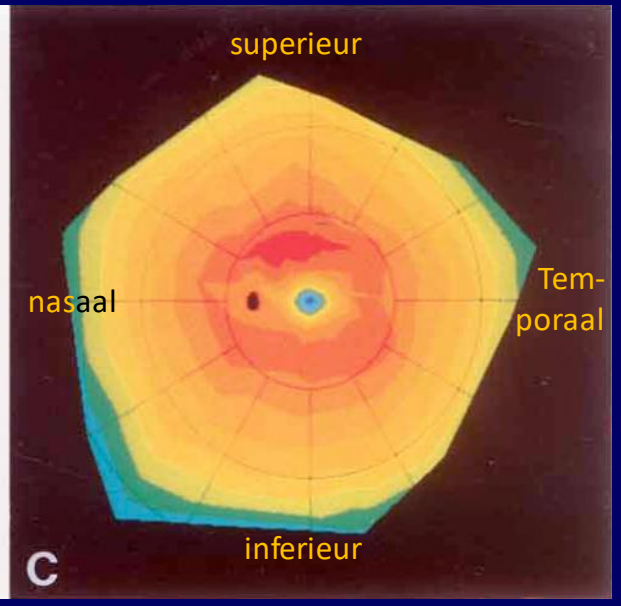
Visuele Helderheidsschattingen

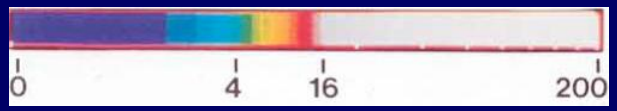
- Moeilijk
- Verschillende methoden (Sidgwick bij voorkeur)
- Vergelijk komeet met uit focus gedraaide referentie sterren
- Gevoeligheid oog is niet lineair
- Purkinje effect (staafjes ongevoelig voor rood licht)
- Zie waarneeminstructie NKV op www.kometen.nl
- Beste schatting met zo *klein mogelijk* instrument – dan wordt de coma relatief helder en meegenomen in de schatting. Uittreepupil 4.6 - 7 mm

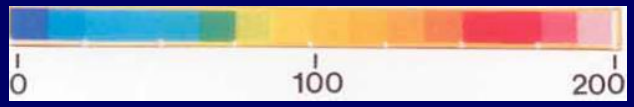
Het Oog

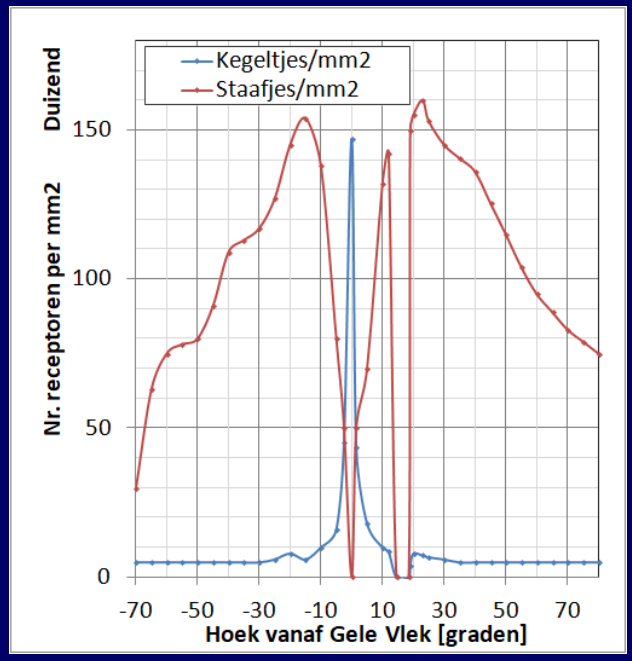
Perifeer waarnemen met staafjes is een kunst!











