

# The contribution of Southern African Amateur Observations to Professional Astronomical Studies

Tim Cooper

# Observing Sections of ASSA

- Comet and Meteor Tim Cooper
- Deep Sky Section Auke Slotegraaf
- Double Stars Chris Middleton
- Occultations Brian Fraser
- Solar Jacques van Delft
- Variable Stars Brian Fraser

# Past, Present and Future

- Variable Stars
- Comets, Meteors, Asteroids

# Variable Stars

- 654000 of 13 million observations
  - plus 70000 from A W Roberts project
- Mattei 2002, ASSA contributions
- Henden 2006
  - Visual - historical observations 1800's
  - Visual - eruptive variables
  - CCD - fainter variables, smaller amplitude

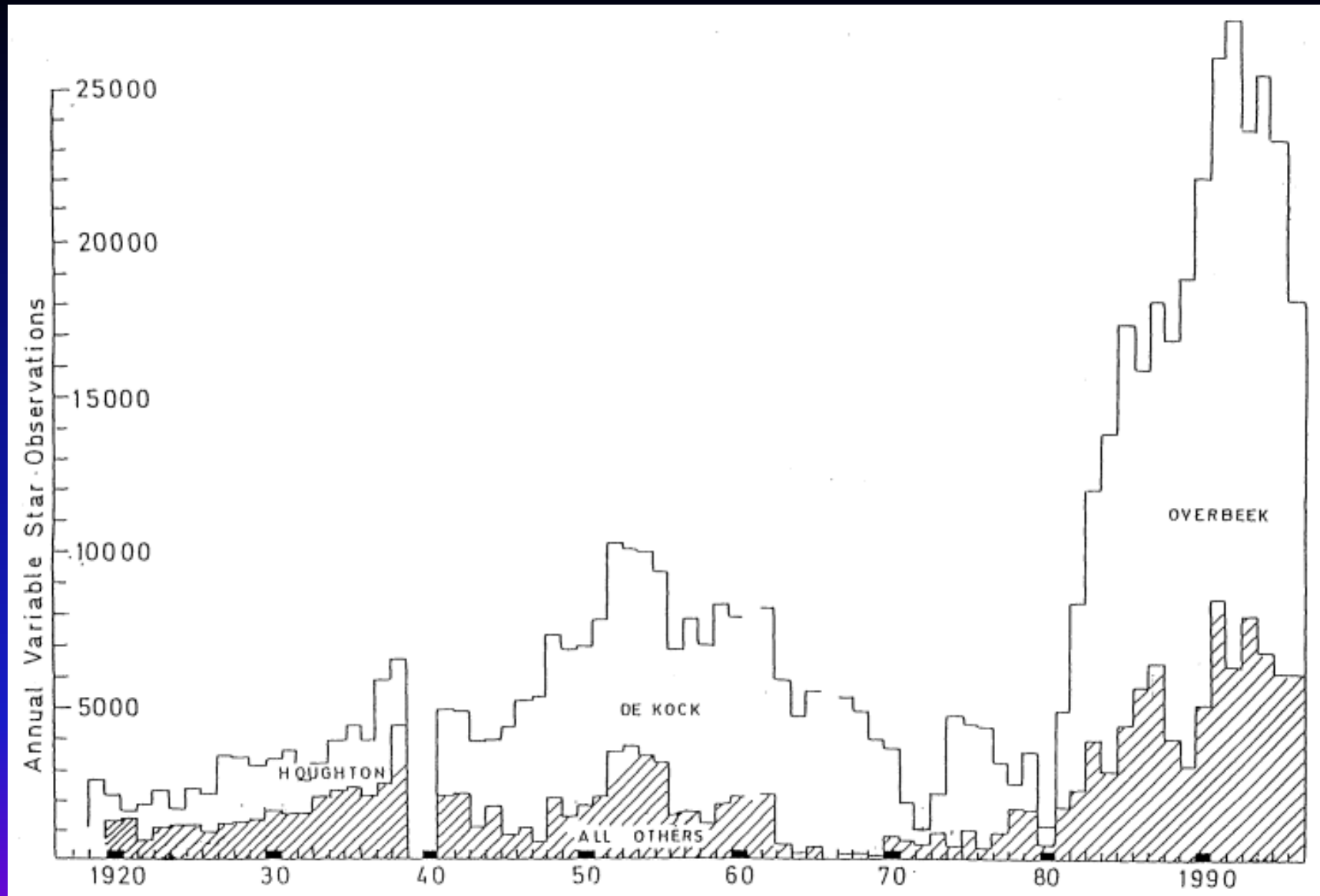
# Variable Stars

- Intrinsic
  - Pulsating
  - Eruptive
  - Cataclysmic
- Extrinsic
  - Eclipsing
  - Rotating

**Around 38,000**  
**200 monitored**

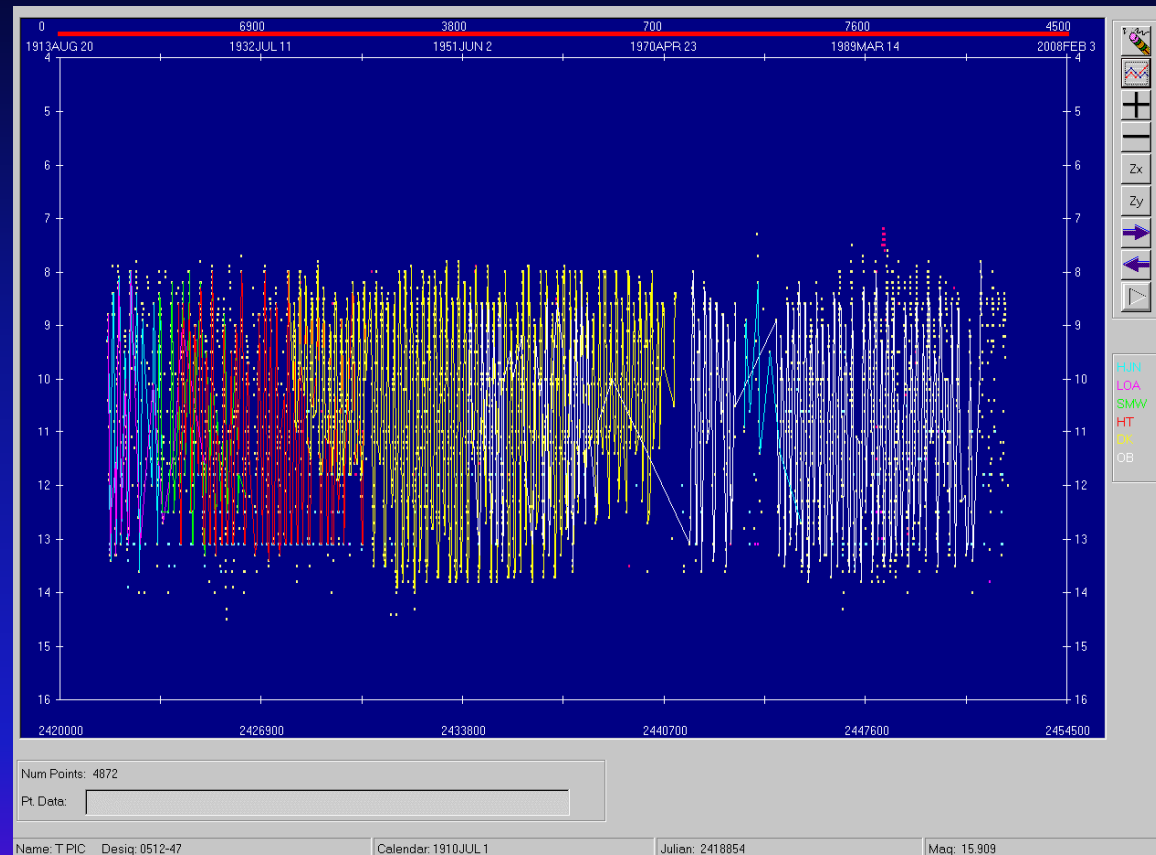
# Prolific Variable Star observers by era

A W Roberts	1891-1932	70,121
J F Skjellerup	1915-1948	6,733
H E Houghton	1926-1942	25,589
R P de Kock	1934-1973	160,777
M D Overbeek	1952-2001	287,150
L A G Monard	1992-	+40,000



7  
Serious Amateur Astronomy: Linking with Professionals

# T Pic



Blue (at left) = SKQ, J. Skjellerup (1915-1948)

Purple = LOA, A. Long (1917-1927)

Green = SMW, W. Smith (1924-1931)

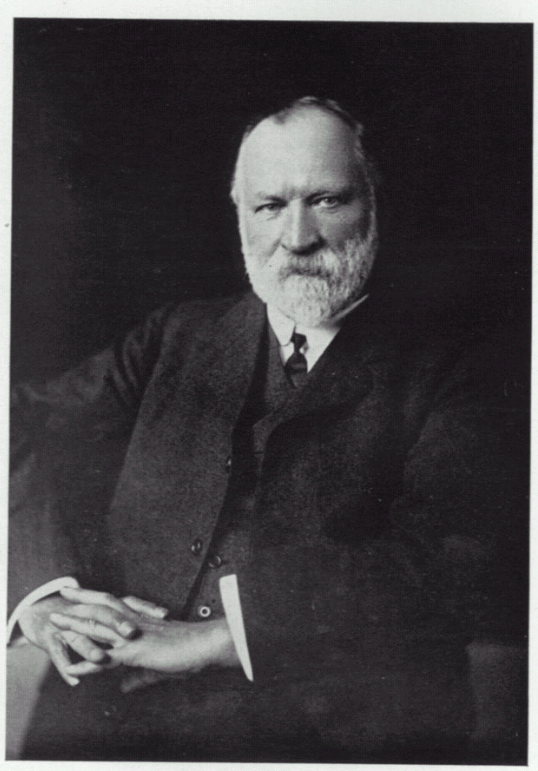
Red = HT, H. Houghton (1926-1942)

Yellow = DK, R. De Kock (1934-1973)

White = OB, D. Overbeek (1952-2001)

Blue (towards right) = HJN, J. Hers (1977- )

