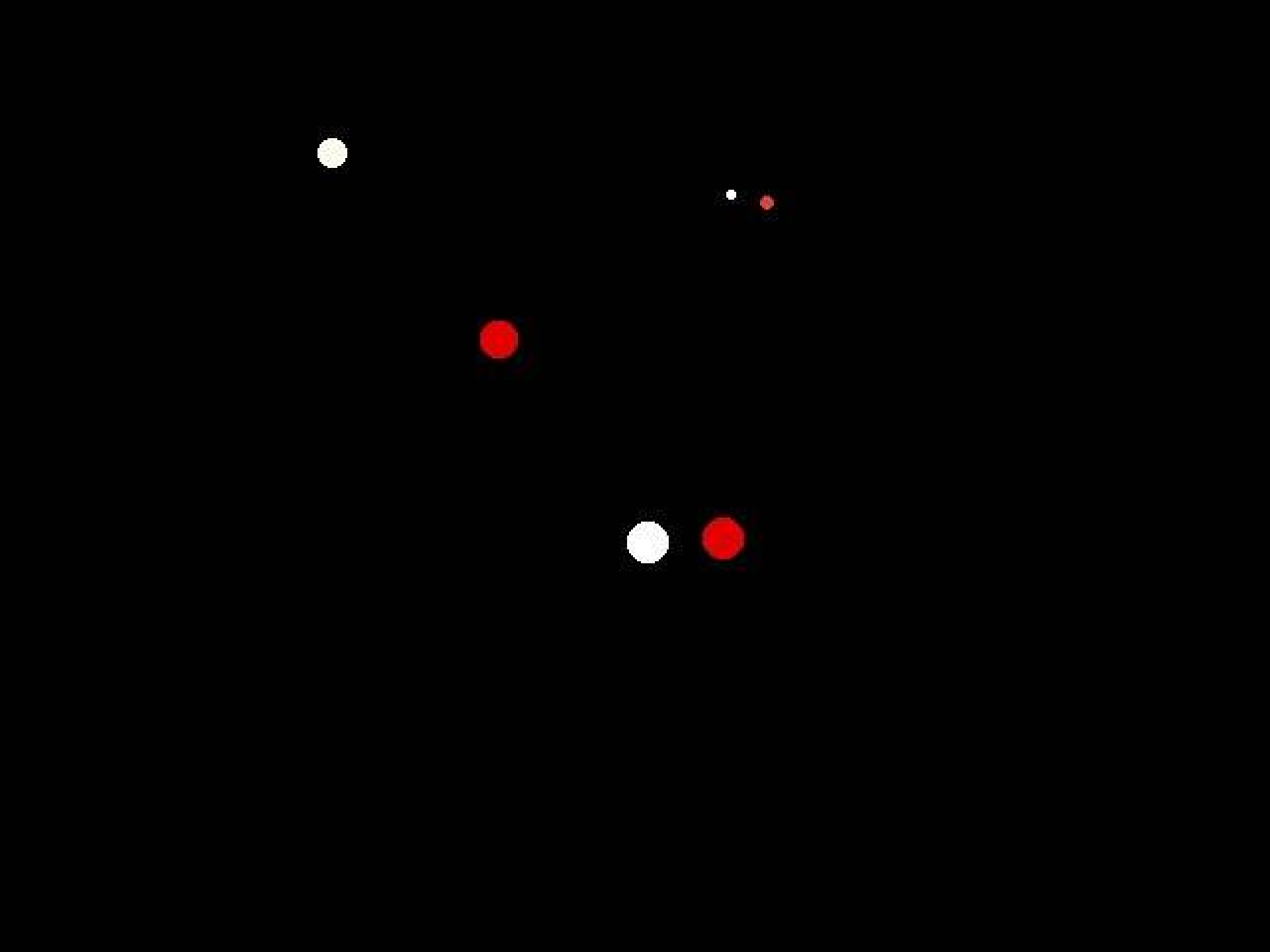
Calibrating your Eyes to Match the V-Magnitude Scale

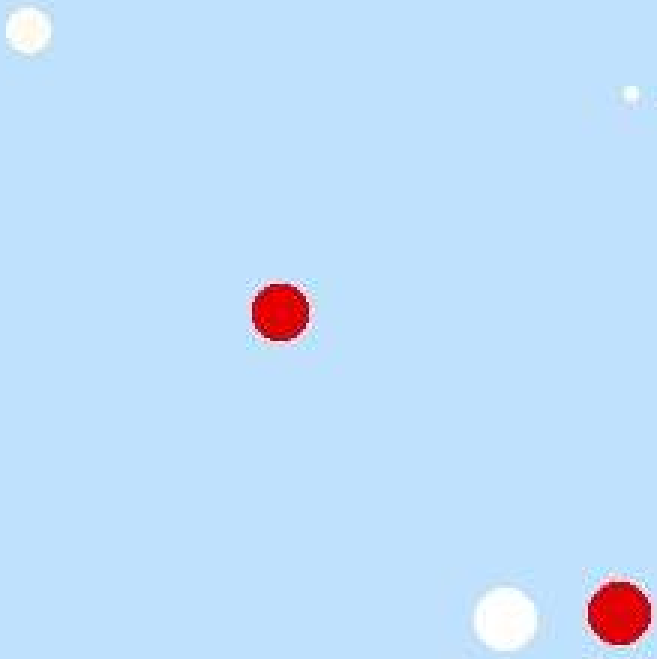
By Sebastián Otero

These observing technics are based on

HALLETT, P.E., 1998, JAAVSO, 26, 139.