Kegeltjes

Staafjes

Gemiddeld Fotoreceptor Dichtheid Linker Oog

Fotometrie met groene kanaal DSLR

European Comet Conference Ondrejov 2015

Total Comet Magnitudes from CCD- and DSLR-Photometry

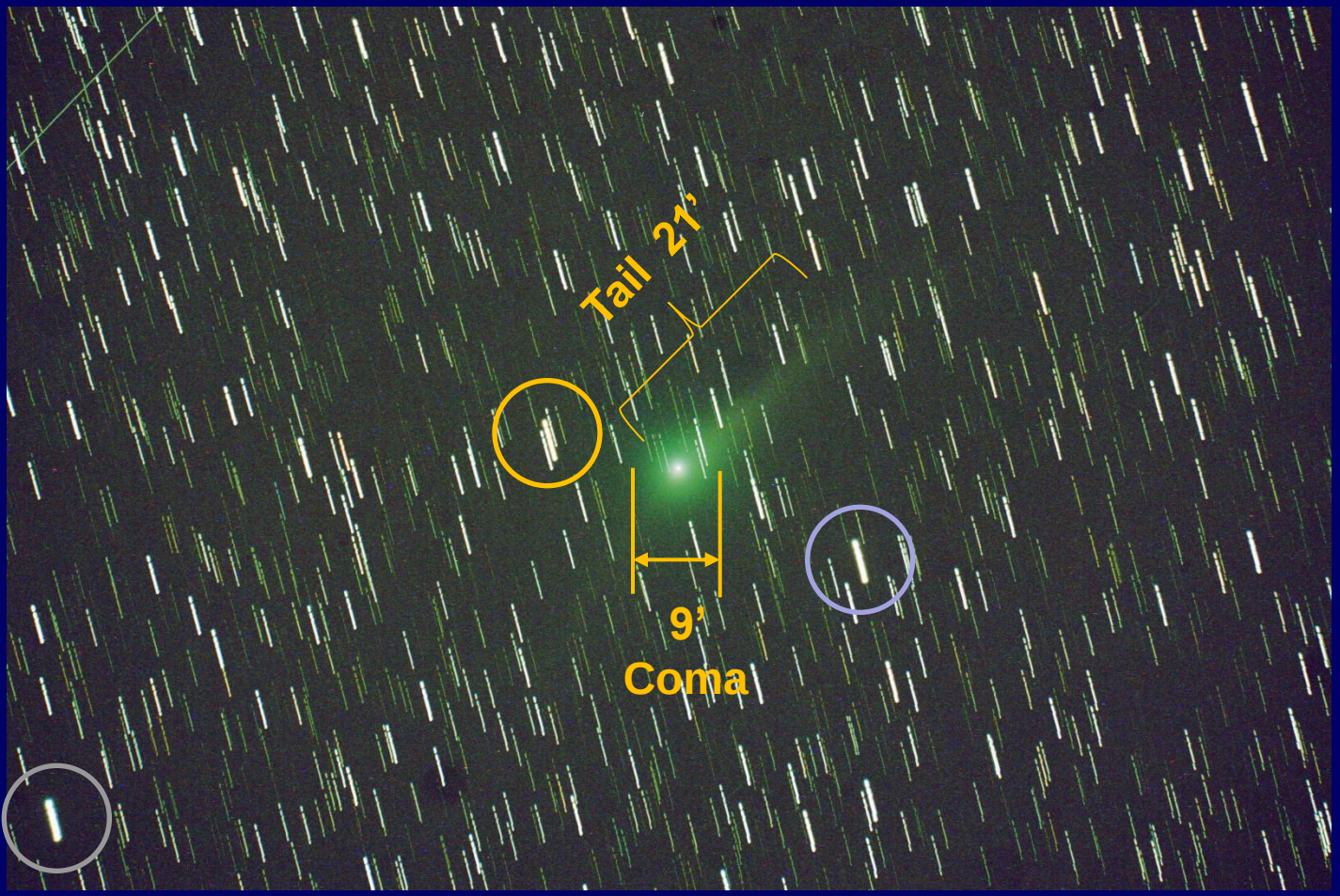
Thomas Lehmann, Weimar (Germany)

https://github.com/ewelot/airtools

Procedure (1) Image Capture

- CCD/CMOS + filter or DSLR; Lineair CCD/CMOS
- Telelens: Snel (f/3-f/5), Grote Opening
- (Twee Stacks van) *Unsaturated* Images, in focus
  - Stack op stars
  - Stack op Comet
  - Average (NOT median – gooit informatie weg)
- 16 bit RAW
- Automatic Noise Reduction – OFF
- Automatic Dark Subtraction – OFF
- Calibratie (Bias, Dark Frame, Flat Frame)
- VERDER GEEN BEWERKINGEN !!