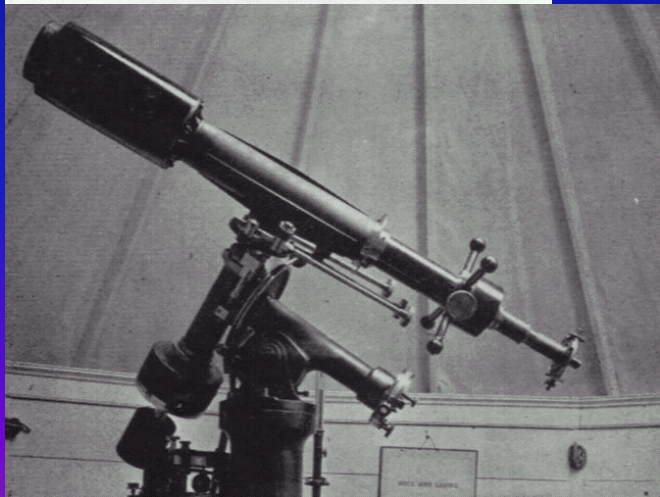




# A W Roberts

1891-1932

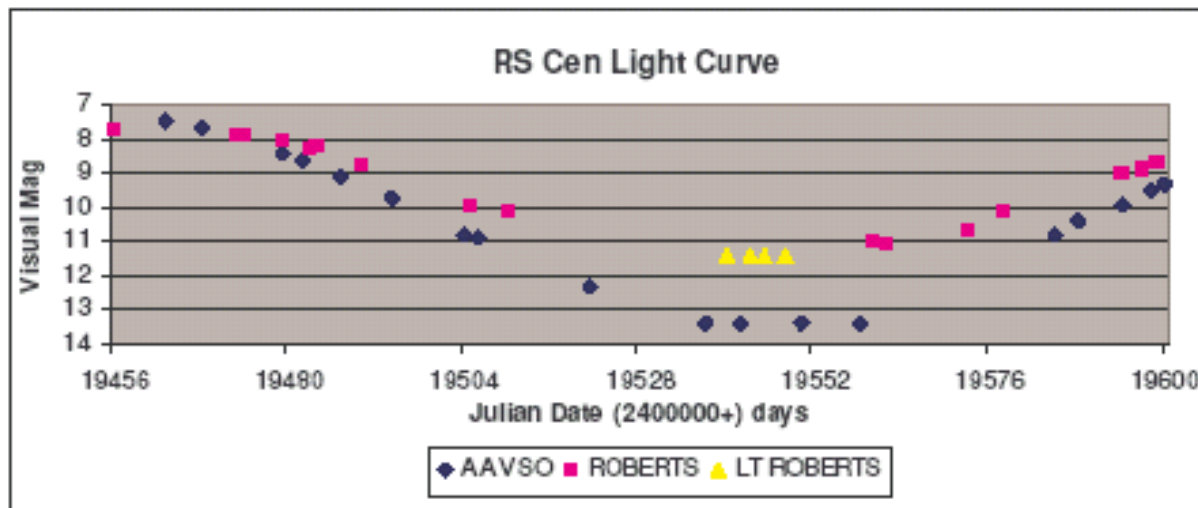
70,121 observations



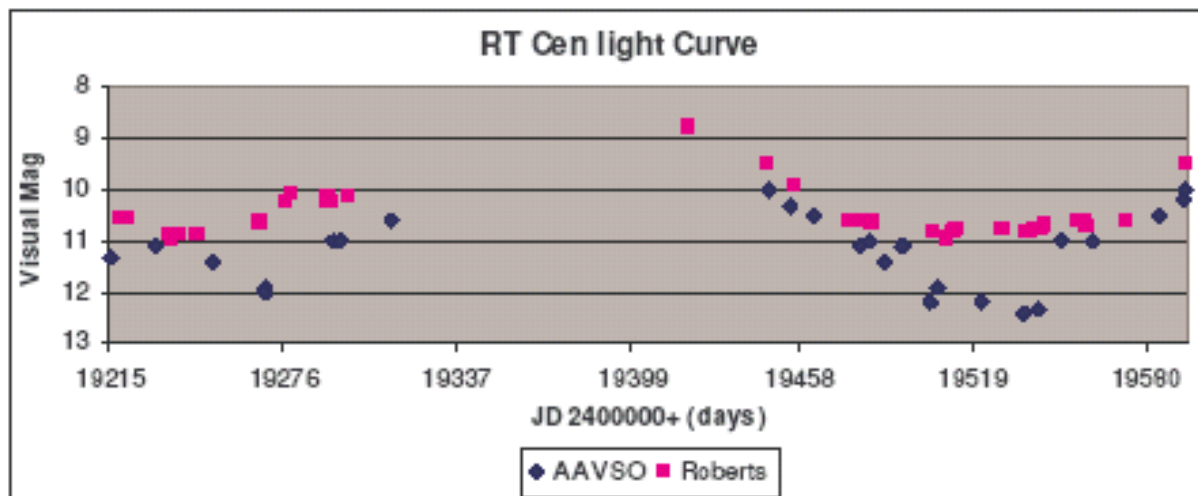
JASSA, 1938

9

**Serious Amateur Astronomy: Linking with Professionals**

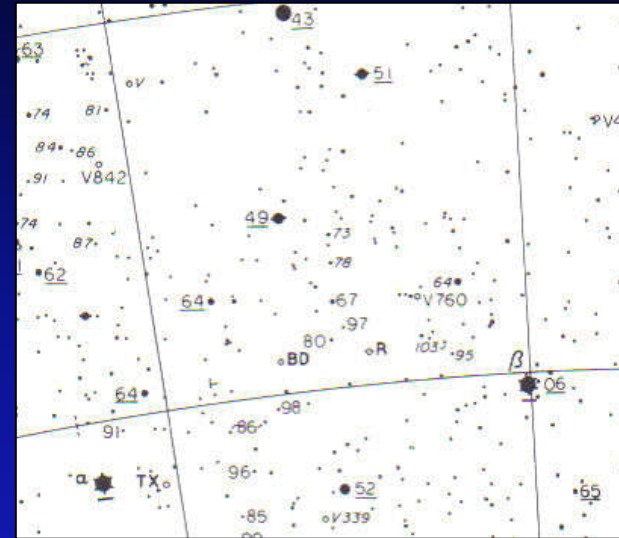


a)

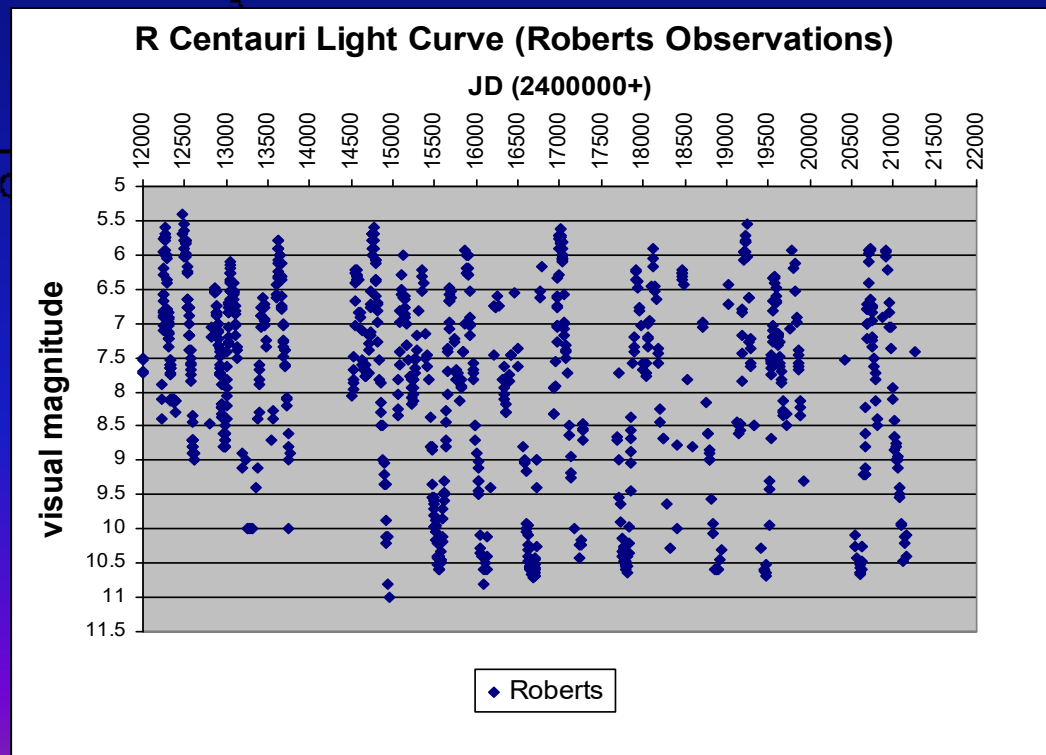
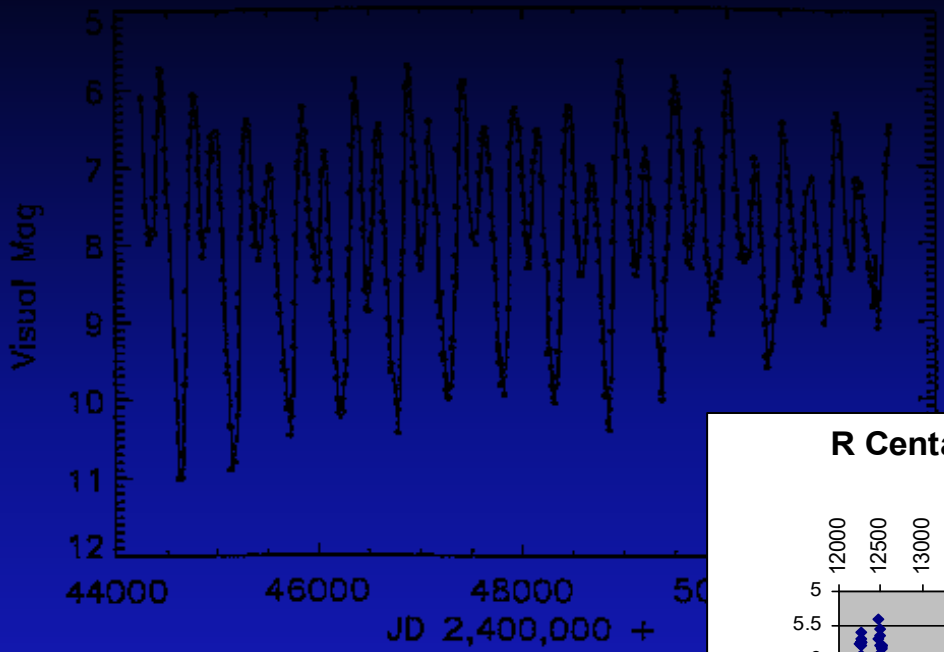


# Roberts Observations R Cen

Sept 25	8-30	70 73  60 72 75 73 76 ✓
Sept 26	7-35	69 72  80 70 80 71 78 ✓
28	7-32	70 72  80 70 75 72 76 ✓

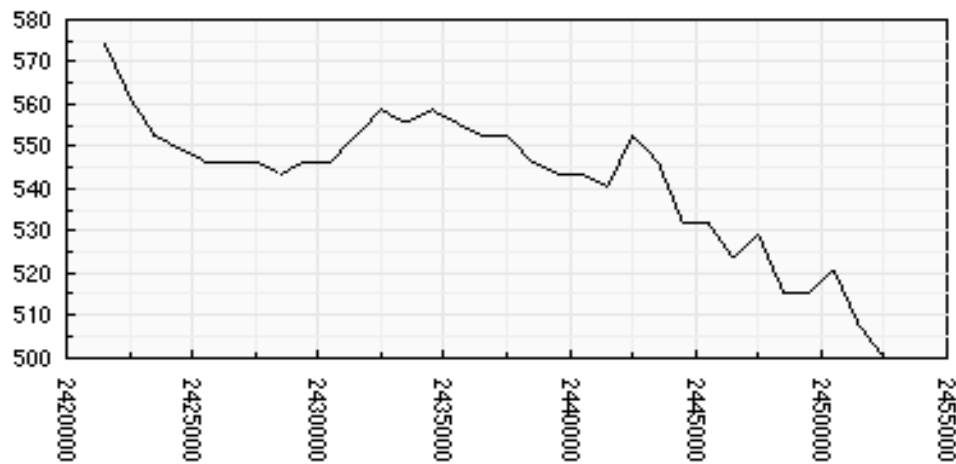


Roberts *	5	7	4	8
Date	73	78	67	80
27/8	75	74		
28/8	73	75	71	80
29/8	73	75	71	75
25/9	73	75	72	80
26/9	72	80	70	80
27/9	72	75	70	80

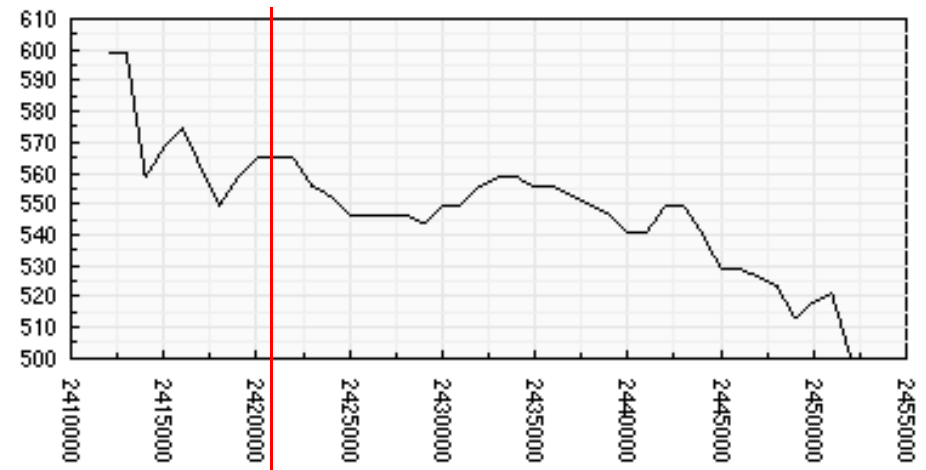




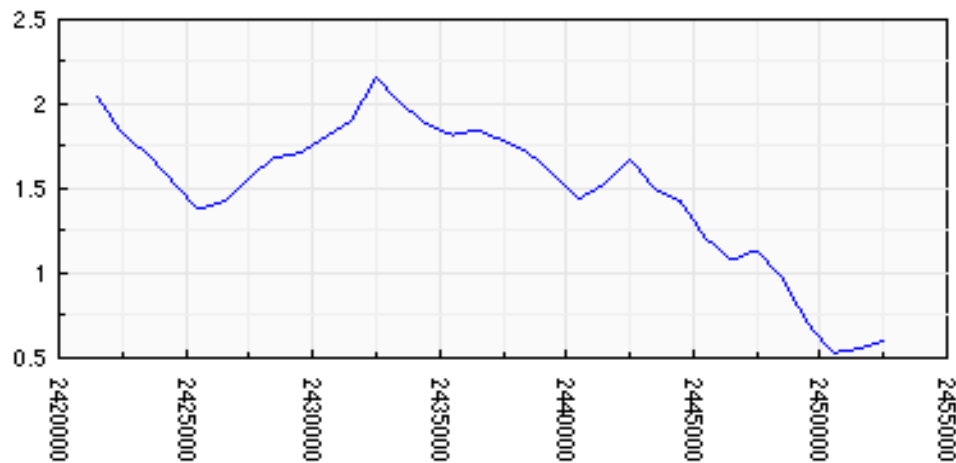
Period vs. JD for max WWZ



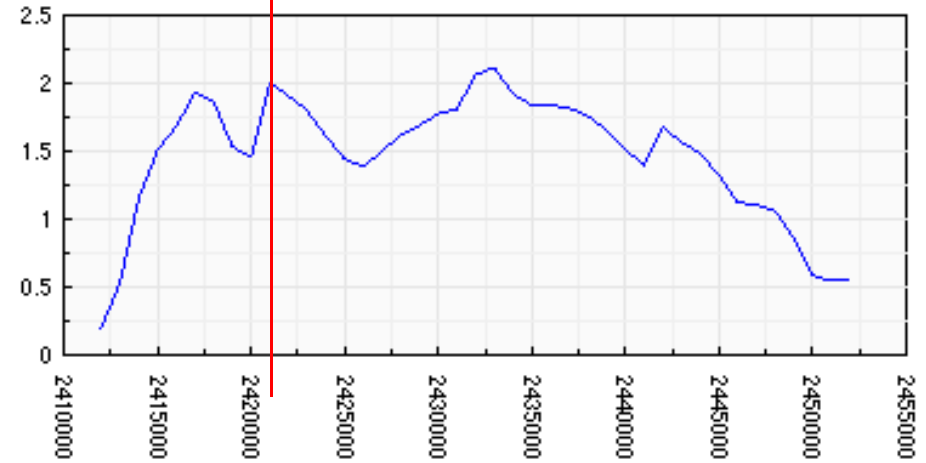
Period vs. JD for max WWZ



Amplitude vs. JD for max WWZ



Amplitude vs. JD for max WWZ



# RR Cen

- Discovered by Roberts
- Quotes over 10 thousand estimates
- 2289 actual observations
- Roberts (1903) explains the discrepancy

# H E Houghton

Born England 1892  
Came to SA 1920  
Cape Astr. Society  
ASSA Secretary 1923-30  
Dir. Variable Star 1934-47

1926-1942

25,589 observations

In continuing the work of variable star observing in South Africa, so ably pioneered by the late Dr A W Roberts, no one has done more for the advancement of the science than Mr Houghton