They are a practical application of the eye physics described in that paper





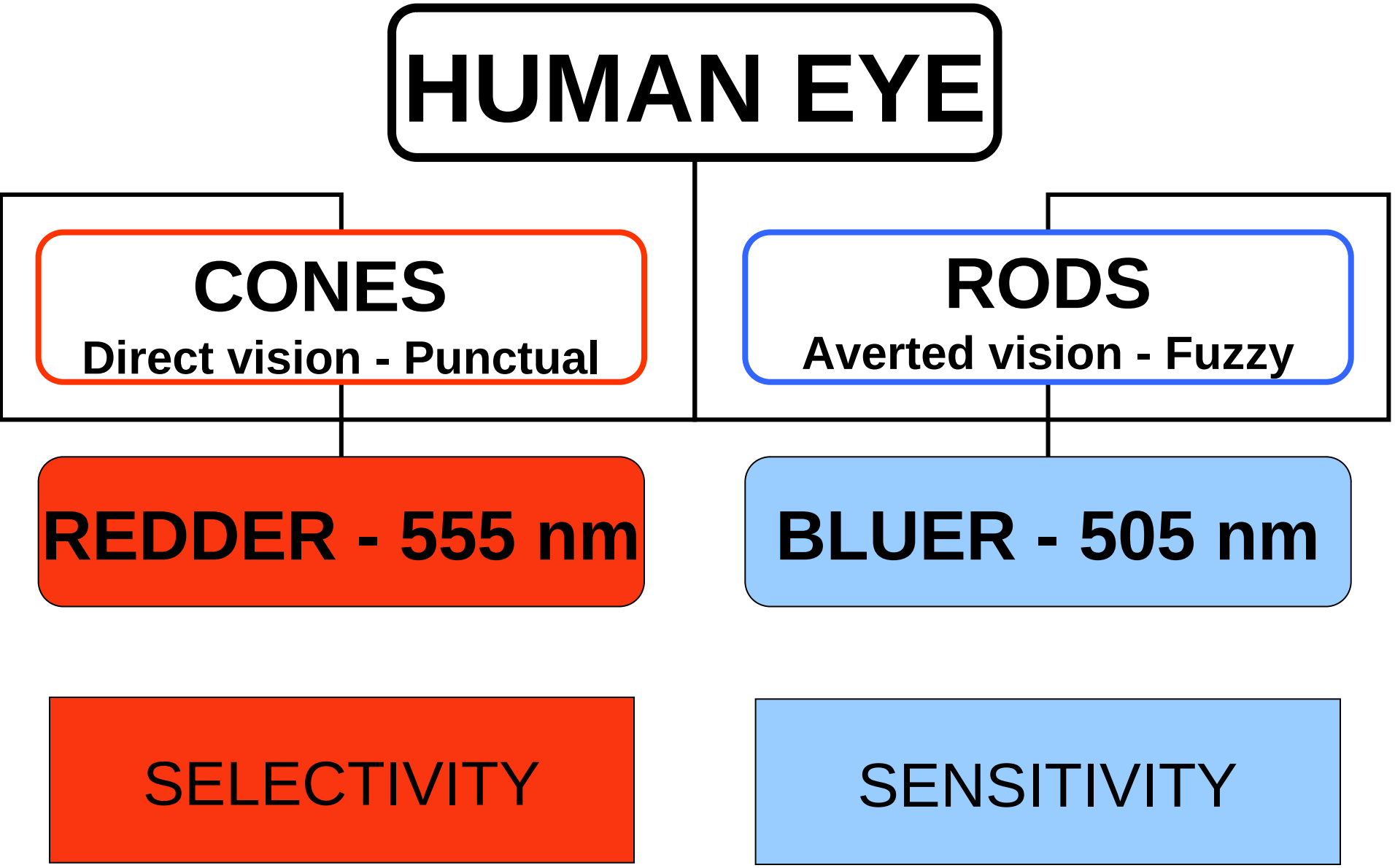
You can discover something if you…

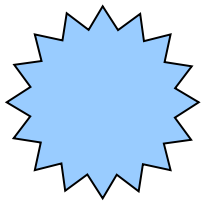
- **PRACTICE** to IMPROVE your skills.
- **KNOW** WHAT YOU ARE OBSERVING (I'm against of blindly observing stars in all respects: comp stars magnitudes, star's colors, variable star's type… Reporting 1 mag. irregular variations in an A5V star wasting other people's time checking our "discovery" is worse than any bias introduced by knowing…

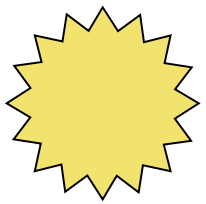
FACTORS playing an important role while observing

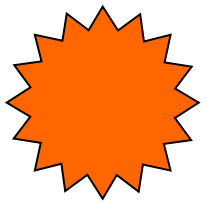
- **BRIGHTNESS OF THE STAR**
- **BACKGROUND SKY BRIGHTNESS**
- **TYPE OF VISION USED**

- VARIABLE STAR'S COLOR
- COMP STARS' COLORS
- STEP BETWEEN COMP STARS
- COMP STARS DISTANCE


HUMAN EYE
CONES
Direct vision - Punctual
RODS
Averted vision - Fuzzy
REDDER - 555 nm
BLUER - 505 nm
SELECTIVITY
SENSITIVITY







BRIGHT STARS	FAINT STARS
* Bright for the rods (fuzzy) * Bright for the cones (punctual)	* Bright for the rods * Faint for the cones
* Less bright for the rods * Bright for the cones	* Less bright for the rods * Faint for the cones
* Faint for the rods * Bright for the cones (Purkinje effect)	* Faint for the rods * Faint for the cones

THE BEST RESULTS ARE OBTAINED BETWEEN 1 and 4 MAGNITUDES ABOVE YOUR INSTRUMENTAL LIMIT

Instrument	Limit. mag.	Ideal range
Naked eye	**5**	**1 - 4**
Binoc. 7x50	**9**	**5 - 8**
Telesc. 20 cm.	**13**	**9 – 12**

The ideal sequence

- **Same color** for variables and the two comp stars.
- That same color is **bluer than B-V 0.8** or so.
- Comp stars **close to the variable** and if possible in a straight line.
- Comp stars are **similar in brightness to the variable star** and are **less than 0.3 mag. different between each other.**

SORRY…IN THE REAL WORLD…

- You have only comparison stars of different colors available.
- The extreme cases are blue and orange/red stars mixed.
- You’re given V magnitudes in the charts. If you don’t apply technics to “observe in V” your result will be impossible to correct properly later.

- To transform the results from v to V, v should have been obtained from v magnitudes in the charts.
- Even if that was the case, v would be dependent on the star's (and sky) brightness so the v to V transformation would only work for estimates made when the red stars are faint, making things worse when they are observed bright. ("bright" or "faint" at the eyepiece… An observer changing aperture (or magnification) when a star gets beyond the limit of a given instrument adds more noise to the results)

PROBLEMS with corrections applied **AFTER** the observation was submitted

- Observers use different types of vision (some direct, some averted) and the correction factors would have to be different.
- The same correction factor based on color works the opposite way for a bright star than for a faint star using a “consistent” type of vision = The consistency becomes inconsistent.
- The background sky brightness at the moment of the observation also affects the result.
- Individual color response needs individual correction from HQ that could be made by the observer a priori.

EYE CALIBRATION

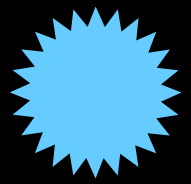
(to be applied while observing stars with different colors)

- Observation of 2 comp stars of the same V-mag. And different B-V (**2 purposes** a) use the appropiate type of vision; b) calibrating the technics for a certain sky brightness)
- Checking the differences between the comparison stars (**purpose**: to confirm that the technics are being applied properly)

WHY “calibration”?

- Because although the technics indicate which type of vision to use under a given circumstance according to star’s brightness and color, **sky bakground changes** from night to night and **individuals also have their own color response** and need to find their own calibration.
- **EXPERIENCE** is the key here.
- **PRACTICING** is the way to get it.

<u>Calibrators</u>: Adapt your type of vision to see them with similr brightness



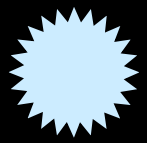
2.34

2.33

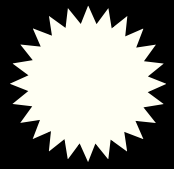
BRIGHT STARS

DIRECT vision: the red star will appear brighter
AVERTED vision: the blue star will appear brighter
Use an **intermediate type of vision**, looking slightly to one side of the star.

2.83

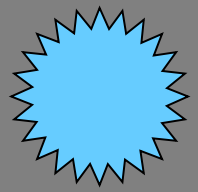


2.64



Variable
(2.75)

<u>Calibrators</u>: Adapt your type of vision to see them with similr brightness



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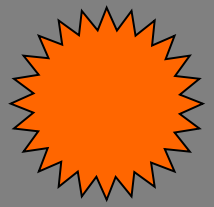
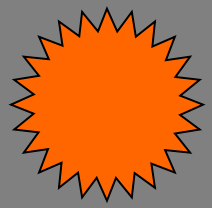


2.33

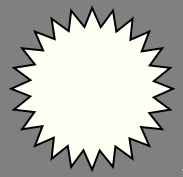
BRIGTHER SKY BACKGROUND
= Rods sensitivity falls

To get a proper calibration **blue stars** would need to be observed almost with averted vision (Naked eye = the brightest sky possible)