Voorbeeld: Komeet C/2015 V2 Johnson



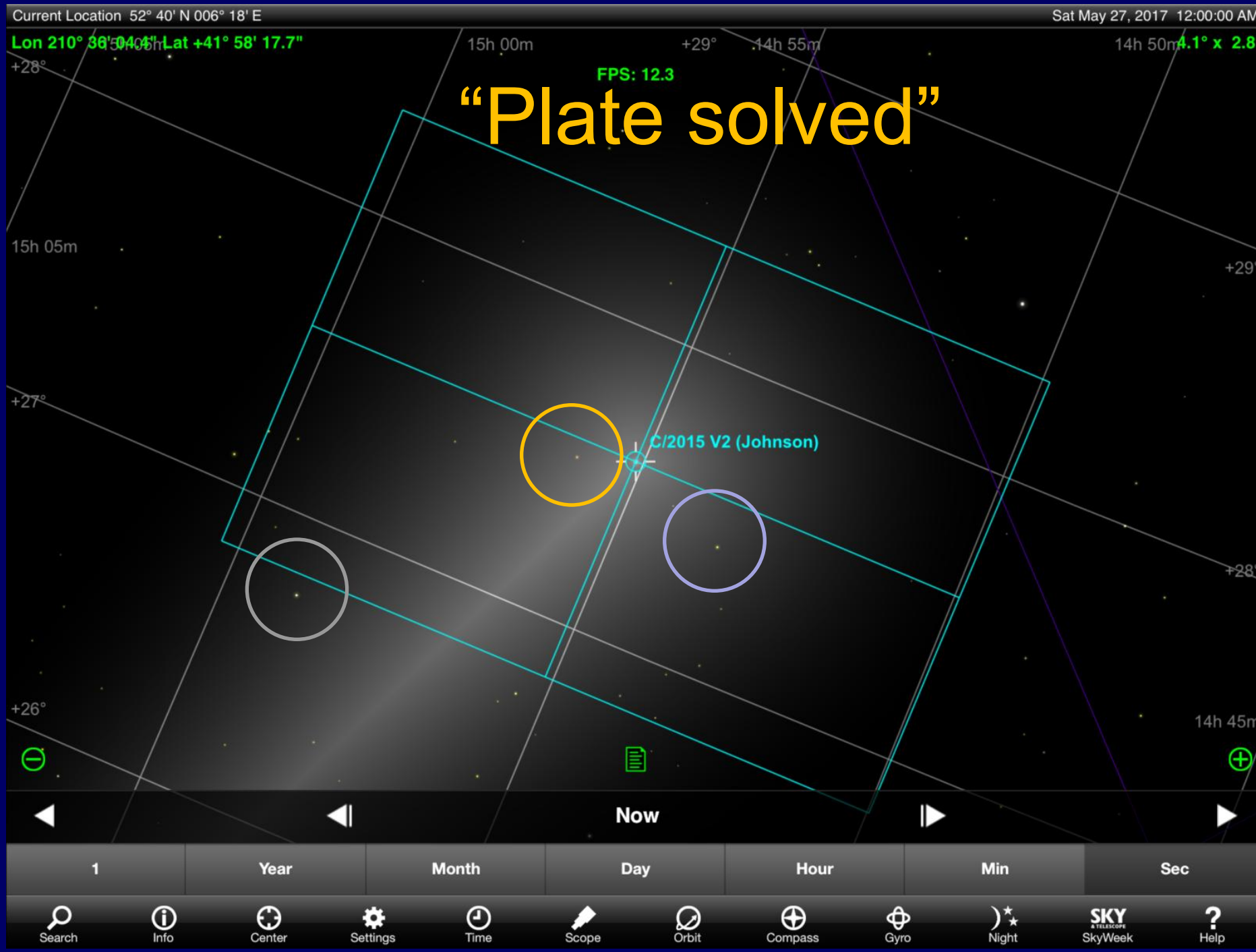

Current Location 52° 40' N 006° 18' E
Sat May 27, 2017 12:00:00 AM
Lon 210° 36' 04" Lat +41° 58' 17.7"
4.1° x 2.8°
FPS: 12.3
“Plate solved”
15h 00m
+29°
14h 55m
14h 50m
+28°
15h 05m
+29°
+27°
C/2015 V2 (Johnson)
+28°
+26°
14h 45m
Now
1
Year
Month
Day
Hour
Min
Sec
Search
Info
Center
Settings
Time
Scope
Orbit
Compass
Gyro
Night
SkyWeek
Help