# R P de Kock

1934-1978

160,777 observations

Born Colesburg 1902  
Dir. Variable Star 1948-75

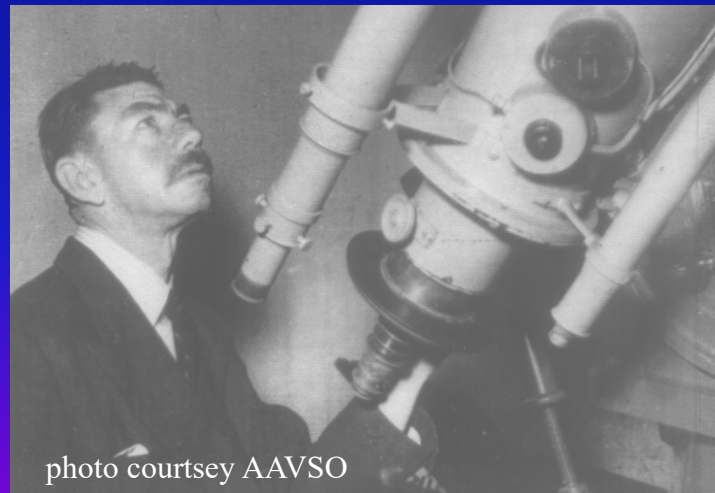


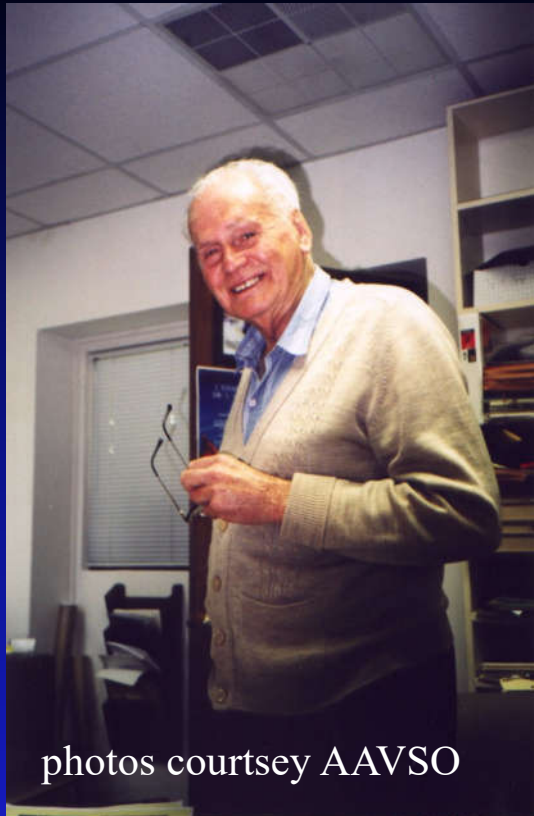
photo courtesy AAVSO



# M D Overbeek

1952-2001

287,150 observations



photos courtesy AAVSO

Born 1920

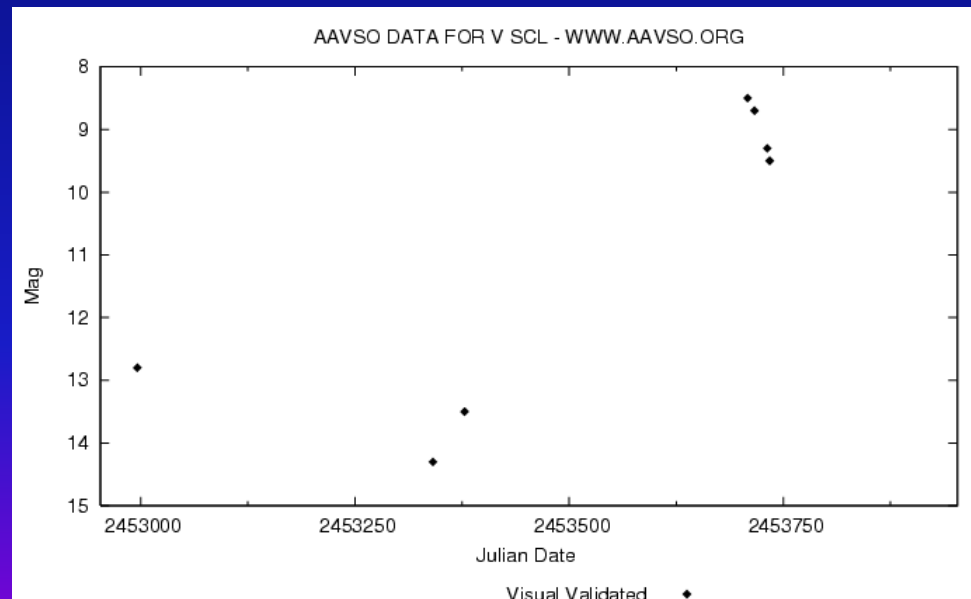
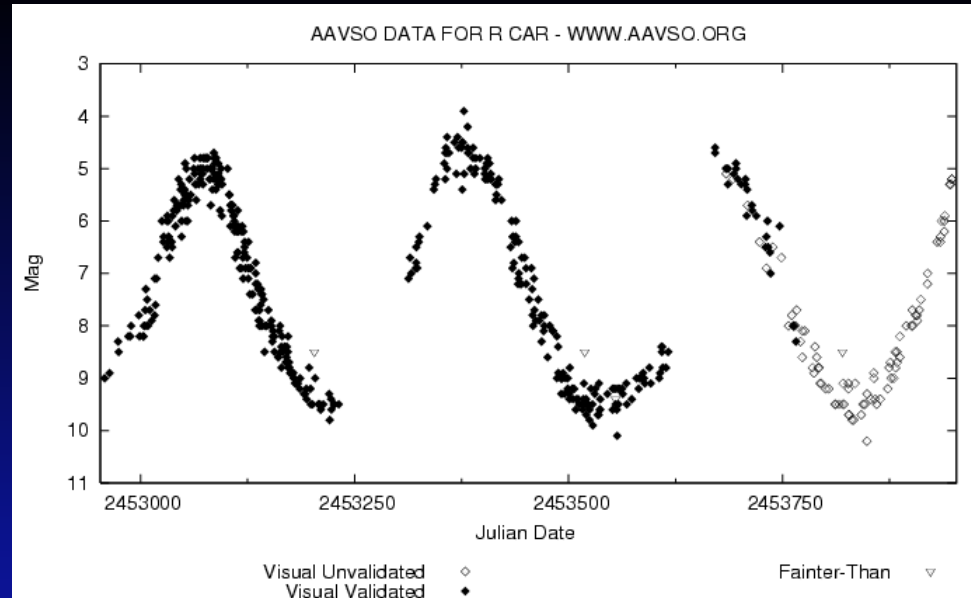
6" reflector 1951

12.5" Dall Kirkham 1953



17

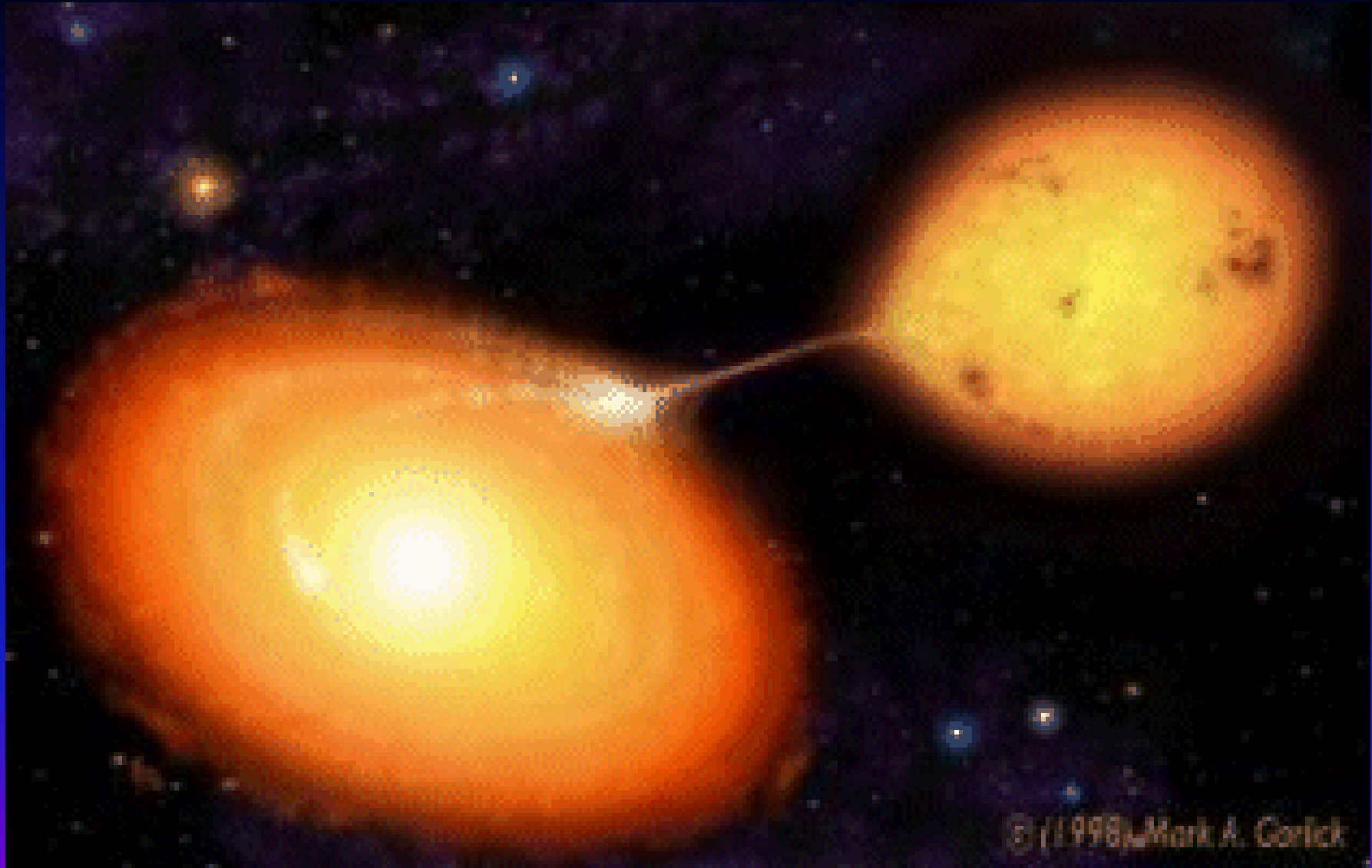
**Serious Amateur Astronomy: Linking with Professionals**



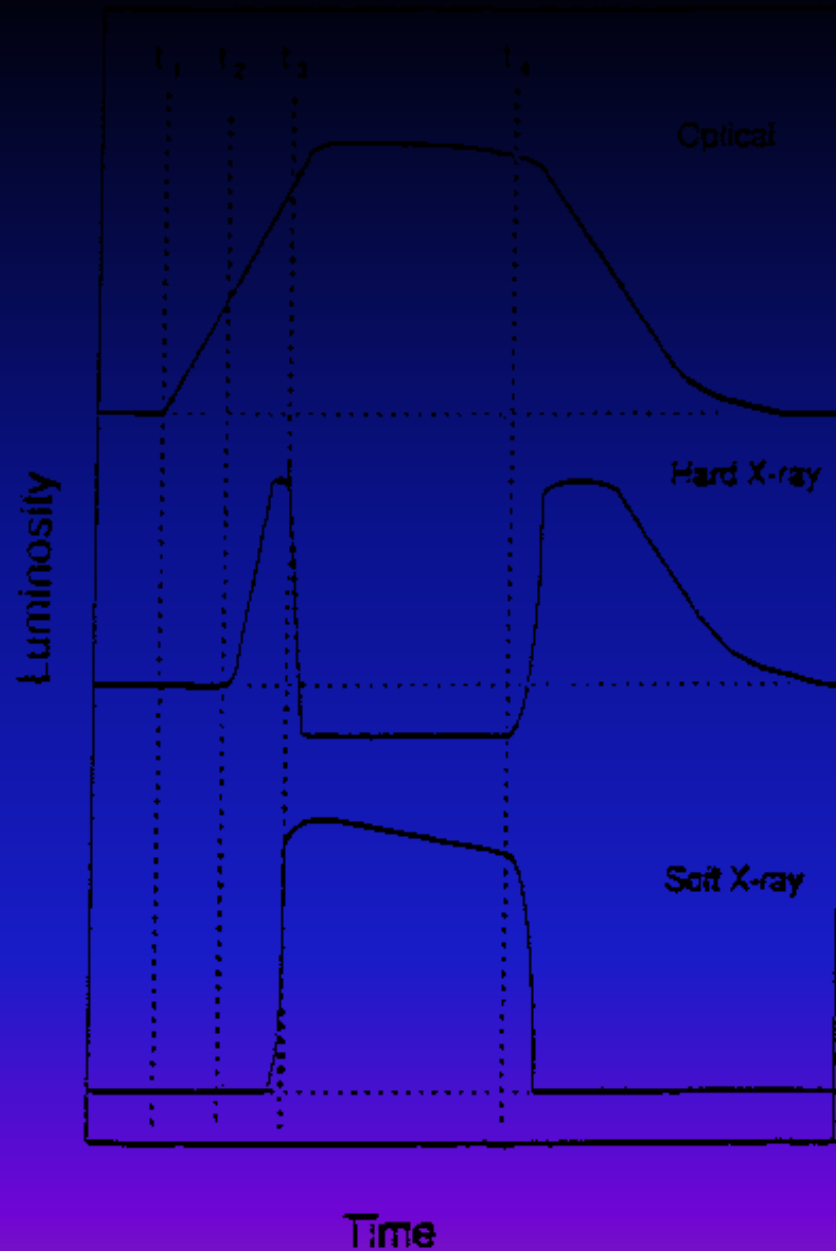
## EUVE Observations of CVs – all triggered by variable star observers