2.83



2.64

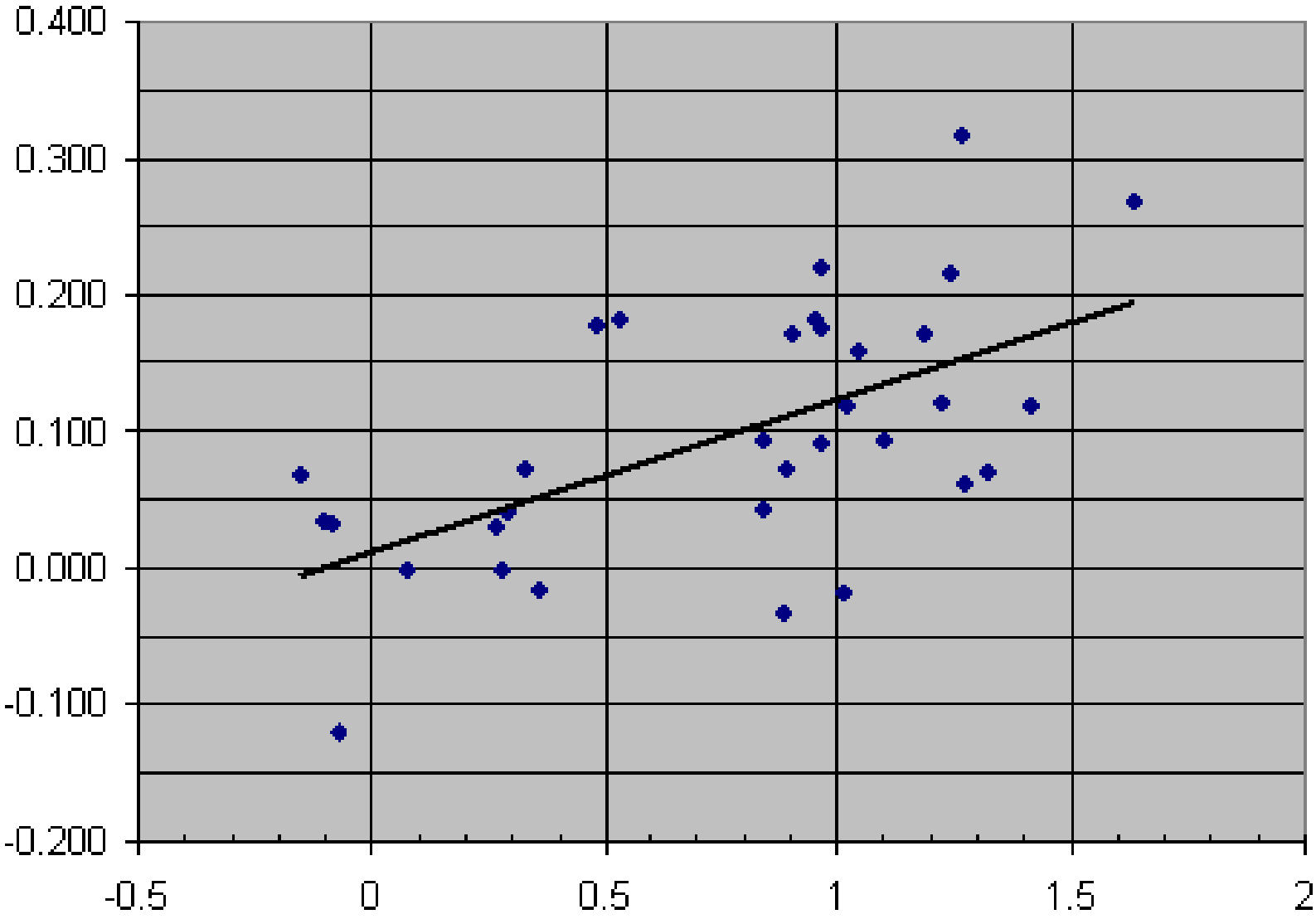


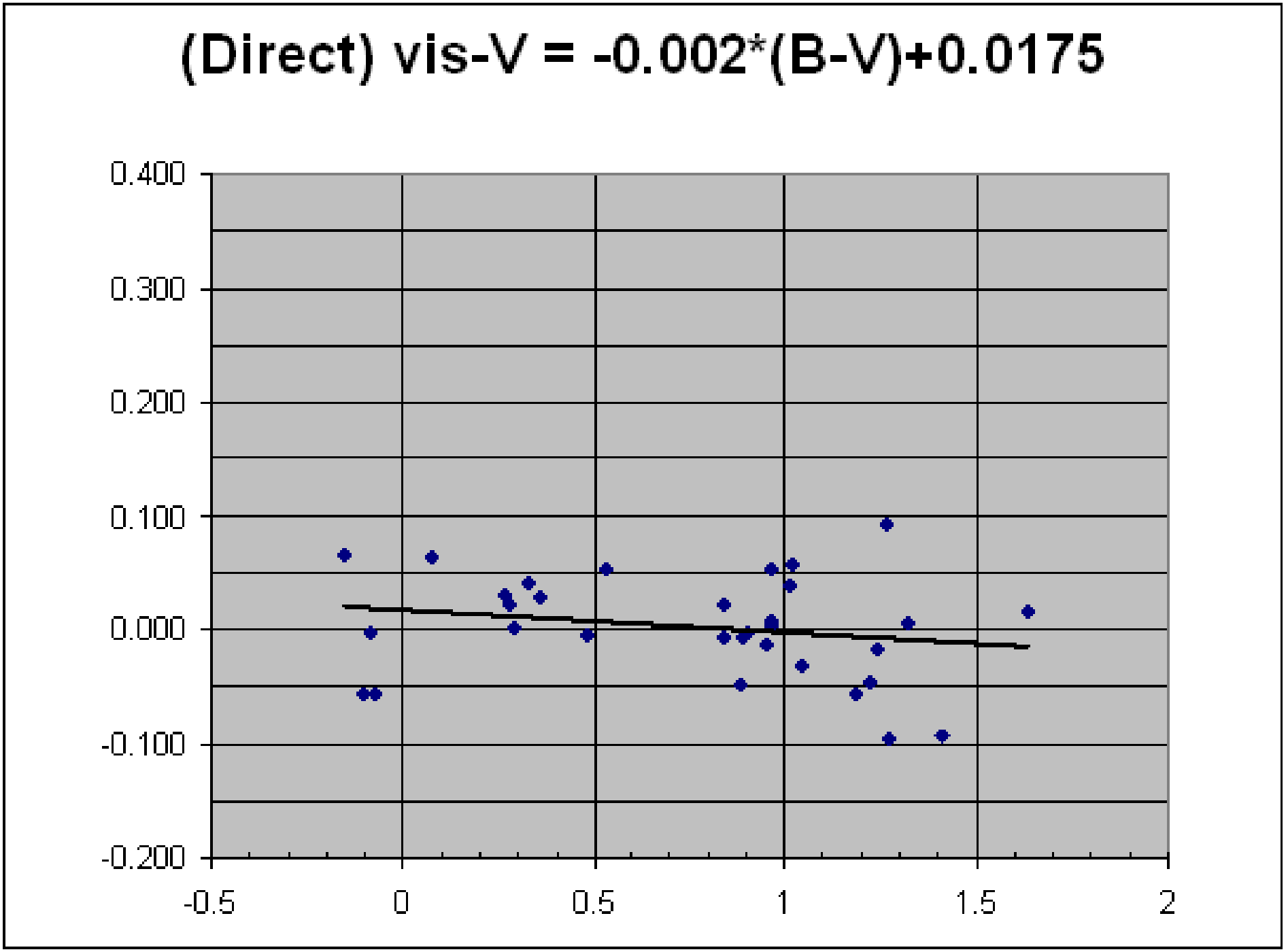
Variable
(2.75)