Image Data

Comet C/2015 V2 (Johnson)

- HD 131862 Mv=8.89 Clr+1.64 Spectra K; RA 14^h 55^m 11.61^s Decl 27^o 35' 41.3"
- HD 131411 Mv=8.03 Clr+0.96 Spectra G5; RA 14^h 52^m 45.94^s Decl 27^o 30' 02.7"
- Angular separation sterren is 0.5463 graden

- Coma diameter 0.1437 ^{o} = 8.6'
- Lengte stof staart 0.36 ^{o} = 21'

- Image 27 May 2017 0h MEZT
- Stack 22x 3 min, cropped 75%

- Instrument William Optics Megrez 80 II ED F/7 & 0.8x flattener / reducer f=560*0.8 = 448 mm
- Canon 70D sensor 22.5 x 15.0 mm / 5472 x 3648 pixels
- 4.11 μm/pixel
- ISO 3200

- Image grootte is ~75% van 2.88 x 1.92 degrees = 2.16 x 1.44 degrees

Image

Gegevens opname

- Datum, tijd (U.T.)
- Geografische positie
- Lens / Telescoop (opening, brandpuntsafstand, f-ratio)
- Camera
- ISO
- CCD/CMOS chip, pixel grootte, grootte beeldveld, #pixels h x b
- Belichtingstijd en stack
- Dark frames
- Flat frames

Resultaten

- Fotometrische Magnitude (groene kanaal)
- Coma diameter
- Lengte en orientatie staart(en)