Star	Date (M/Y)	Interval (JD–2400000)	Exp. (ks)	Type of Outburst	Comment
SS Cyg	08/93	49216.58–222.86	179.4	Anom. Wide	
U Gem	12/93	49350.00–361.15	249.0	Normal	
VW Hyi	06/94	49505.46–507.66	89.4	Super	
SS Cyg	06/94	49526.67–536.69	147.8	Normal Wide	
VW Hyi	07/95	49906.70–917.29	183.8	Normal	+ <i>Voyager</i>
VW Hyi	05/96	50210.58–218.47	55.4	Super	+ <i>RXTE</i>
SS Cyg	10/96	50366.40–379.45	208.1	Normal Narrow	+ <i>RXTE</i>
OY Car	03/97	50534.46–537.64	94.8	Super	
U Gem	11/97	50760.27–766.85	150.0	Normal	+ <i>RXTE</i>
SS Cyg	06/99	51336.84–349.67	274.0	Anom. Narrow	+ <i>RXTE</i>
OY Car	02/00	51597.66–601.26	69.1	Super	& <i>HST</i>

Mauche, C.W., Mattei, J.A., & Bateson, F. 2001, in *Evolution of Binary and Multiple Star Systems*

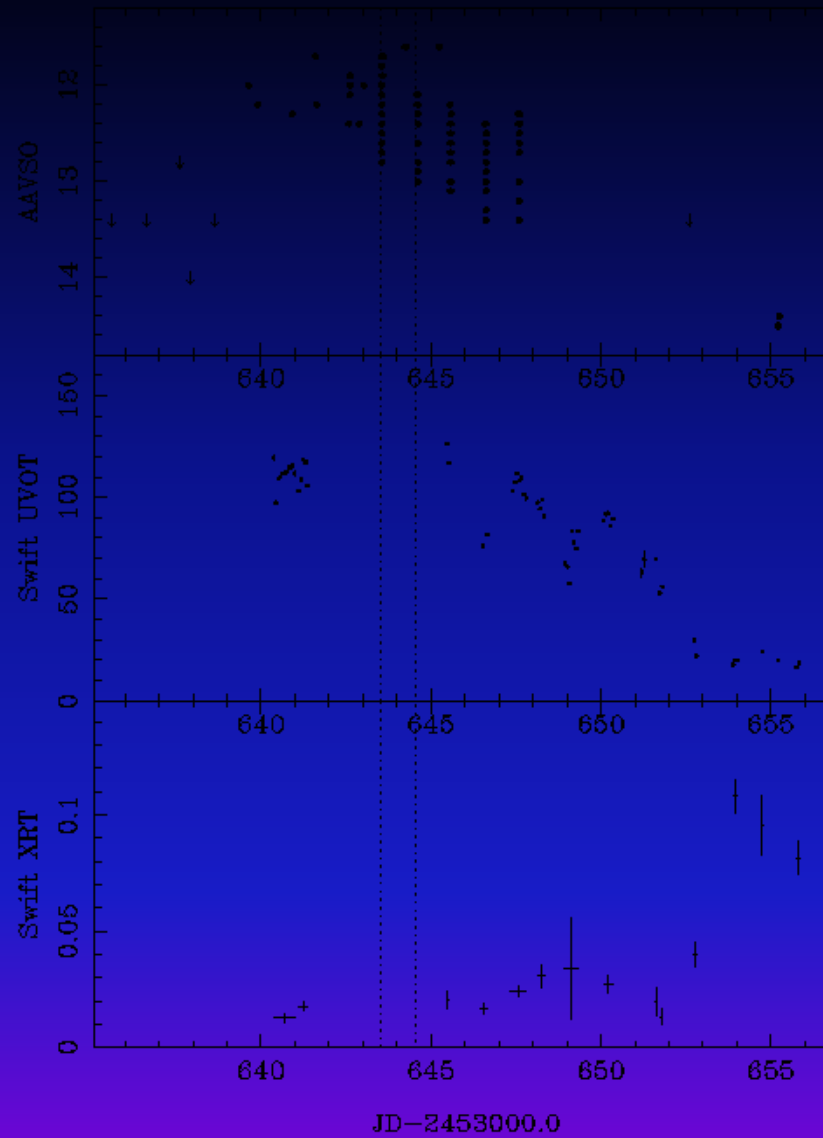


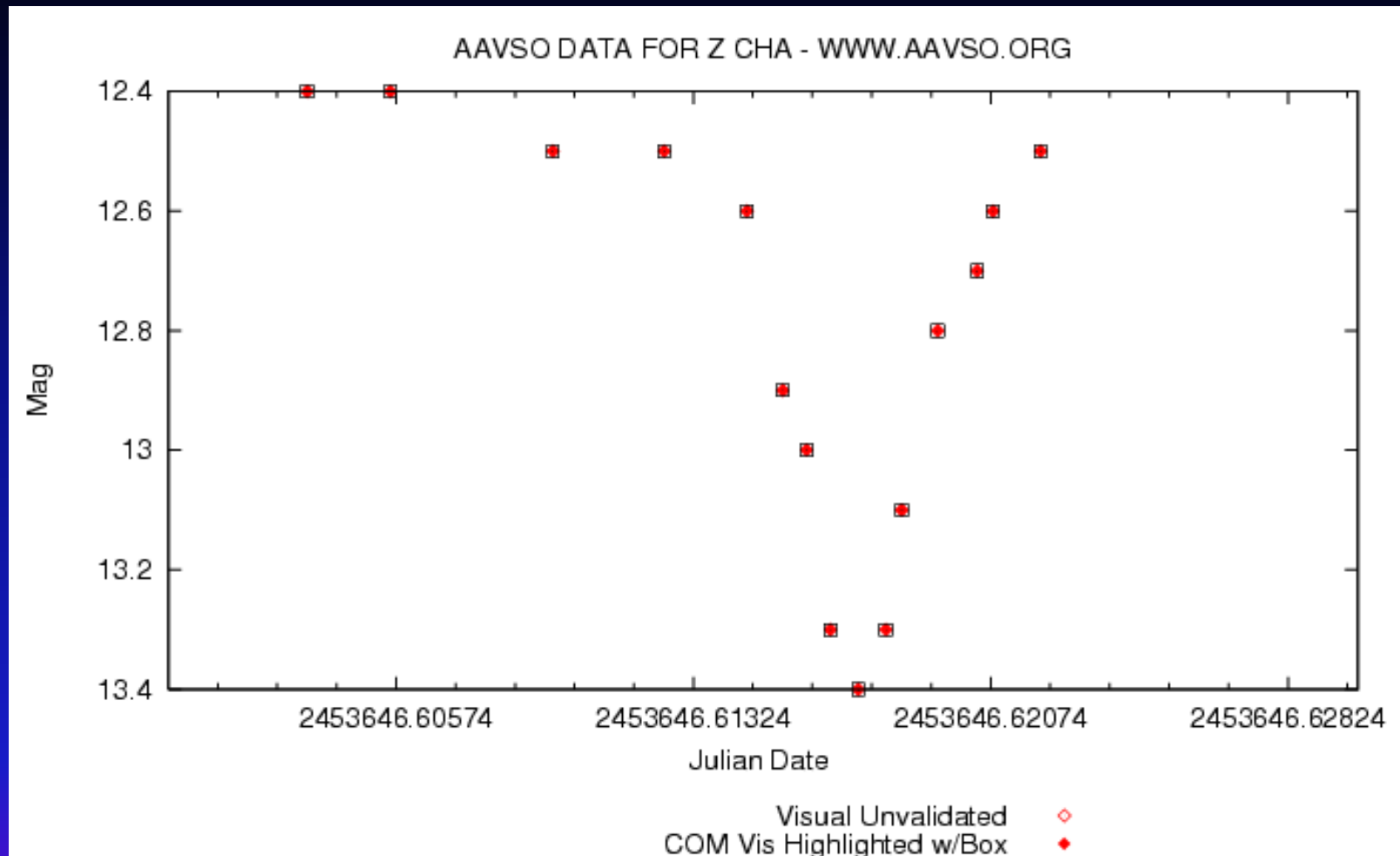
20  
Serious Amateur Astronomy: Linking with Professionals



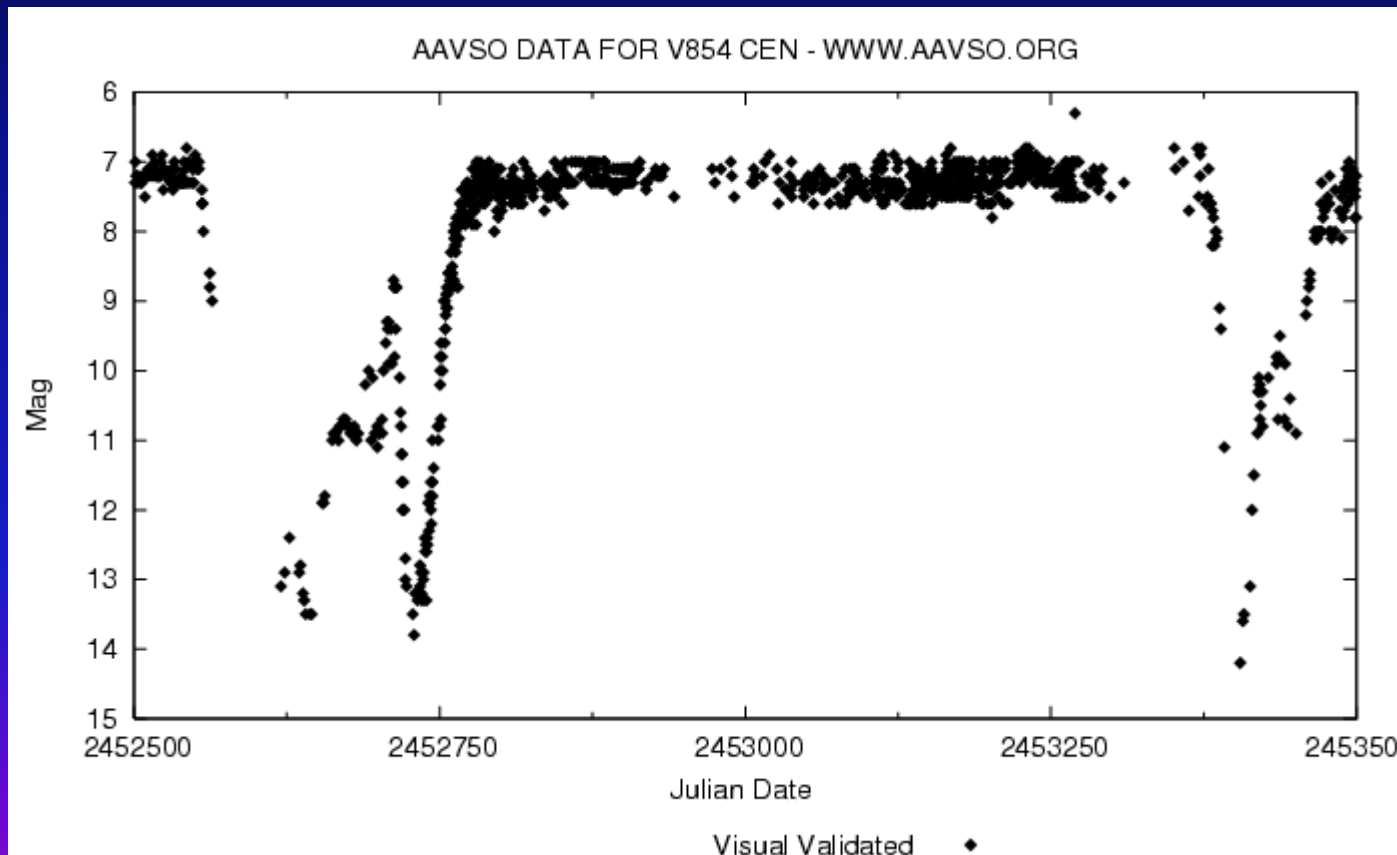
A schematic of the behavior of the optical, soft x-ray (<0.5 keV) and hard x-ray (>1 keV) intensity of SS Cygni through an outburst.