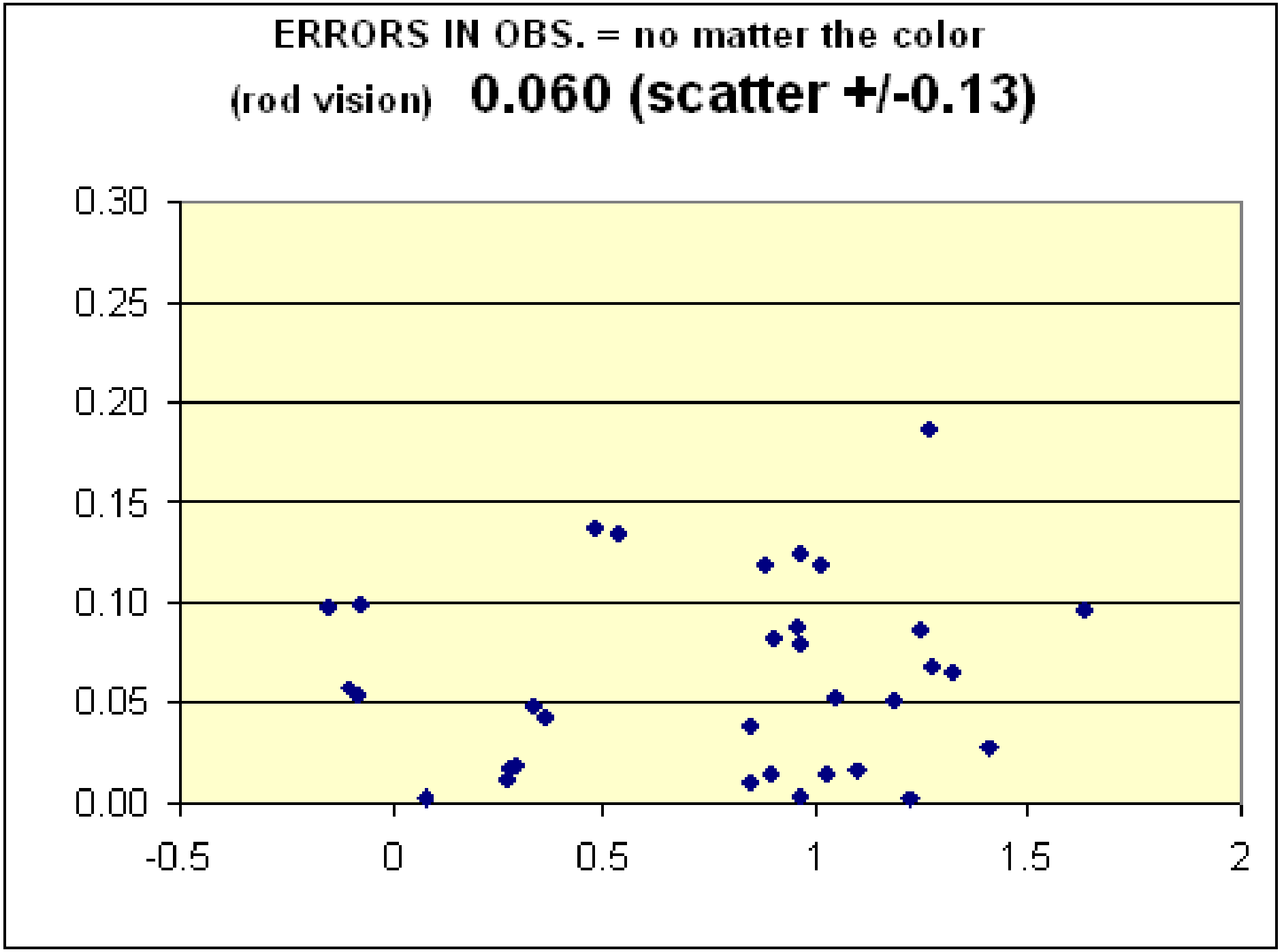
Cone vision accuracy

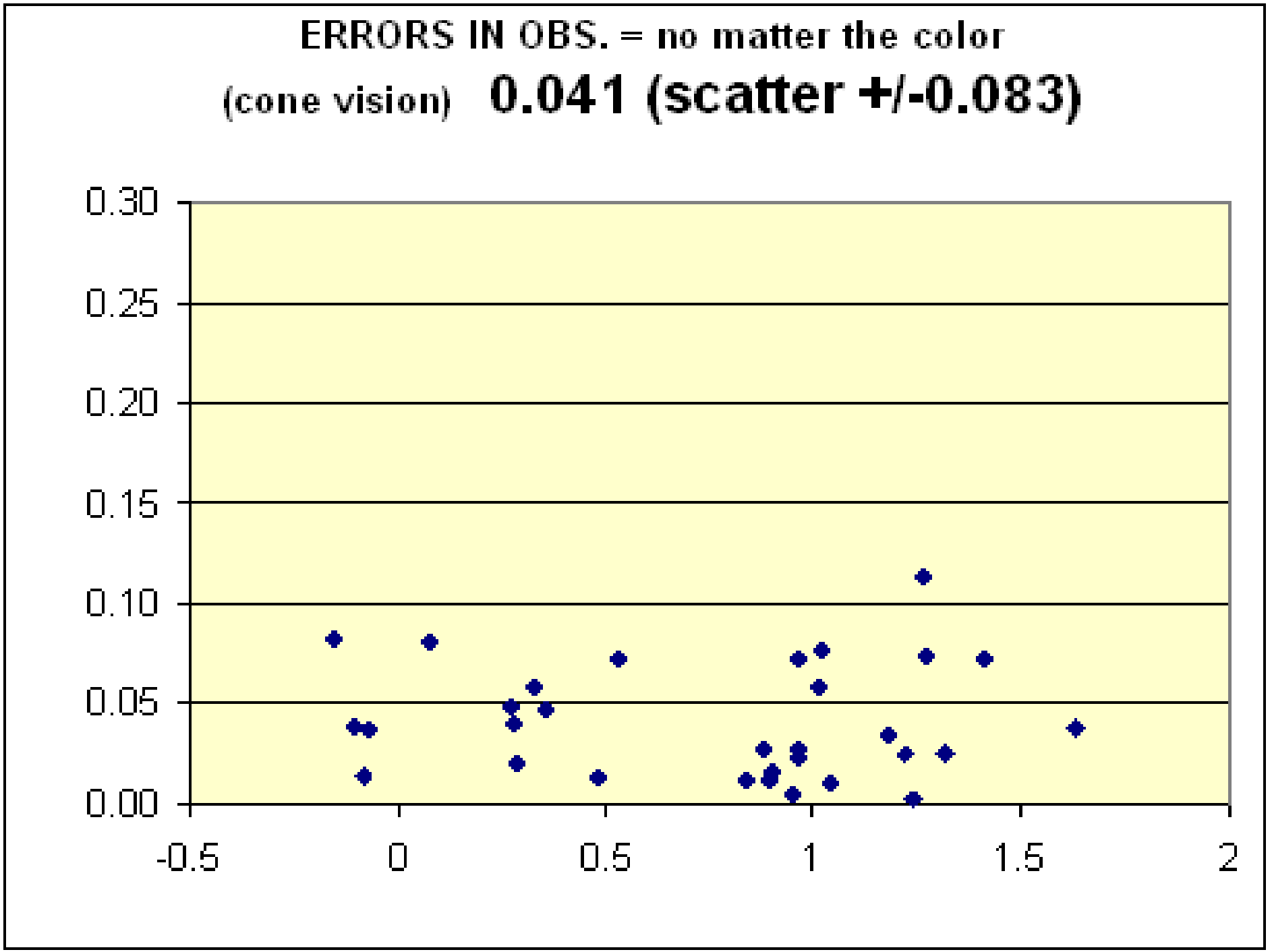
Instrument	Ideal sequence error	Average sequence error
Naked eye	0.03 mag.	0.05 mag.
Binoculars	0.05 mag.	0.05-0.1 mag.
Telescope	0.1 mag.	0.1-0.15 mag.