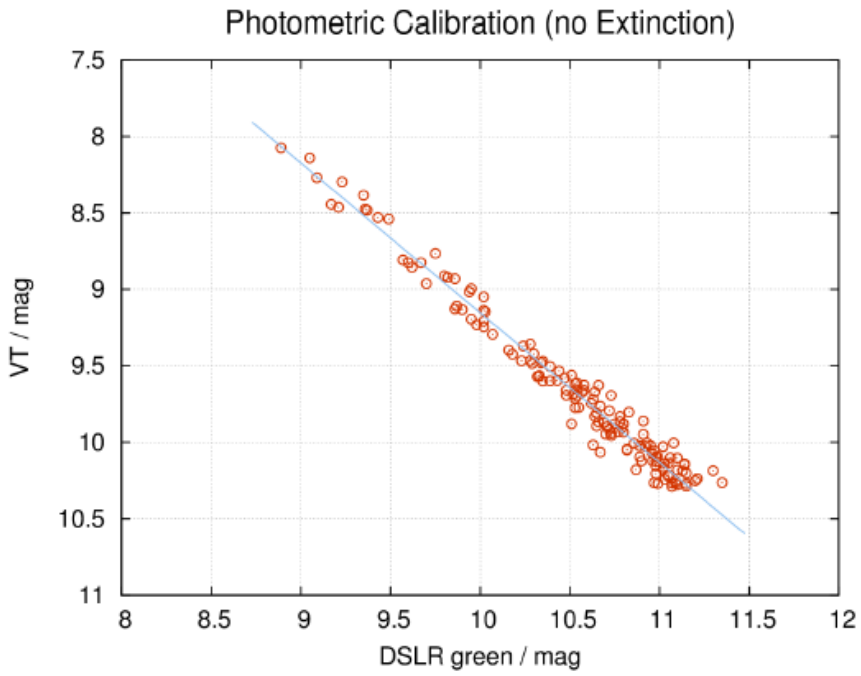
→ vandorps@kpnmail.nl

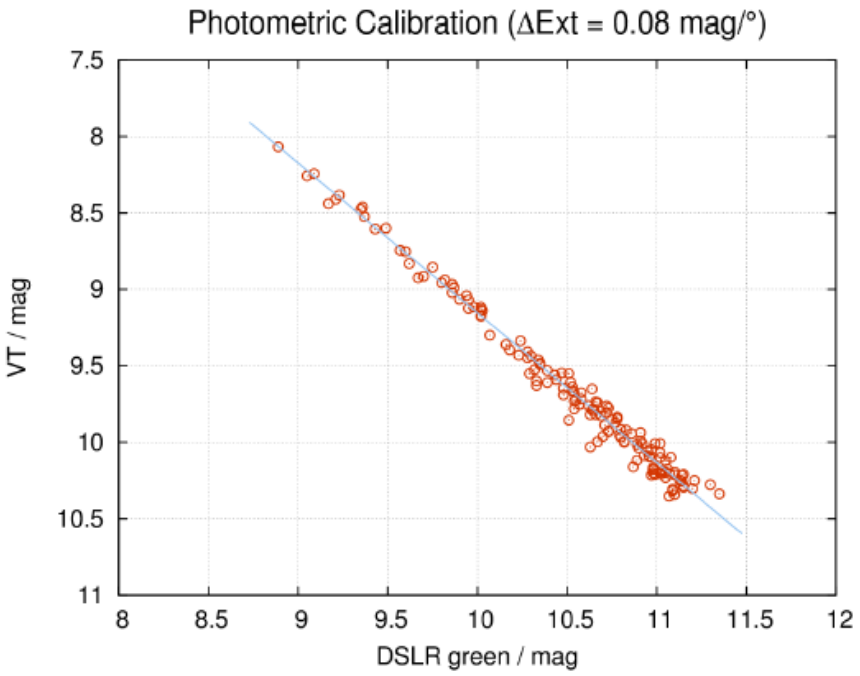
Procedure (2) Image Analyse

- AIRTOOLS (Thomas Lehmann) draait onder Linux
  - Helderheid & gradient hemelachtergrond (e^- / pixel)
  - Fotometrie vergelijkings-sterren
    - Geen dubbelsterren
    - Geen veranderlijke sterren
    - Geen sterren met spectraalklasse roder dan K0 of B-V > 0.8