Jones, M.H., & Watson, M.G.  
1992, *MNRAS*, **257**, 633





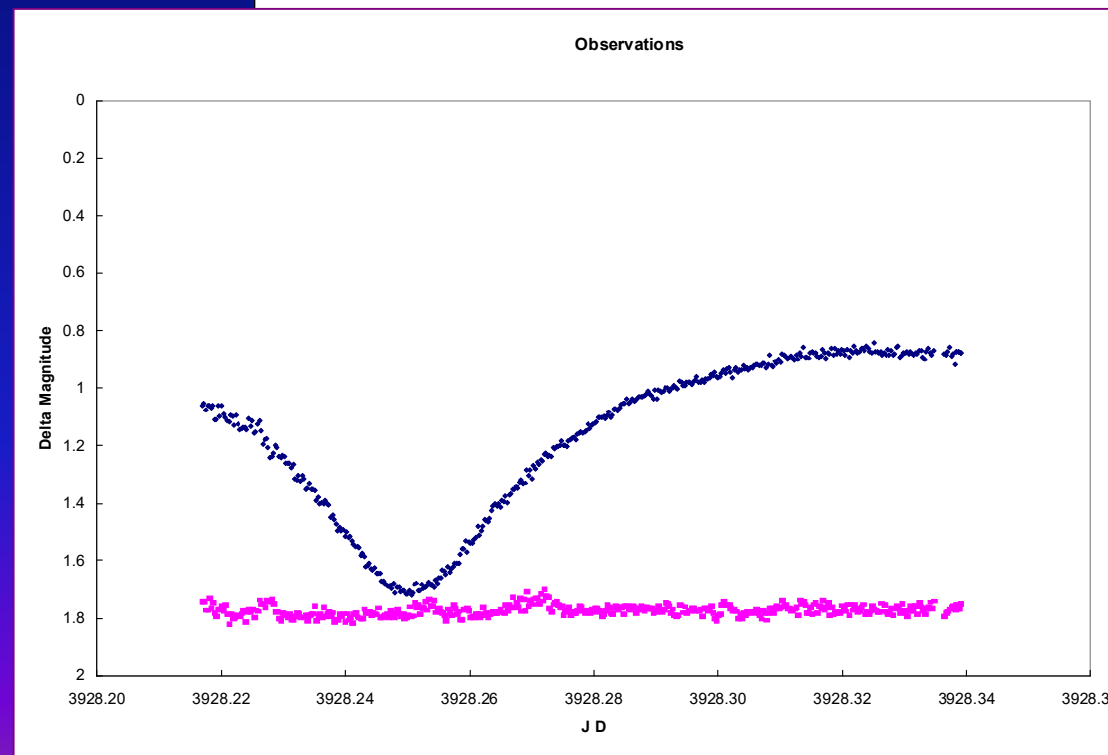
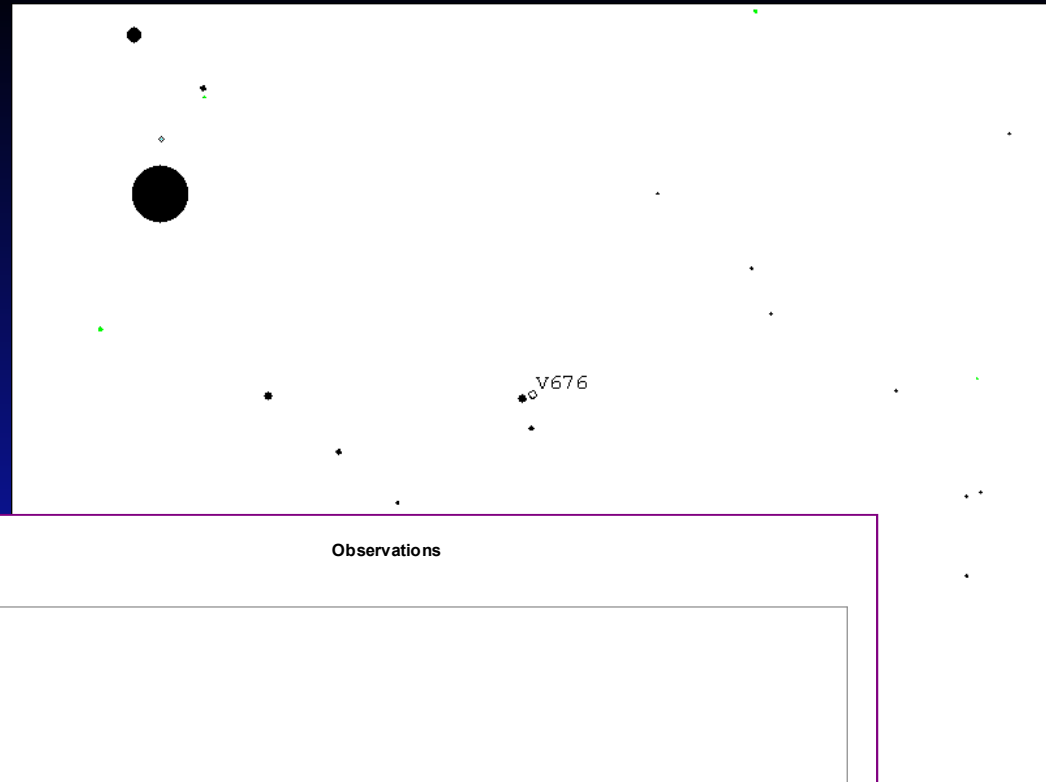
# Fade behaviour of RCB star V854 Cen



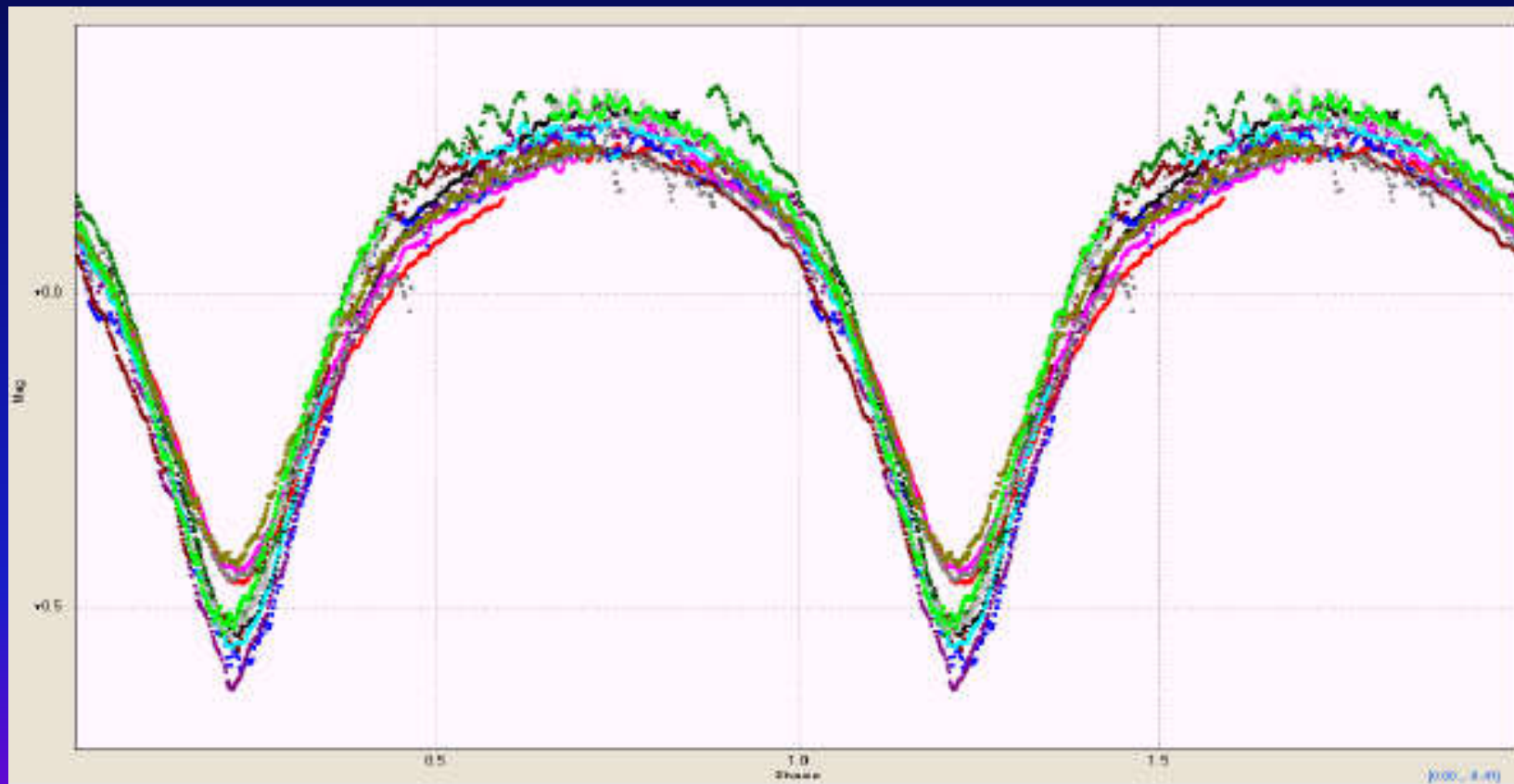


# V676 Cen

Type EK/KW  
Range 11.9-12.6  
Period 0.2924 days  
(7h01m03s)



# V676 Cen



# Comets, Meteors, Asteroids

- Comets

- study the primordial solar nebula
- nature of comets and interaction with sun

- Meteors

- understand parent comet, how dust is spread in solar system, interaction with planets

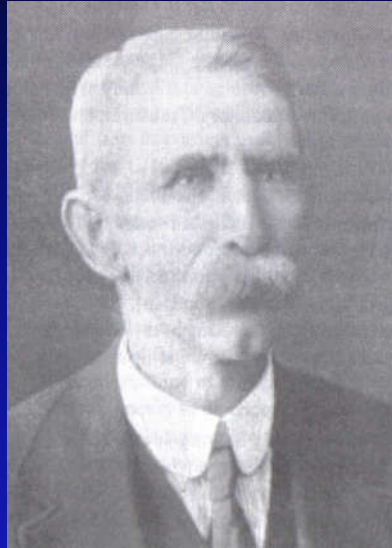
- Asteroids

- understand link with comets, formation of bodies in the solar system

# Comets - Historical

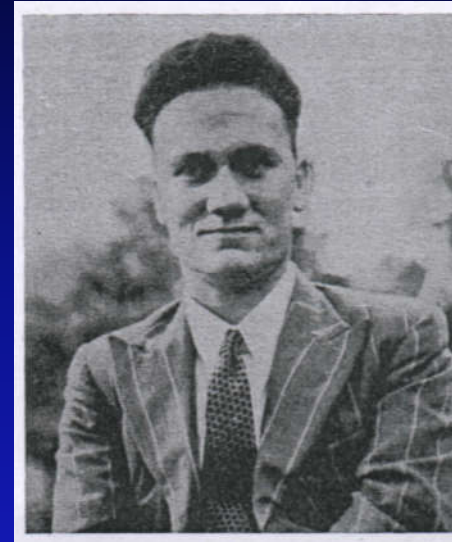
- First discovery, van Riebeeck, 1652
- 57 comets discovered from South Africa
- Reid (6), Bester (6), du Toit (5)
- de Kock-Paraskevopoulos and Houghton-Ensor
- Last discovery 1978 Haneda-Campos

# William Reid



<u>Comet</u>	<u>Magnitude</u>
C/1918 L1	10.5
C/1921 E1	9
C/1922 B1	9.5
C/1924 F1	10
C/1925 F2	8
C/1927 B1	8

# Michiel Bester



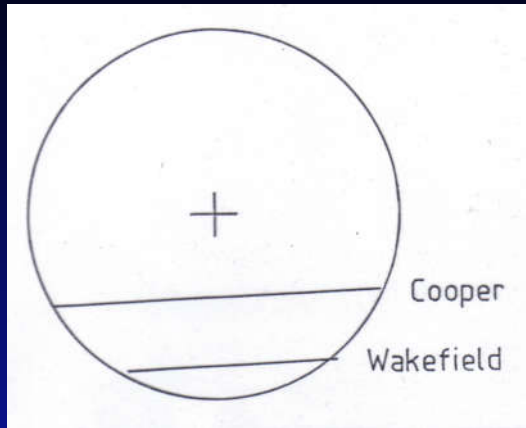
<u>Comet</u>	<u>Magnitude</u>
C/1946 U1	10
C/1947 F1	10.5
C/1947 K1	11
C/1947 S1	11
C/1948 W1	7.5
C/1959 O1	8

# Asteroids - Historical

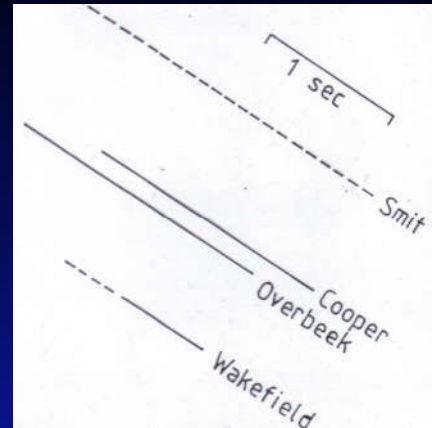
- 156 confirmed discoveries
- Cyril Jackson (71), Hendrik van Gent (39), E L Johnson (18)
- 1982 first occultation results

# Successful Asteroidal Occultation Events

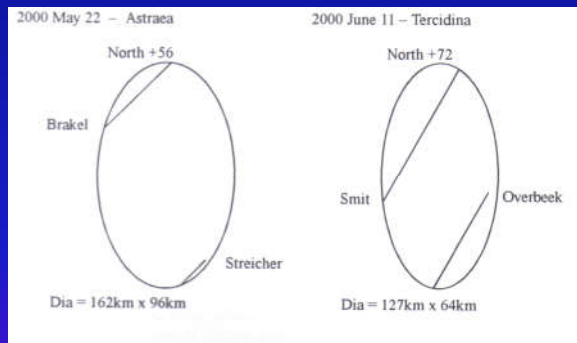
	Date	Asteroid	Dia	Observers	Chords
1	03/30/82	15 Eunomia	>309	Overbeek	1
2	05/05/83	65 Cybele	>150	Hers	1
3	08/08/84	87 Sylvia	>249	Strobos, Hirsch	1
4	04/21/85	12 Victoria		V Ellinckhuyzen	0.5
5	04/21/88	139 Juewa	164±20	Cooper, Wakefield	2
6	07/09/88	250 Bettina	>97	Cooper, Wakefield, Overbeek, Fraser	3
7	06/15/90	3 Juno		Overbeek	1
8	06/15/91	356 Liguria		Lund	1
9	12/15/94	336 Lacadiera	>52	Overbeek	1
10	06/27/98	248 Lameia	62x53 or 55x52	Cooper, Overbeek, Fraser, Smit, Lund	5
11	10/14/99	48 Doris		Cooper, Overbeek, Fraser, de Jager	4
12	06/11/00	345 Tercidina	127x64	Overbeek, Smit	2
13	10/05/00	135 Hertha		Turk	1
14	05/22/00	5 Astraea	162x96	Streicher, Brakel	2
15	01/07/02	712 Boliviana		Streicher	1
16	04/09/03	693 Zerbinetta		Cooper	1
17	08/05/05	246 Asporina		Fraser, Smit	2
18	04/09/05	42 Isis		Streicher	1
19	06/26/05	207 Hedda		Fraser	1



139 Juewa  
1988 Apr 21

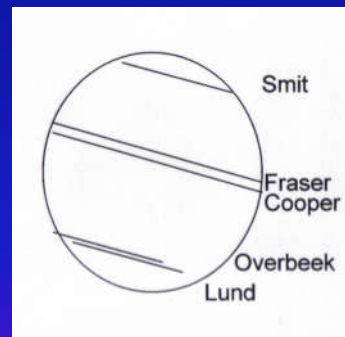


250 Bettina  
1988 Jul 9

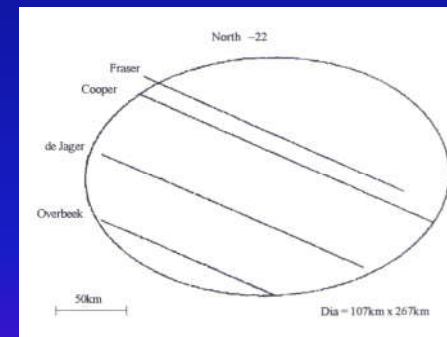


5 Astraea  
2000 May 22

345 Tercidina  
2000 Jun 11



248 Lameia  
1998 Jun 27



48 Doris  
1999 Oct 14



# Meteors - Historical

- Hoffmeister 1948, list of 5406 radiants
- 1950-1960s SC Venter
- 1970-1980s JC Bennett
- Recently good coverage of eta Aquarids, amongst others