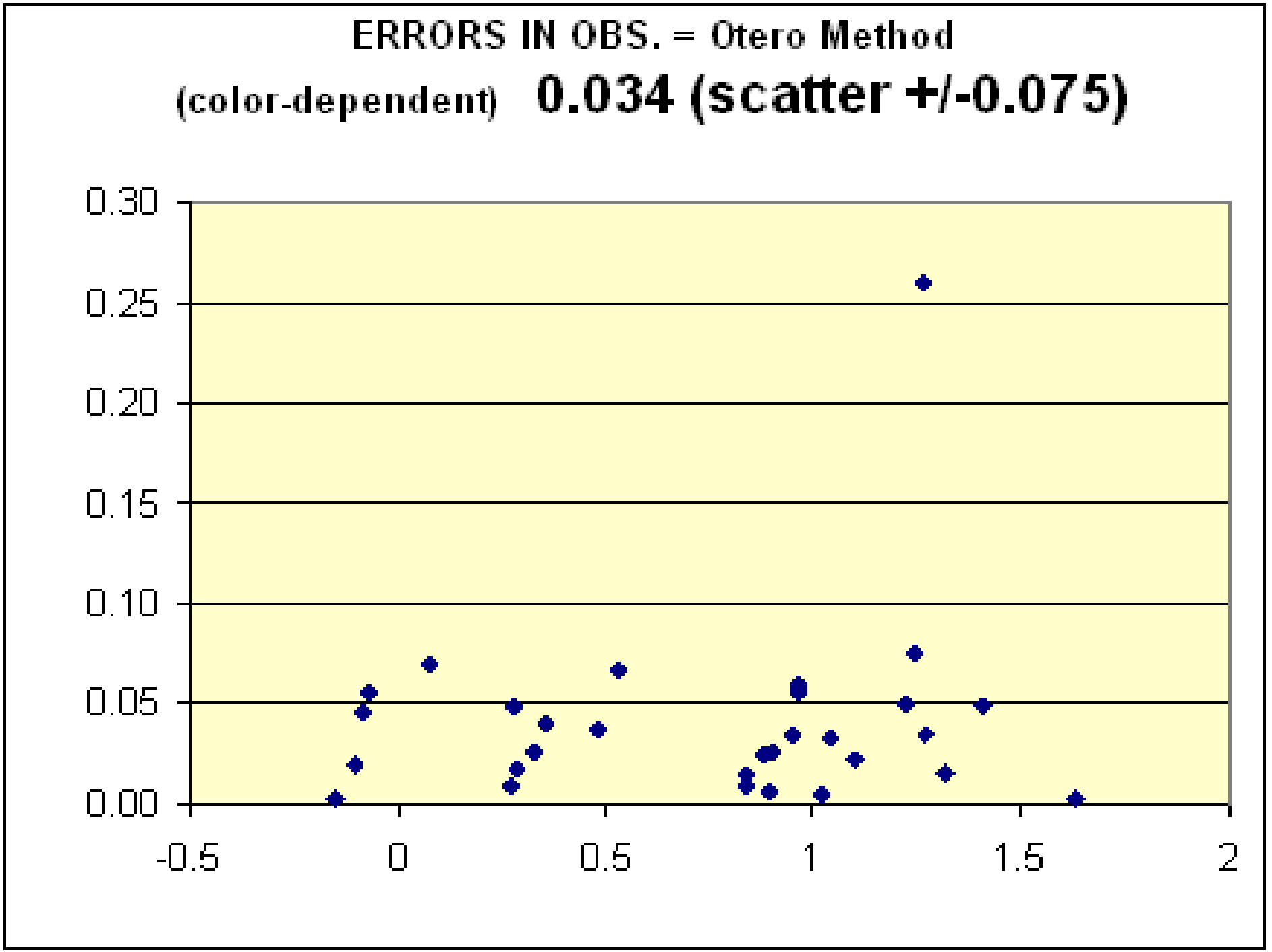
(Averted) vis-V = 0.1125*(B-V)+0.0125




(Direct) vis-V = -0.002*(B-V)+0.0175
0.400
0.300
0.200
0.100
0.000
-0.100
-0.200
-0.5
0
0.5
1
1.5
2


ERRORS IN OBS. = no matter the color
(rod vision) 0.060 (scatter +/-0.13)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.5
0
0.5
1
1.5
2


ERRORS IN OBS. = no matter the color
(cone vision) 0.041 (scatter +/-0.083)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.5
0
0.5
1
1.5
2


ERRORS IN OBS. = Otero Method
(color-dependent) 0.034 (scatter +/-0.075)
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.5
0
0.5
1
1.5
2

R Centauri - M - V= 5.3 - 11.8 - B-V= 2.0v - M4e - Per: 495 d

V883 Centauri - EA - V= [6.31 - 6.35] - 6.55 - B-V= 0.05 - B5IV - Per: ?

V Centauri - DCEP - V= 6.41 - 7.21 - B-V= 0.66 - 1.1 - F5Ib-II-G0 - Per: 5.4938 d.

V737 Centauri - DCEP - V= 6.54 - 6.93 - B-V= 0.87 - 1.1? - G0/G2Ib - Per: 7.06585 d.

BP Circini - DCEPs - V= 7.36 - 7.69 - B-V= 0.6 - 0.75 - F2/F3II - Per: 2.398 d.

V418 Centauri - Lc - V= 7.1 - 7.3? - B-V= 1.7 - 1.8 - K4II ó K5III

OR Circini - Lc - V= 7.4? - 7.6? - B-V= 1.74 - M2-M3II

V1001 Centauri - IA? V= 7.20 - 7.38 - B-V= 0.10 - B4IV/V

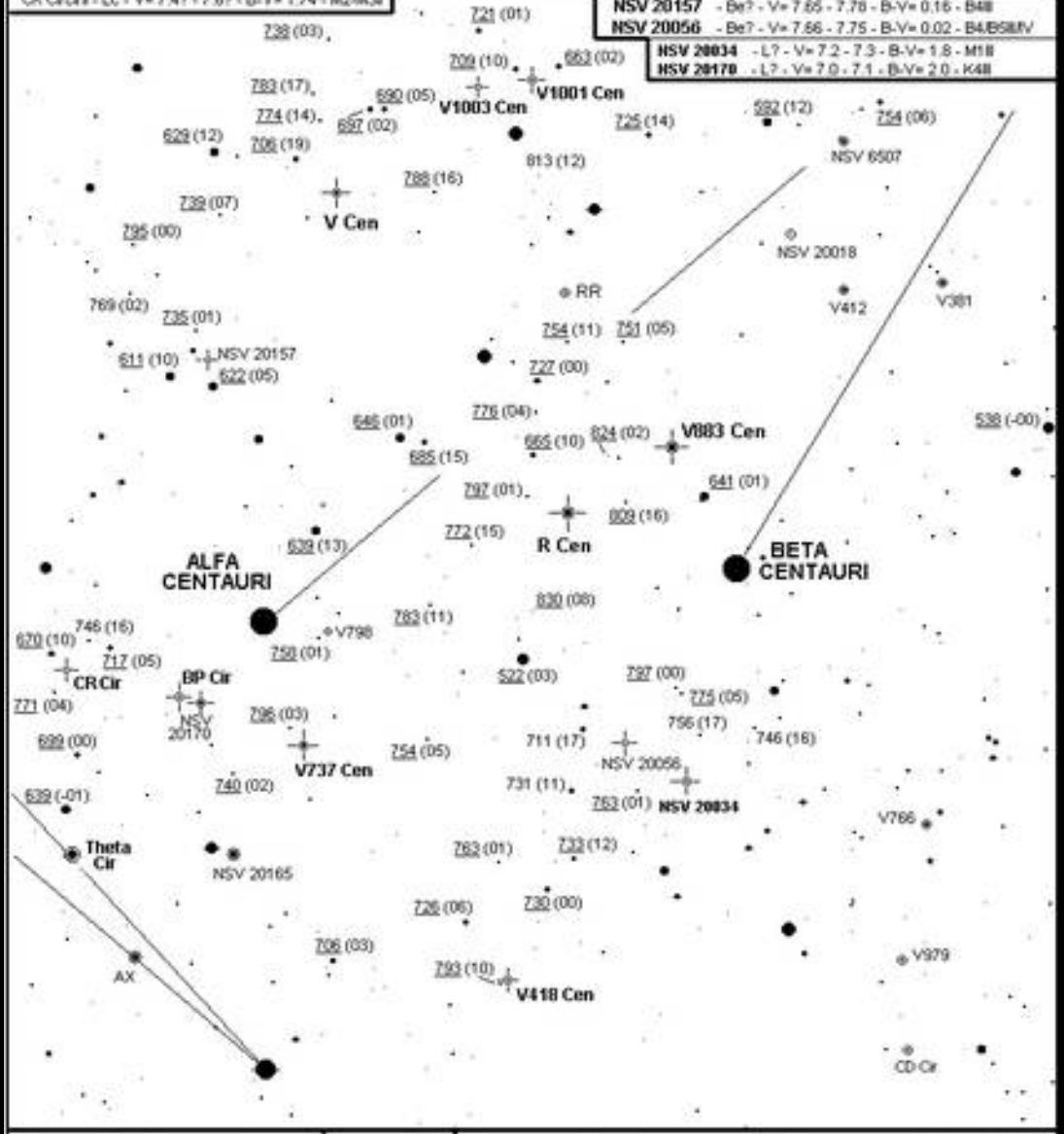
V1003 Centauri - Lc - V= 7.7? - 8.0? - B-V= 1.8 - M5II