    - Integreer e^- count in gebied ~FWHM van ster, pas “aperture correctie” toe, corrigeer voor hemelachtergrond
    - Calibratie $m-m_{ref} = 2.5 \log (I / I_{ref})$
  - Herhaal Fotometrie op komeet (komeet stack)

https://github.com/ewelot/airtools

- Example: Comet C/2014 E2 (Jacques), 2014-05-03, altitude 11°, telelens 200mm, Pentax K5IIs





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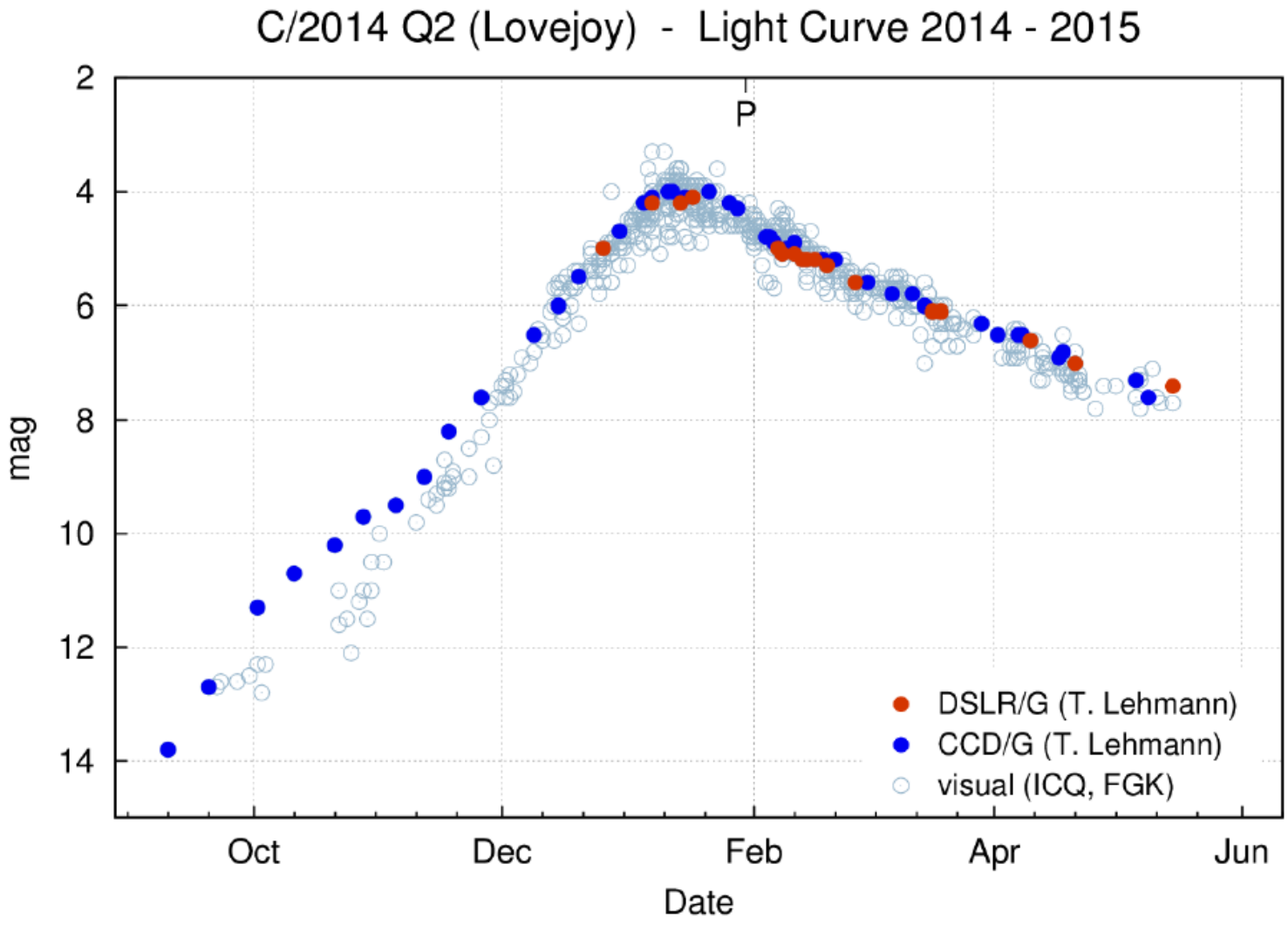