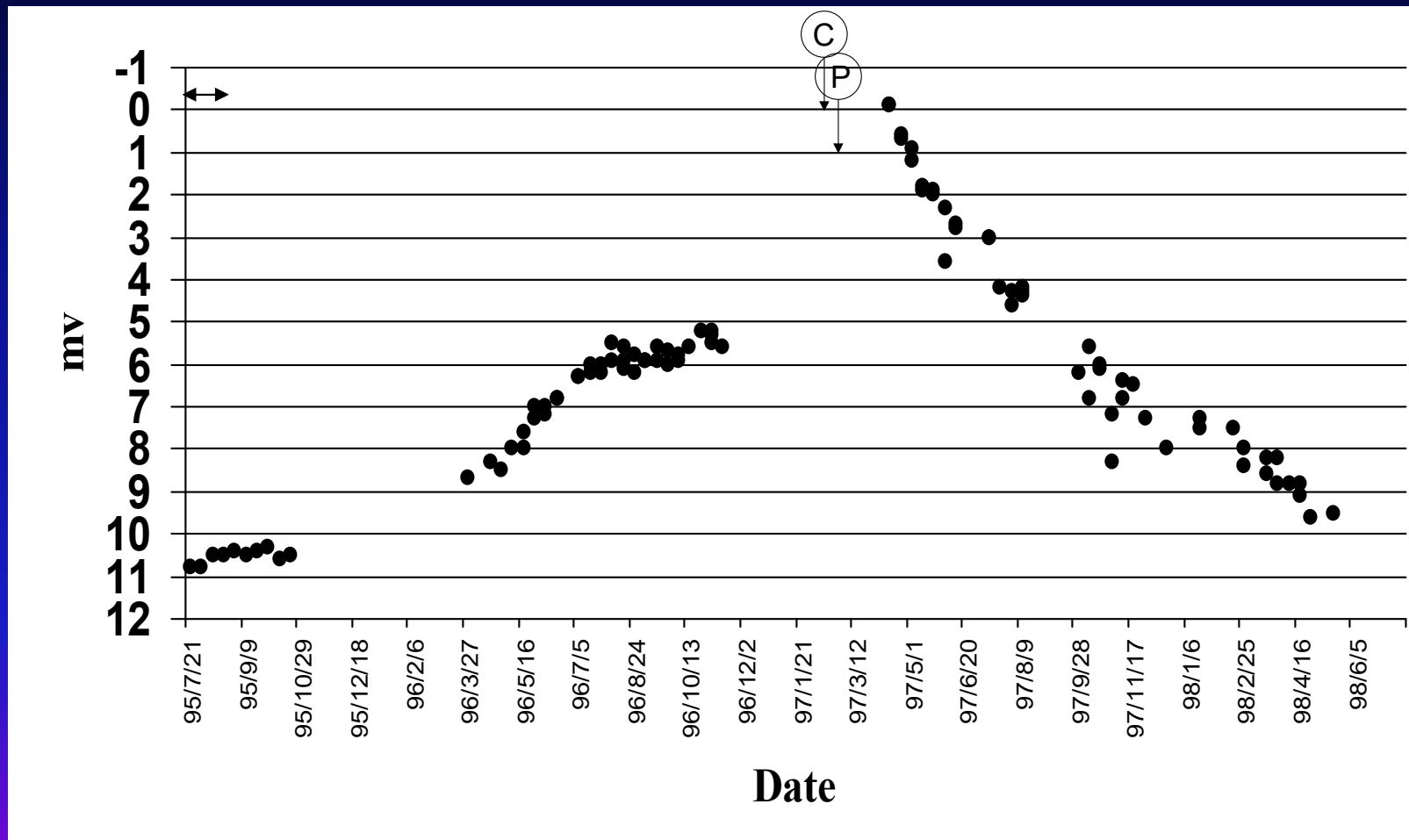
# General Brightness of Comets

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

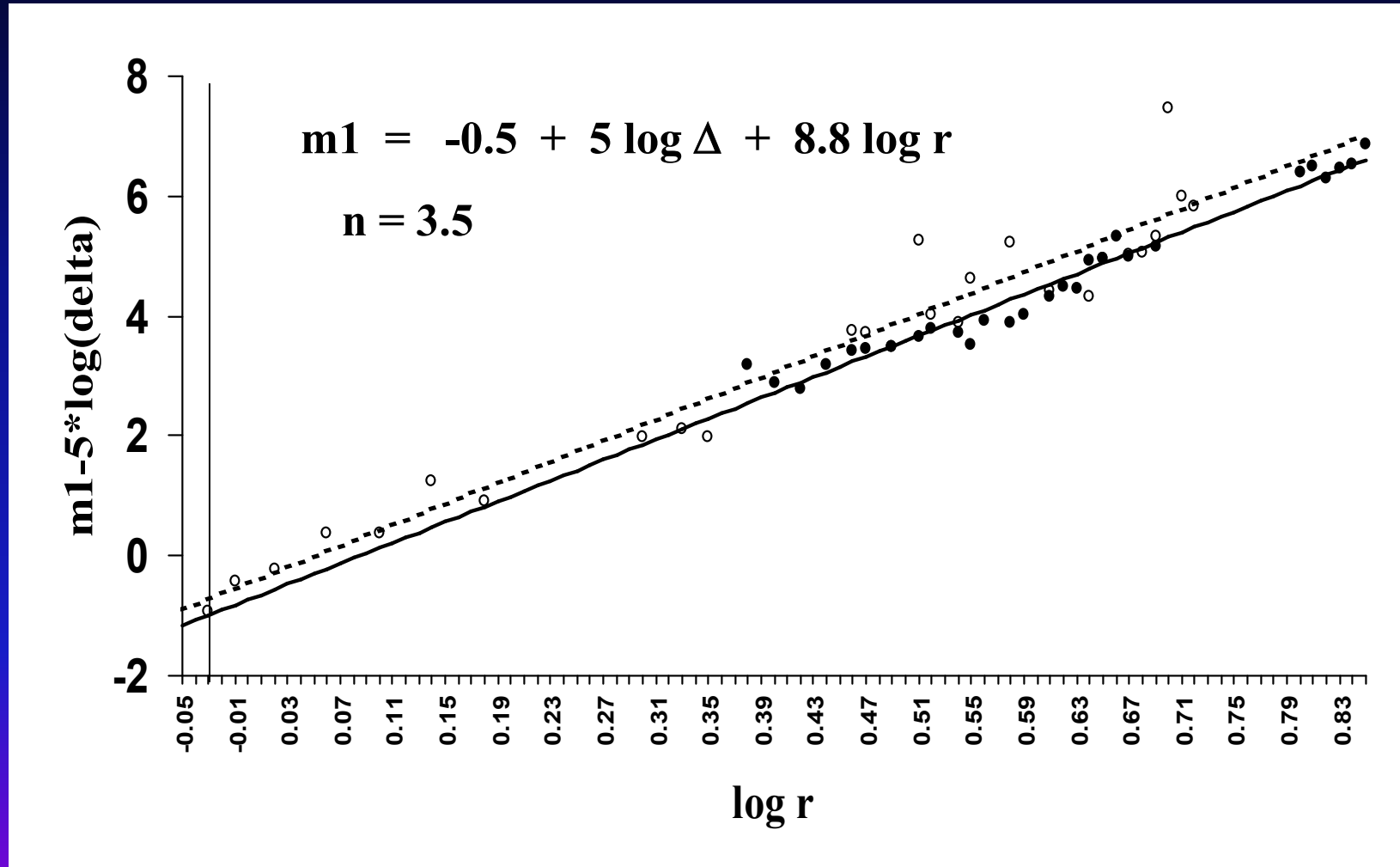
$$\boxed{m_1 - 5 \log \Delta} = \boxed{2.5n \log r} + H_0$$

$y = mx + c$

# Light-curve Comet C/1995 O1 Hale Bopp



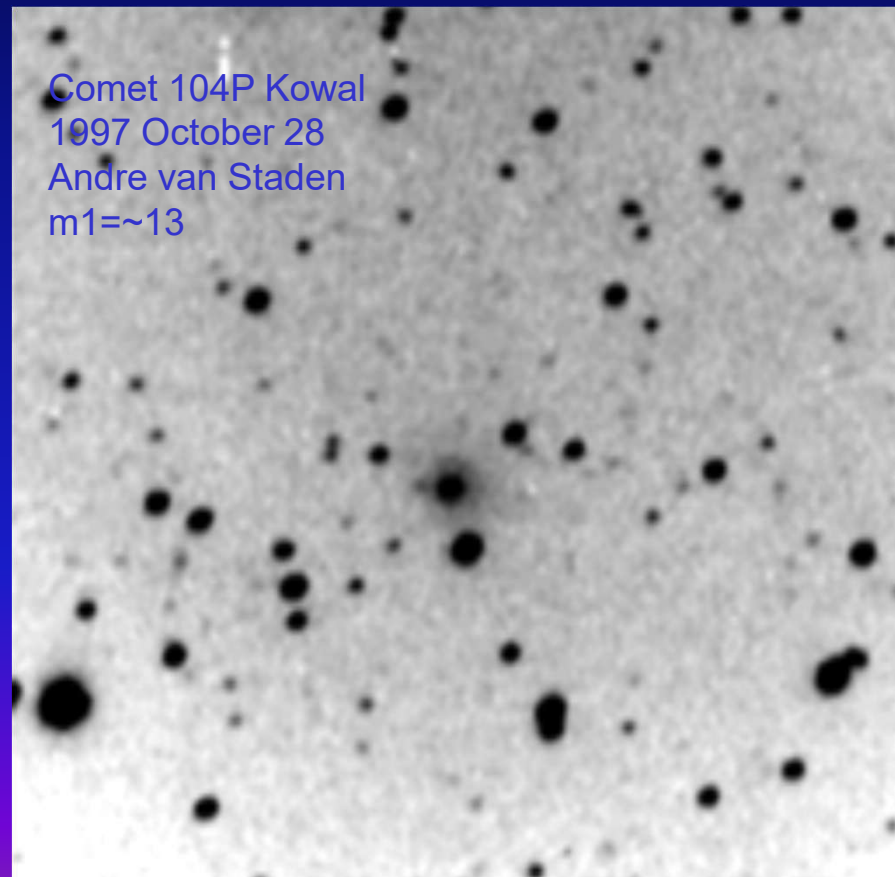
# Brightness behaviour Comet C/1995 O1 Hale-Bopp



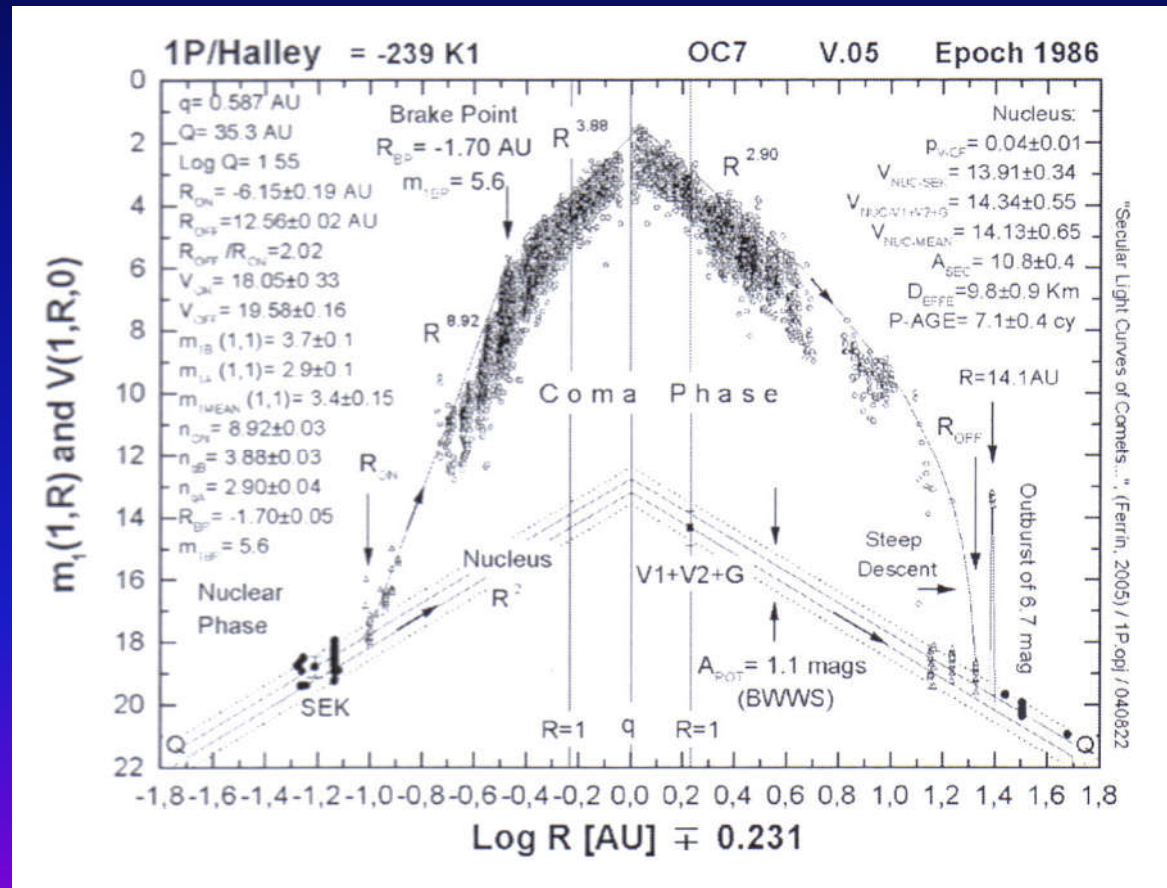
# Comparison of ASSA data to BAA published data