NSV 20157 - Be? - V= 7.65 - 7.78 - B-V= 0.16 - B4II

NSV 20056 - Be? - V= 7.66 - 7.75 - B-V= 0.02 - B4/B5II/V

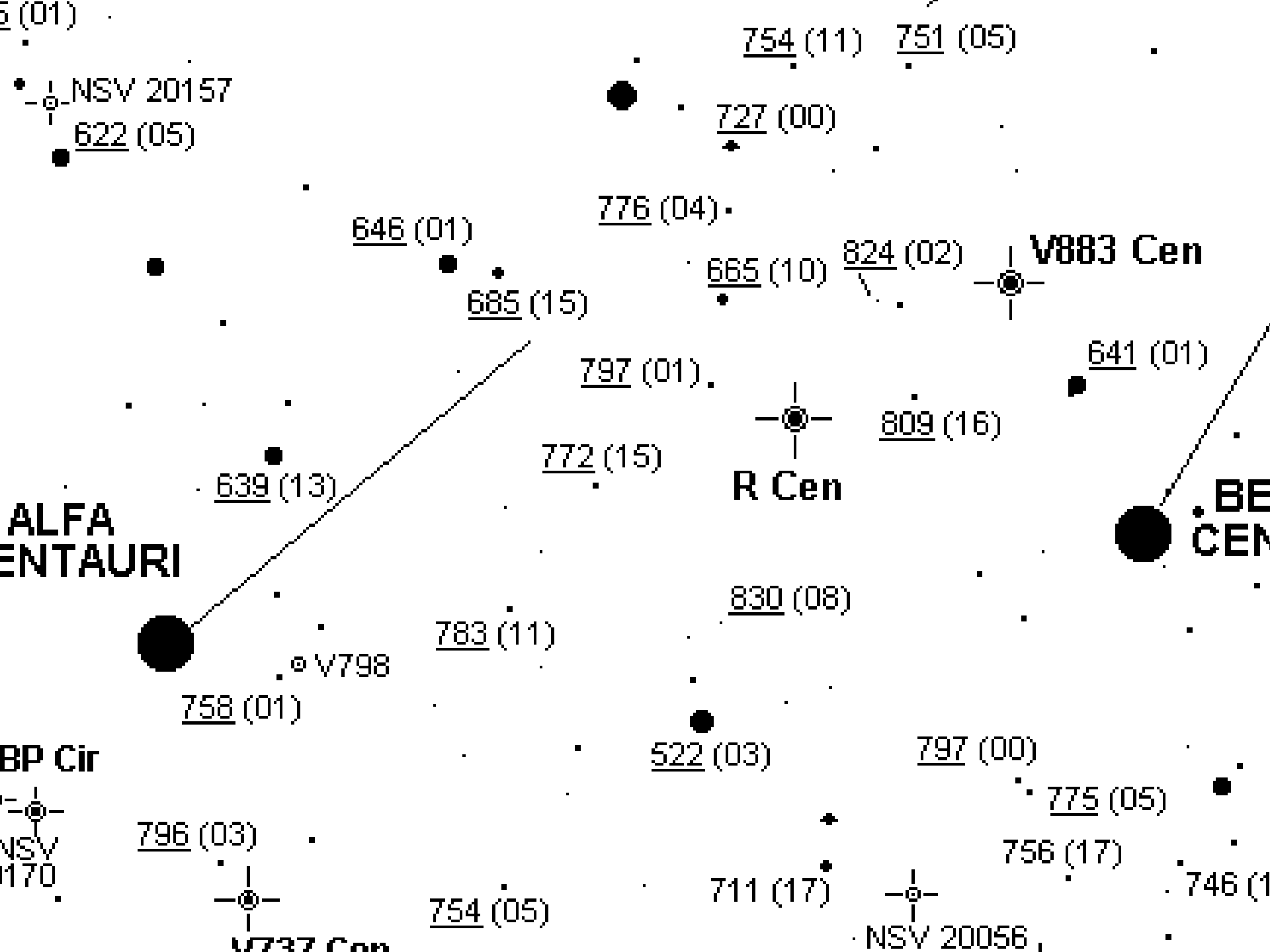
NSV 20034 - L? - V= 7.2 - 7.3 - B-V= 1.8 - M1II

NSV 20170 - L? - V= 7.0 - 7.1 - B-V= 2.0 - K4II



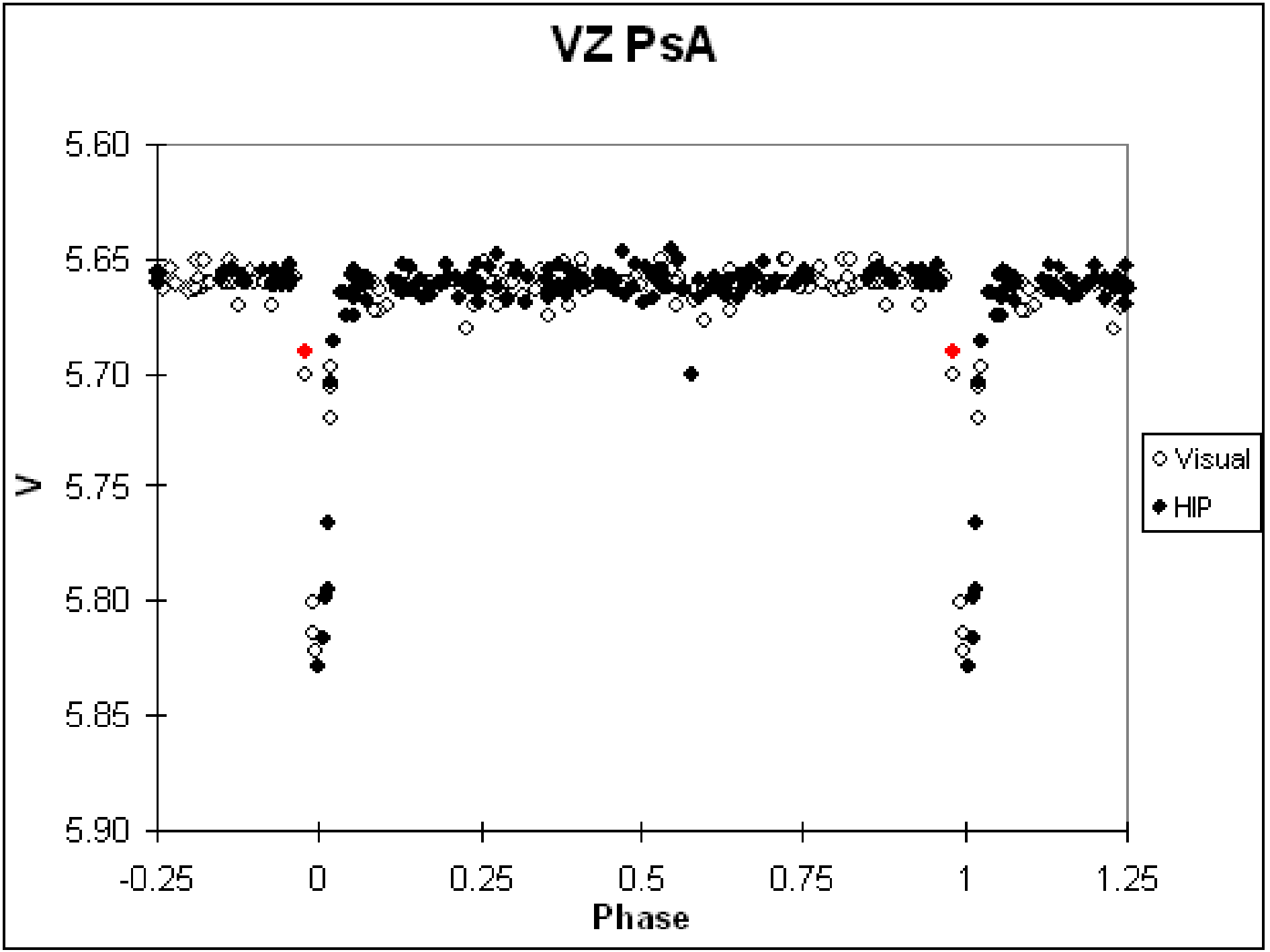
Carta S. Otero - 2002

Magnitudes PEP(V) & Hipparcos + Tycho


754 (11)
751 (05)
NSV 20157
727 (00)
622 (05)
776 (04)
646 (01)
824 (02)
V883 Cen
665 (10)
685 (15)
641 (01)
797 (01)
809 (16)
772 (15)
R Cen
639 (13)
ALFA
ENTAURI
BE
CEN
830 (08)
783 (11)
V798
758 (01)
522 (03)
797 (00)
BP Cir
775 (05)
796 (03)
756 (17)
711 (17)
754 (05)
NSV 20056