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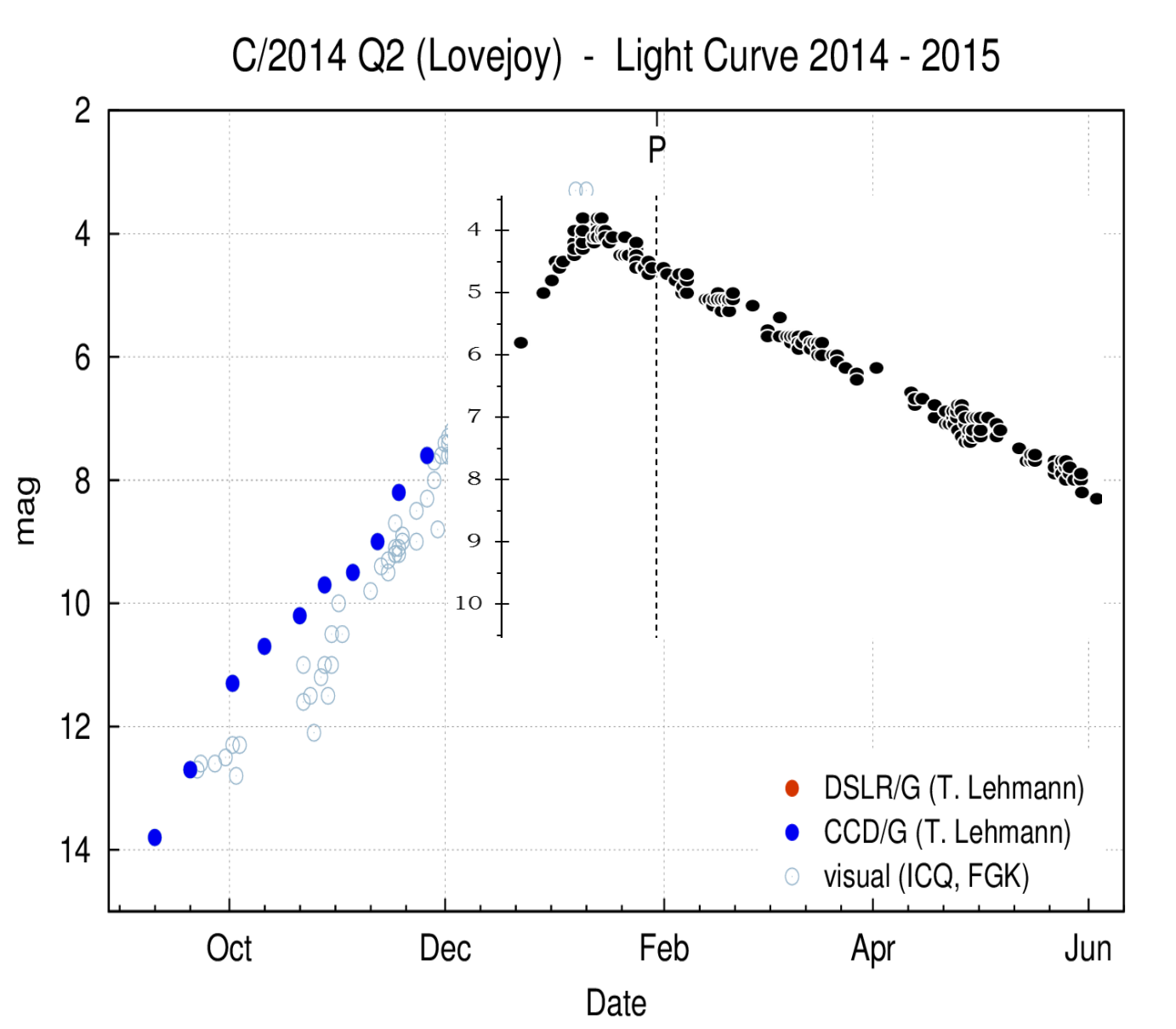
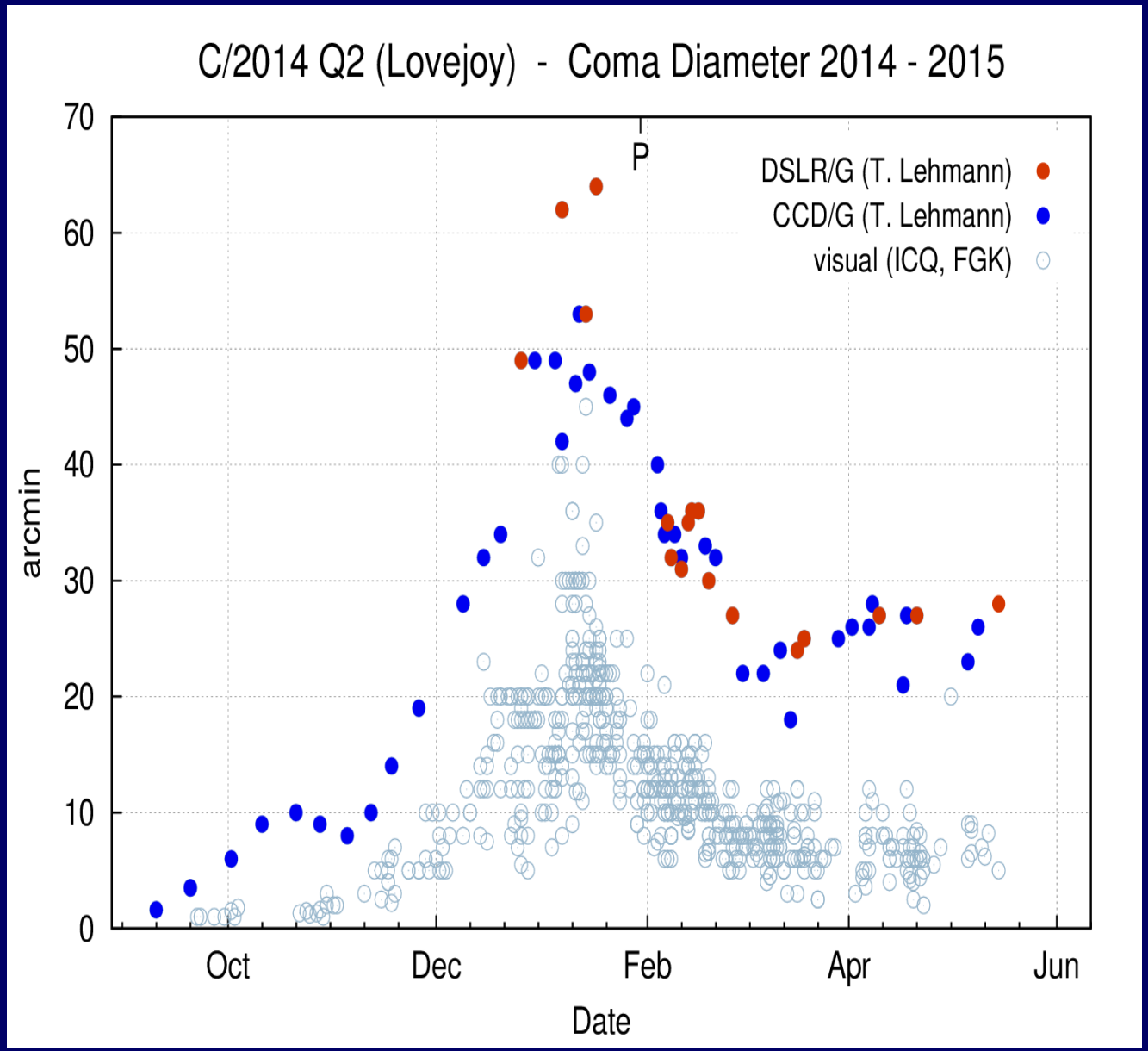