<u>Comet</u>	<u>H<sub>0</sub> ASSA</u>	<u>H<sub>0</sub> BAA</u>	<u>n ASSA</u>	<u>n BAA</u>
1995 O1	-0.5	-0.6	3.5	3.0
1998 J1	6.3	6.2	2.4	2.5
2000 WM1	7.0	7.1	4.4	4.2
2001 A2	7.2	7.3	4.8	4.2
2002 C1	6.5	6.6	3.1	3.4
2001 Q4	5.5	5.5	2.2	1.8
2002 T7	5.5	5.3	2.8	2.2

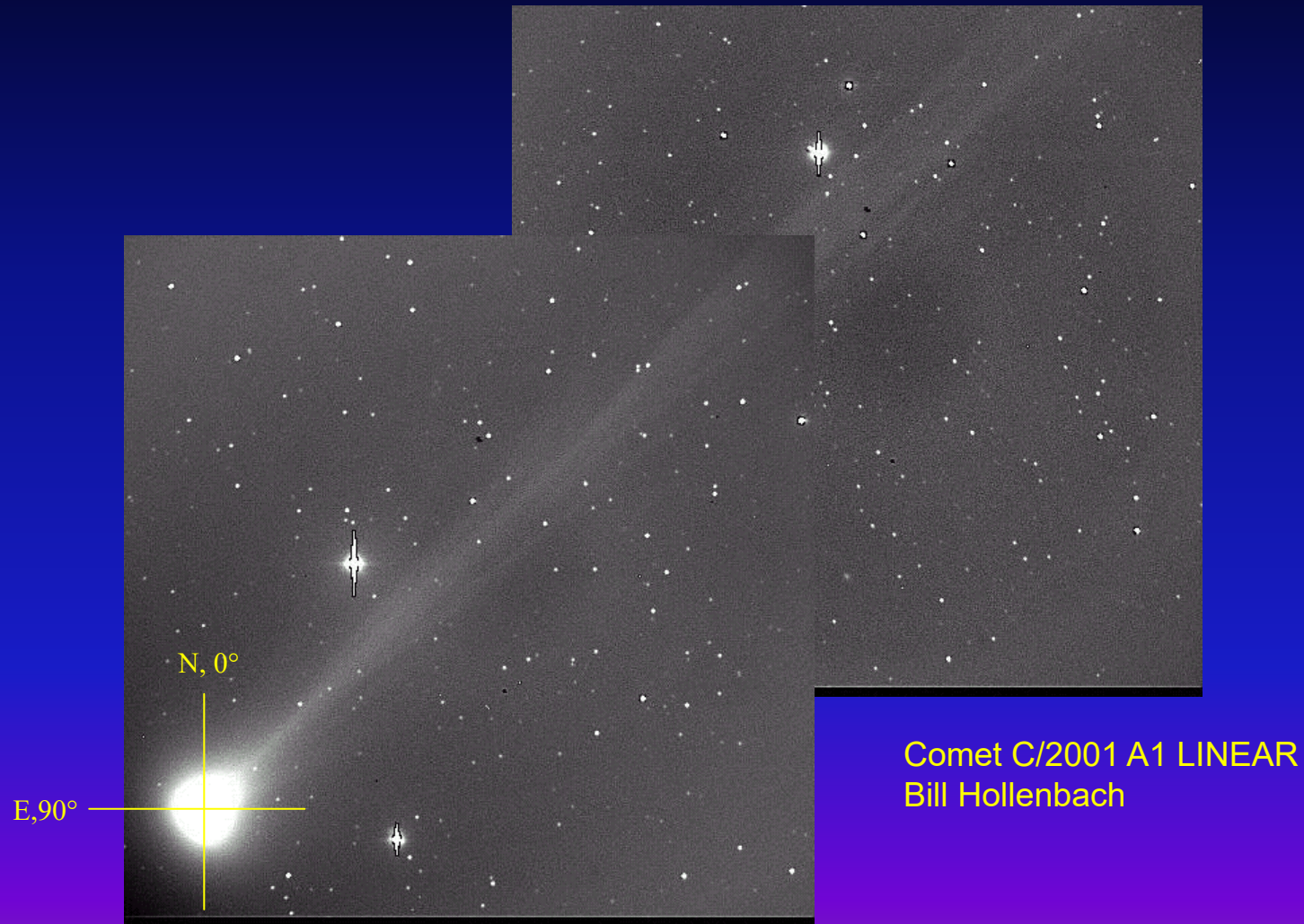
# Photometry and Imaging of faint comets



# Light Curve comet 1P Halley, Ferrín 2006

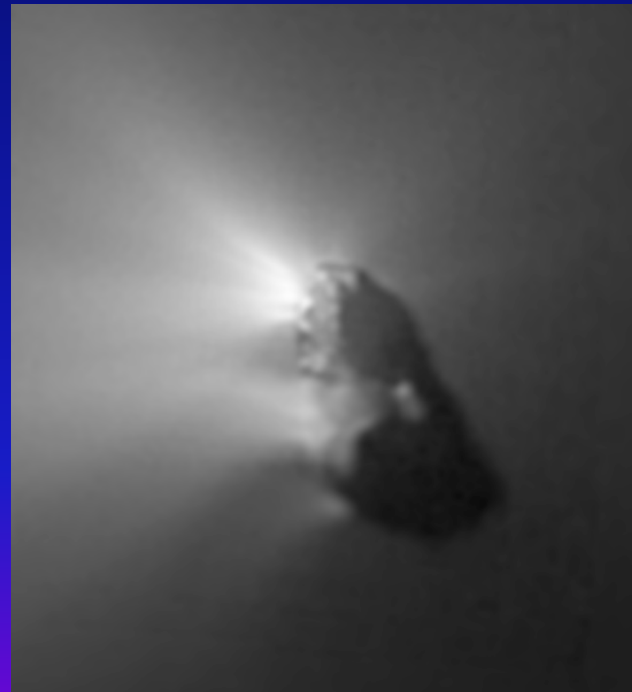


# CCD Imaging of comets





# Rotation Rate

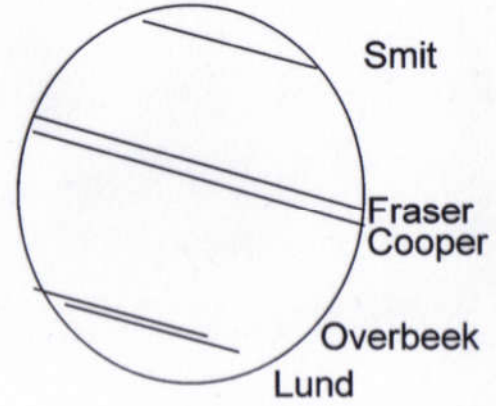


# Asteroids

- Discovery
- Relationship with comets
- Size
- Shape
- Rotation rate
- Binary asteroids
- Satellites



**Path of 248 Lameia  
Across Gauteng  
1998 June 27**

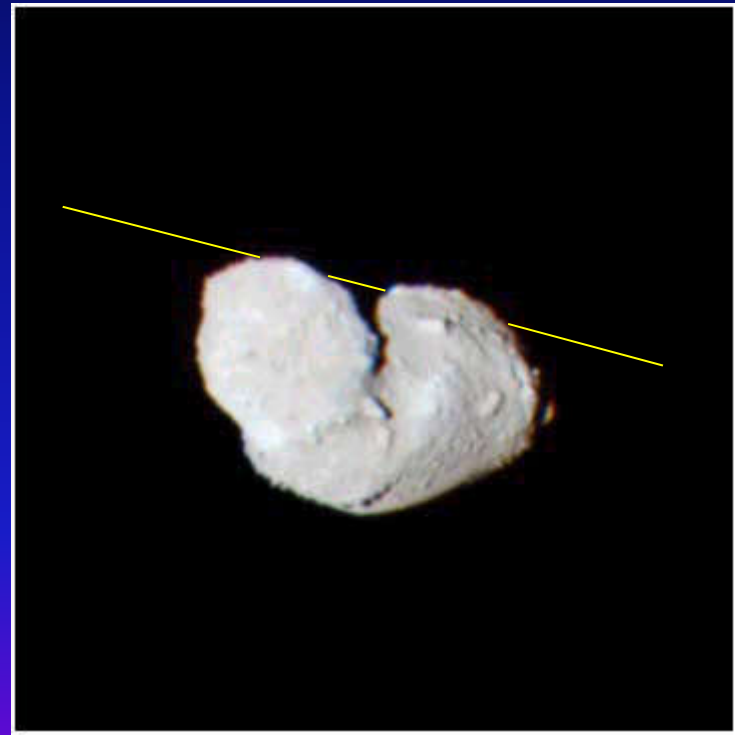


# Gaspra



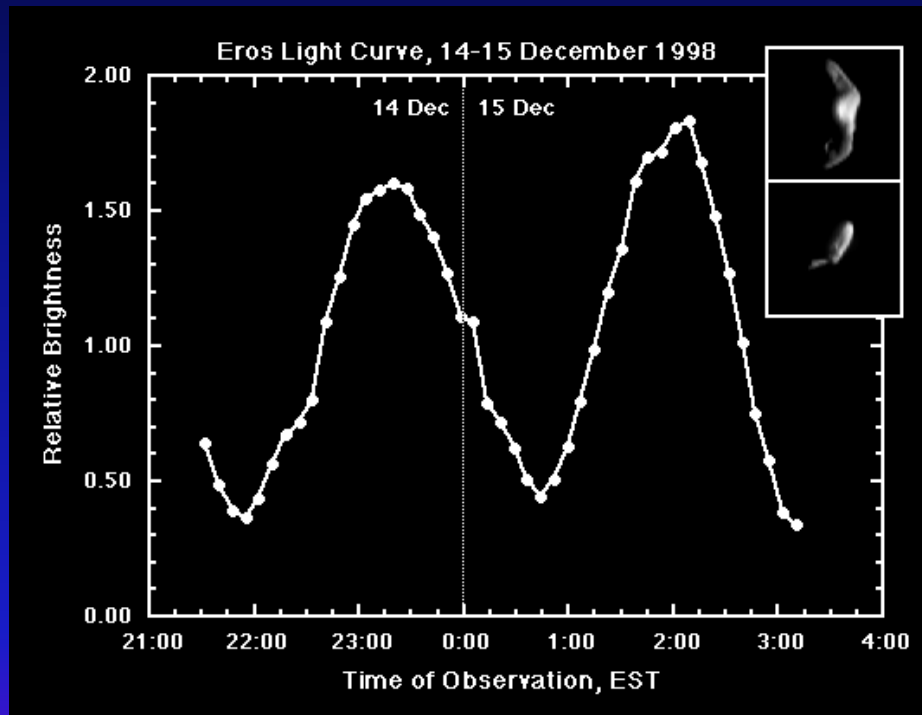
NASA, The Galileo Project, USGS, Cornell U., JPL

# Itokawa

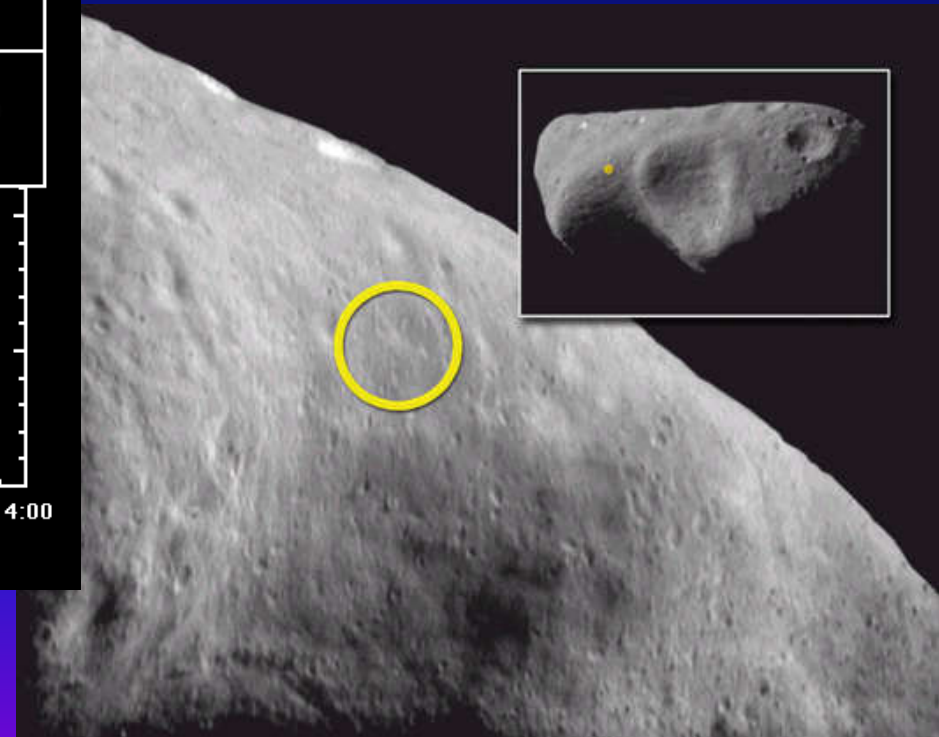




# Rotation Rate Asteroid Eros



NEAR Shoemaker image



NASA

46

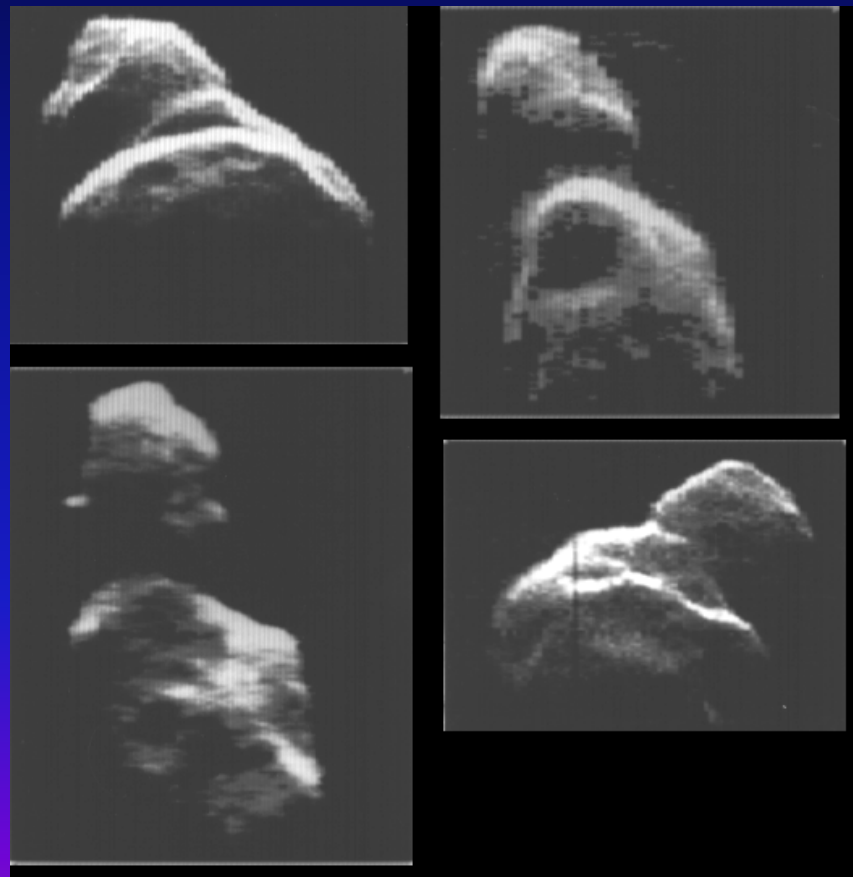
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# Suspected Binary Asteroids and Satellites 1986