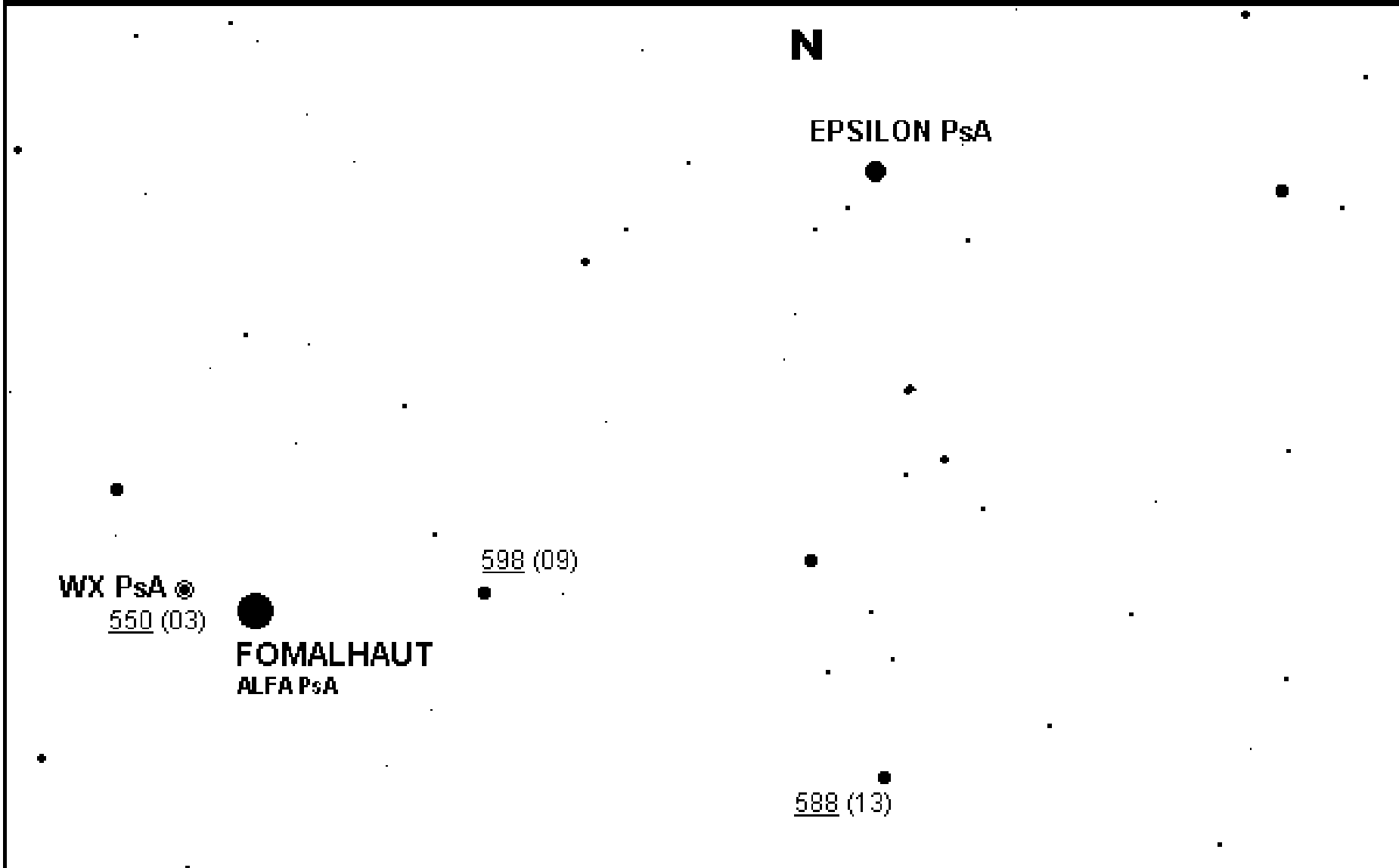
The goals of being V-calibrated

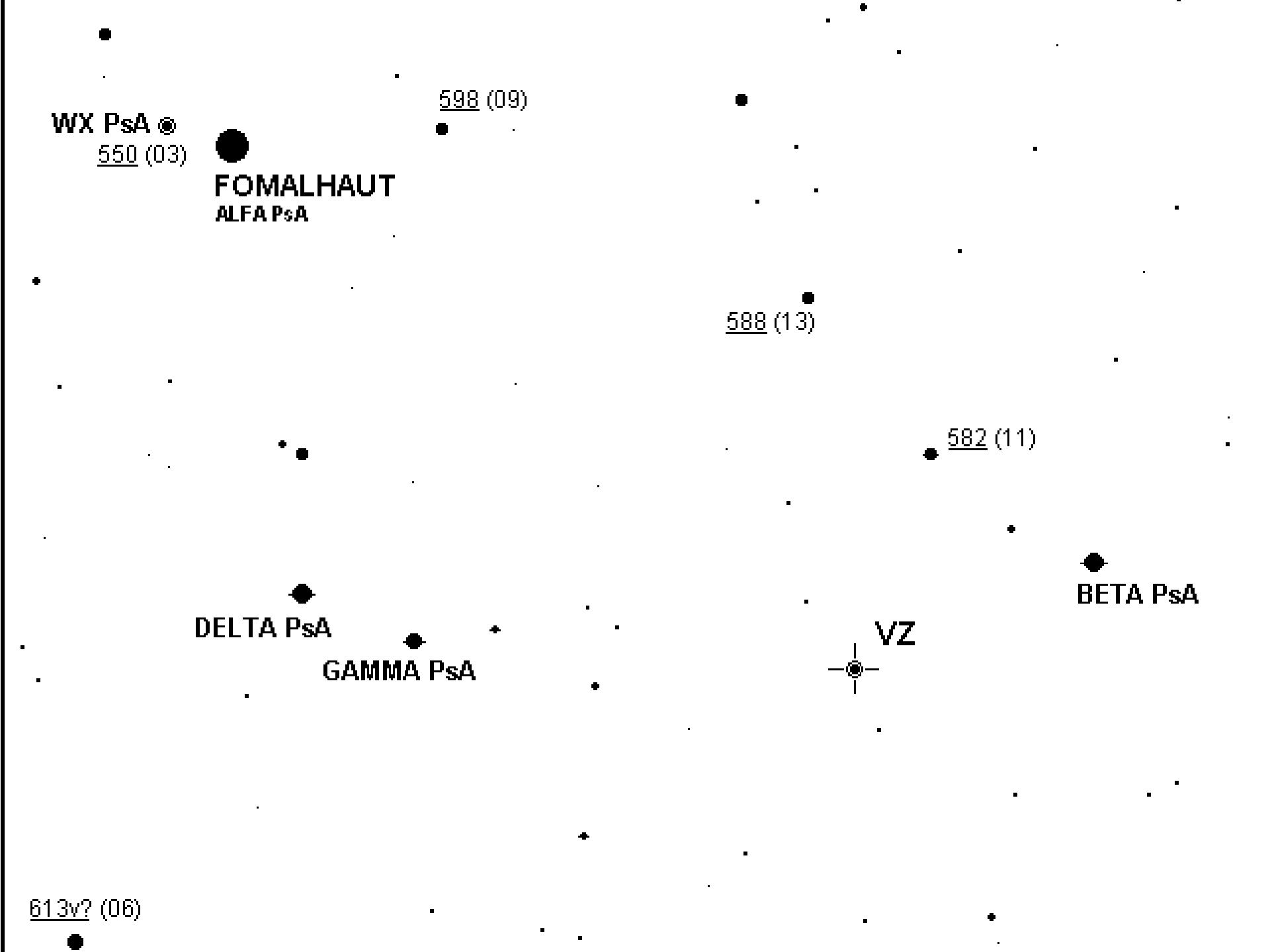
1) Detecting or confirming a new variable by means of a visual observation after comparison with published V values.