C/2014 Q2 (Lovejoy) - Light Curve 2014 - 2015
mag
2
4
6
8
10
12
14
P
4
5
6
7
8
9
10
DSLR/G (T. Lehmann)
CCD/G (T. Lehmann)
visual (ICQ, FGK)
Oct
Dec
Feb
Apr
Jun
Date


C/2014 Q2 (Lovejoy) - Coma Diameter 2014 - 2015
P
DSLR/G (T. Lehmann)
CCD/G (T. Lehmann)
visual (ICQ, FGK)
arcmin
70
60
50
40
30
20
10
0
Oct
Dec
Feb
Apr
Jun
Date

Conclusie

Contributie d.m.v. Astrofotografie:

- Verloop Absolute Magnitude
- Coma morfologie en rotatie nucleous
- Staarten – structuur en evolutie
- Uitbarstingene en Fragmentatie

Tools beschikbaar voor reductie van astrofoto’s

End

Airtools – Thomas Lehmann

There have been several approaches/attempts to obtain visual equivalent magnitudes of comets. I have tried some ideas but finally came up with my own solution which - apart from the usual steps as you describe - focuses on removing background stars and uses extreme contrast stretches to detect and include the faint outer coma regions. It turns out that the coma size I detect is 3 to 5 times as large as visual observers report.
If I would measure the coma flux in an aperture as small as visual estimates suggest, then my magnitudes would be 0.2-1mag fainter. This means there is substantial light contribution from outer areas.

With the large coma sizes of evolved comets (e.g. 21P at m1=7.5 mag has a coma size of 25') some observational "problems" arise:
- The need for large fields (at minimum 5 times the coma size).
- The need for precise flat field correction.
-The need for excellent detector linearity, because the average intensity of a pixel in the coma region is far below the average pixel of even fainter comparison stars.

I have spent a lot of time on the flat field topic and might give some advice or share ideas.

The current AIRTOOLS version assumes, that you have calibrated and stacked your images yourself. It takes the stack centered on stars and a second stack centered on comet as initial images to work on. The reason for this is, that most observers have their own established processing pipeline already, whereas my software should focus on the star subtraction, comet extraction and large aperture photometry.

I have analyzed image sets of a dozen observers so far but there is currently only one other person using my software routinely.
A major problem of other observers data is non-linear processing. It seems that some stacking software used allows little control over this essential aspect. Also, many observers do apply cosmetic corrections, e.g. background flattening, which can heavily affect the faint outer coma regions.
Another point which has to be taken into account when planning observations is to not produce too many saturated stars within the coma region. In general it is a good idea to obtain high dynamic range images, e.g. by taking
10 exposures of 3 minutes instead of 3 exposures of 10 minutes and by avoiding very high ISO settings. The best S/N per pixel is less important than improving the dynamic range.

Besides all those hassles it is still possible to fulfill the needs of both the astrophotographer - having pretty pictures in mind - and the photometrist. It is mostly a matter of wise planning and slightly adjusting habits. On the software side I do plan to include all the basic image reduction steps from raw data to stacked images in the next program version (about the end of this year).

Do not hesitate to ask any further questions. If you (or other observers) plan to test/use the AIRTOOLS software I'd happily help on getting things up and running.