<u>Binary</u>		<u>Satellites</u>
24 Themis	171 Ophelia	2 Pallas
29 Amphitrite	349 Dembowska	6 Hebe
44 Nysa	354 Eleanora	9 Metis
46 Hestia	511 Davida	18 Melpomene
49 Pales	532 Herculina	129 Antigone
51 Nemausa	944 Hidalgo	146 Lucina
129 Antigone	1580 Betulia	532 Herculina

**2006 = over 100 confirmed objects, none of the above**

# Binary Asteroids Toutatis



NASA/JPL

48

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# Asteroid Satellites Ida and Dactyl



Galileo Project, JPL, NASA

## Largest known Kuiper Belt objects



NASA, ESA,  
and A. Feild  
(STScI)

# Meteor Parent Bodies

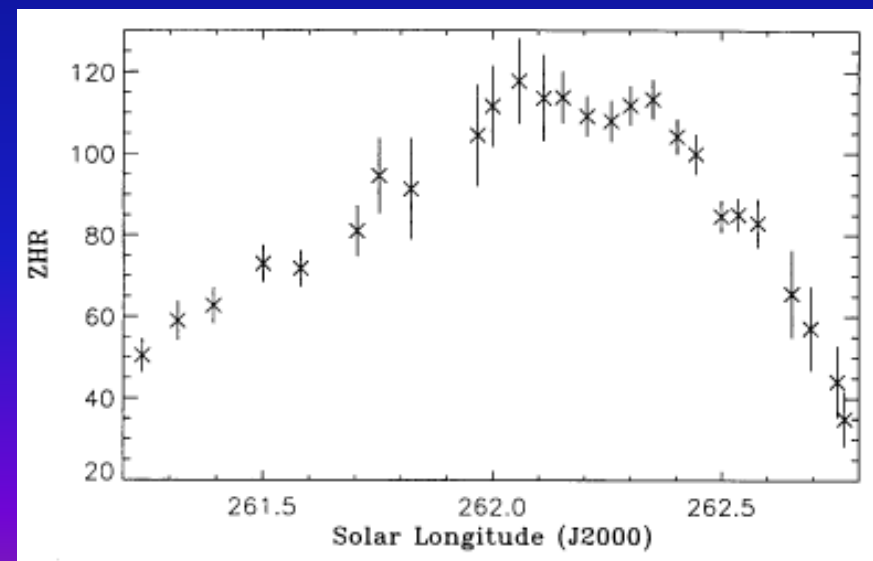
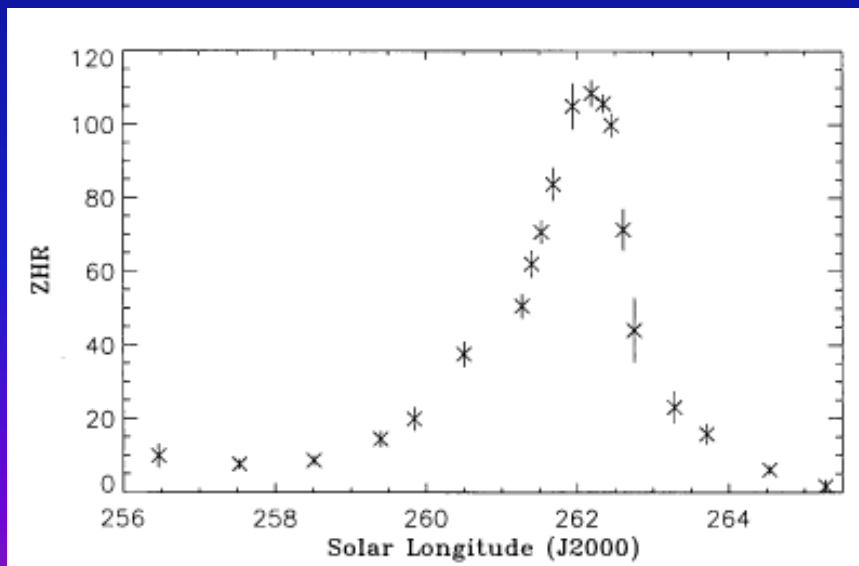
<u>Meteor shower</u>	<u>Parent Body</u>
Quadrantids	2003 EH1
delta Leonids	1987 SY Pan
April Lyrids	C/1861 G1 Thatcher
pi Puppids	26P Grigg-Skjellerup
eta Aquarids	1P Halley
tau Herculids	29P Schwassman-Wachman
June Bootids	7P Pons-Winnecke
delta Aquarids	96P Machholz
Perseids	109P Swift-Tuttle
Orionids	1P Halley
Taurids	2P Encke
Leonids	55P Tempel-Tuttle
Phoenicids	D/1819 W1 Blanpain
Geminids	3200 Phaethon

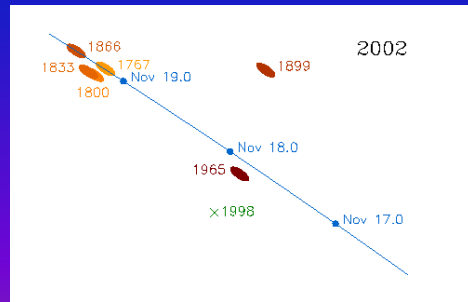
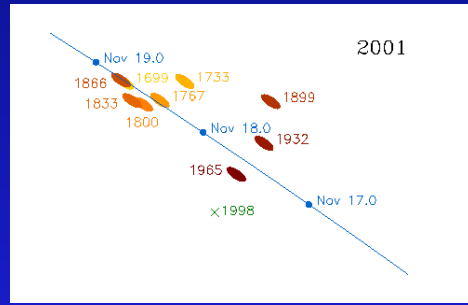
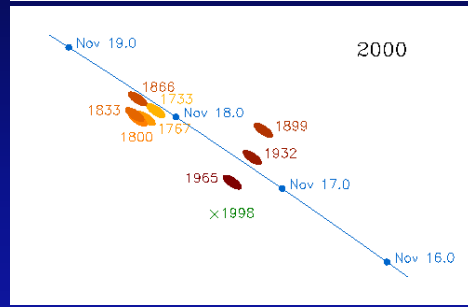
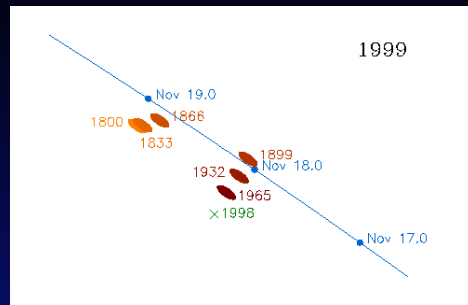
# Meteors

- Commission 22 of the IAU - Pro-Amat working group
  - Visual Observation
  - Radio
  - Photographic and video

# 1996 Geminids

$$\text{ZHR} = \frac{N \times F \times r^{(6.5-LM)}}{T_{\text{eff}} \times \sin h}$$





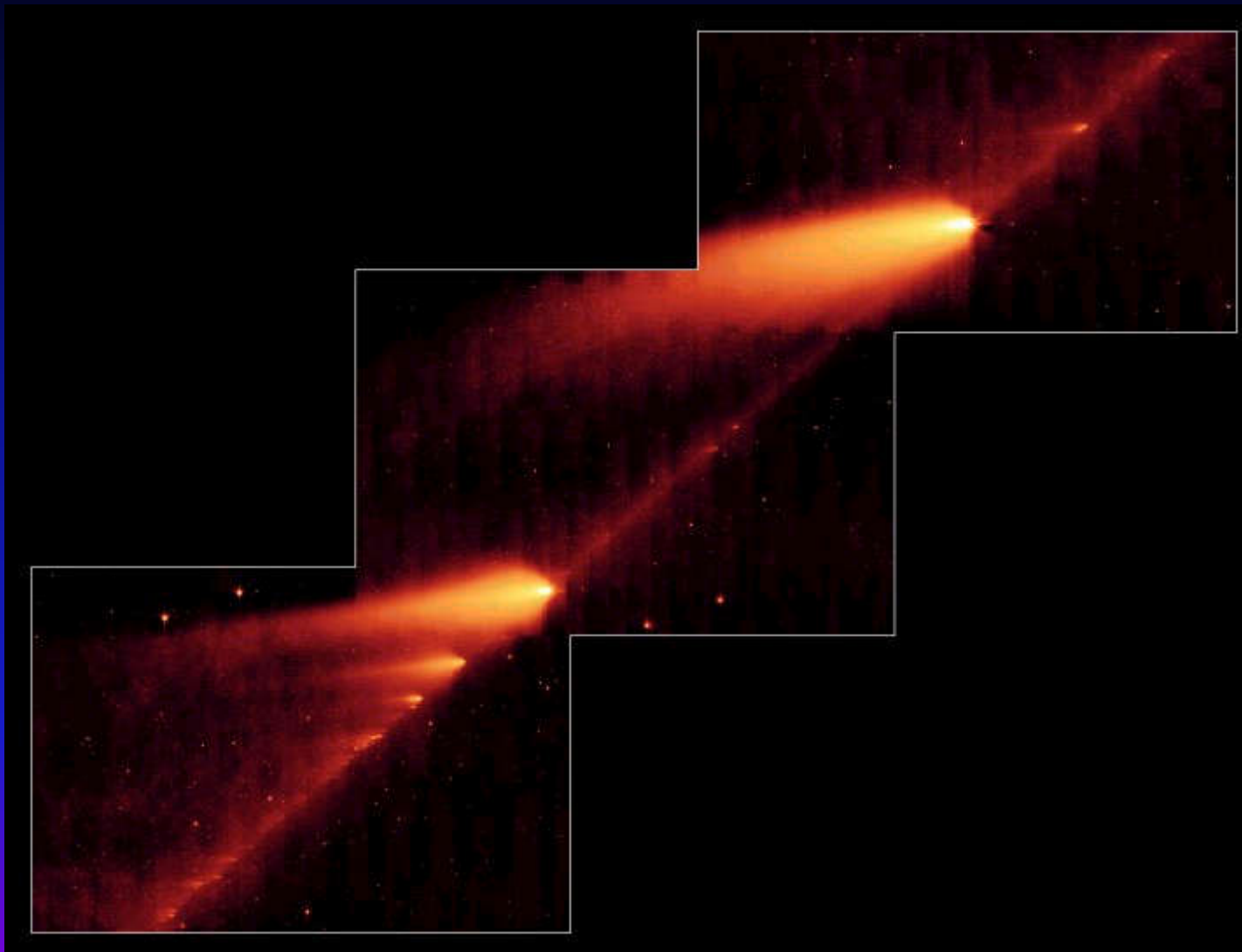
# Serious Amateur Astronomy: Linking with Professionals

(C/1975 V1) March 1976 by Peter Stättmayer,  
Munich Public Observatory. Courtesy ESO



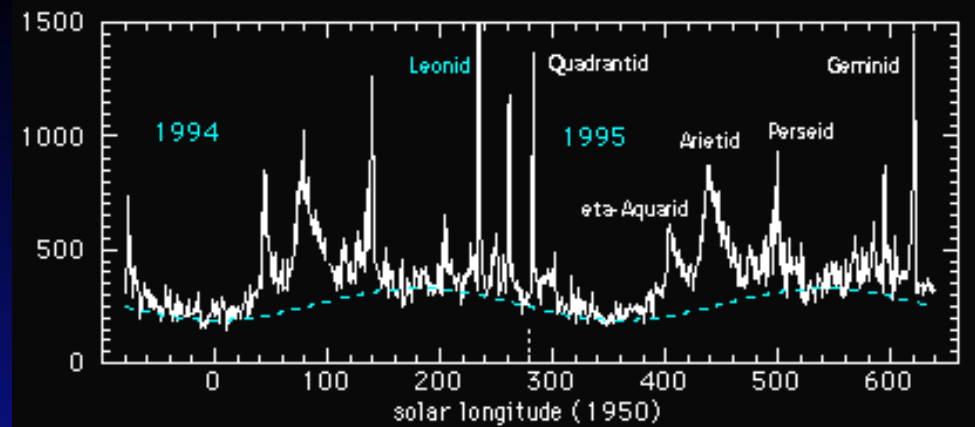
55

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# Radio



# Photographic



# Conclusions

- Perception that amateurs need large telescopes and expensive equipment
- In fact amateurs can contribute visually with modest equipment
- These observations are in demand by professionals
- We need more observers to become involved - no, we need you to become involved