VZ PsA
5.60
5.65
5.70
5.75
5.80
5.85
5.90
V
-0.25
0
0.25
0.5
0.75
1
1.25
Phase
Visual
HIP

VZ Piscis Austrini - EA - V= 5.66 - 5.83? - B-V= 0.05 - A2V - Per:

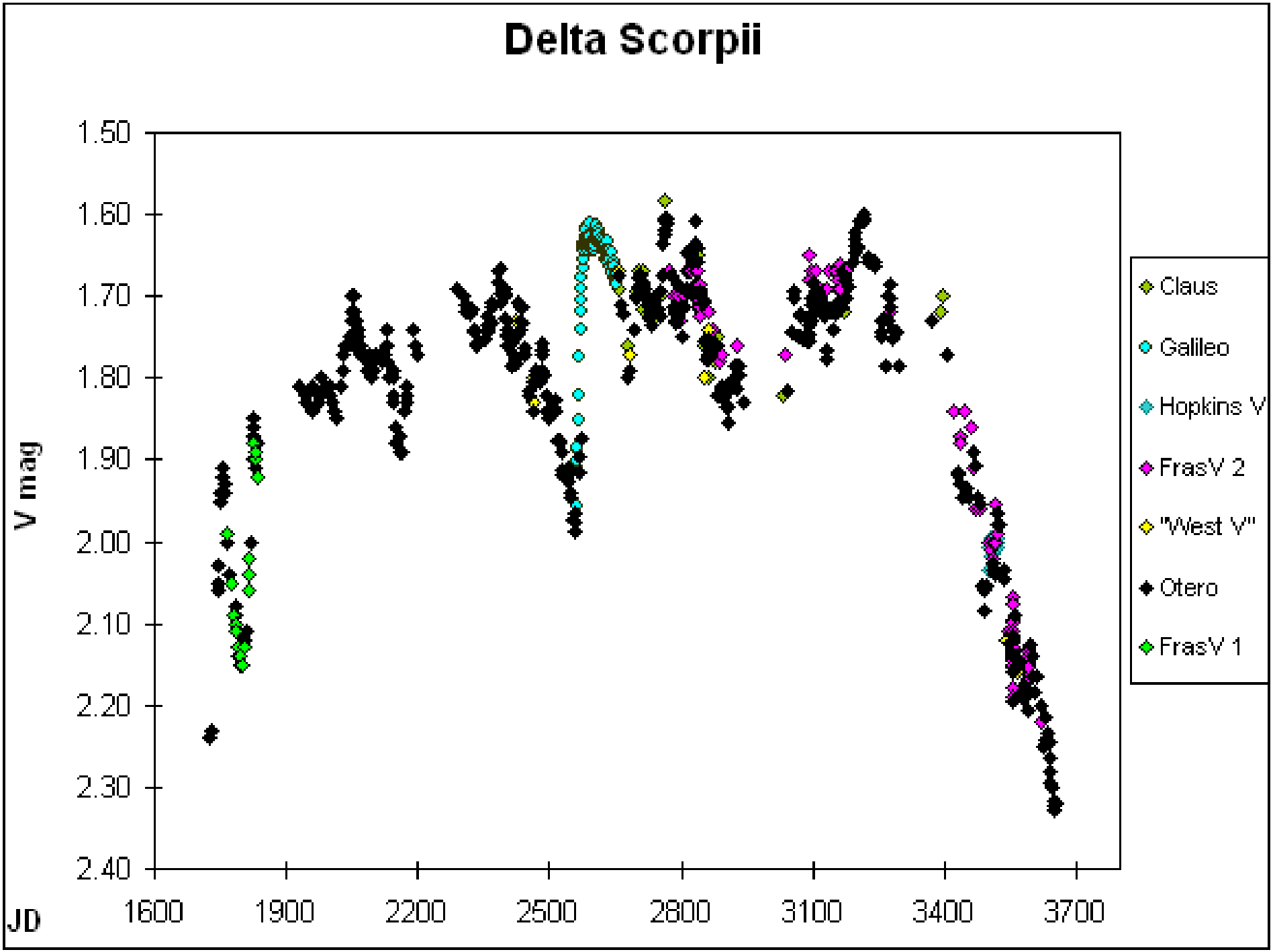
22h 38m 51.47s -33º 04' 52.8" (2000.0)




598 (09)
WX PsA
550 (03)
FOMALHAUT
ALFA PsA
588 (13)
582 (11)
BETA PsA
DELTA PsA
GAMMA PsA
VZ
613v? (06)

The goals of being V-calibrated

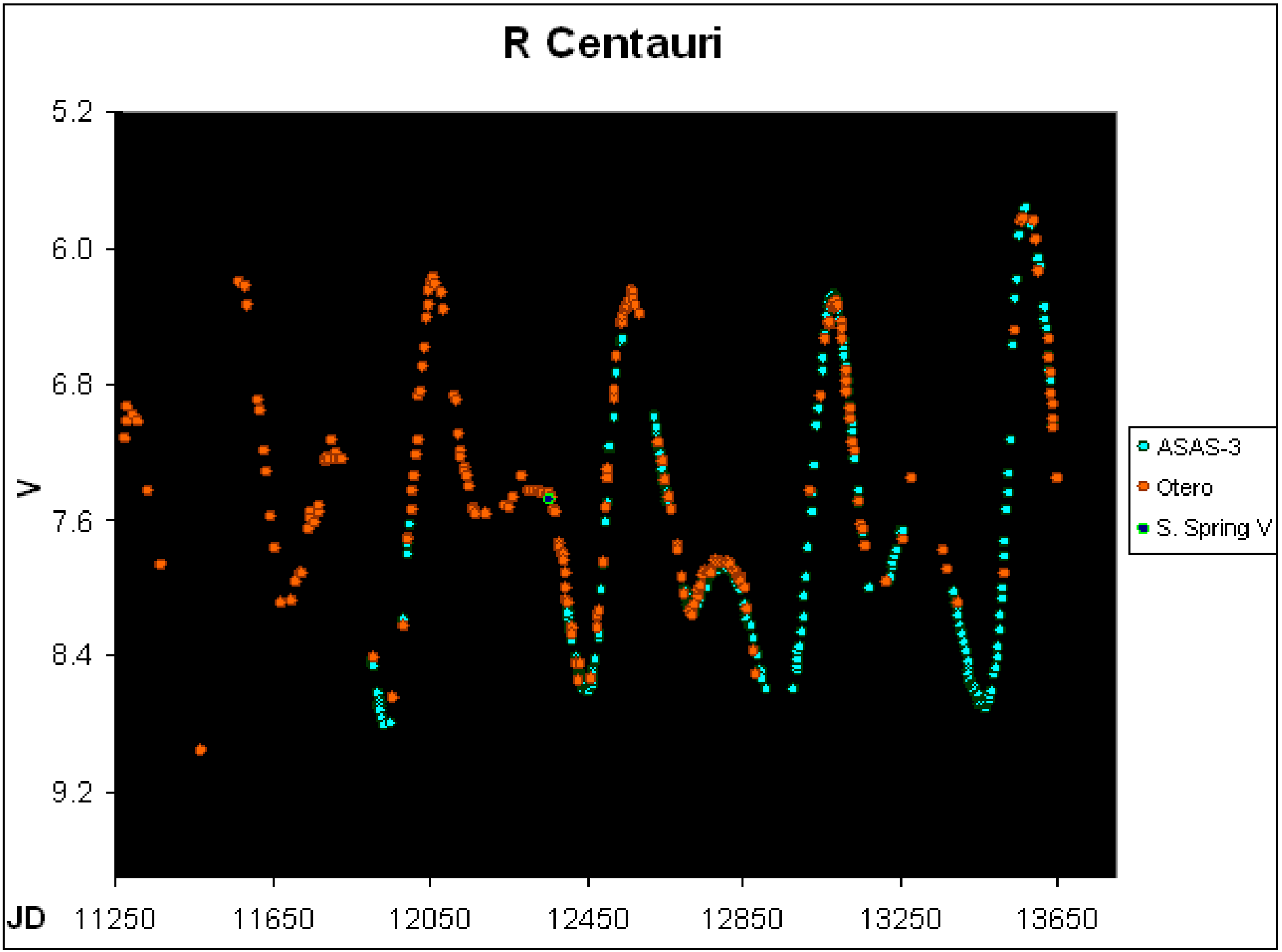
2) Detecting small amplitude unusual activity in a star by comparison with the normal published V values.


Delta Scorpii
V mag
1.50
1.60
1.70
1.80
1.90
2.00
2.10
2.20
2.30
2.40
JD
1600
1900
2200
2500
2800
3100
3400
3700
Claus
Galileo
Hopkins V
FrasV 2
"West V"
Otero
FrasV 1

The goals of being V-calibrated

3) Possibility of combining visual and V observations for a study of a given star.

NO AMPLITUDE DIFFERENCES between visual and V

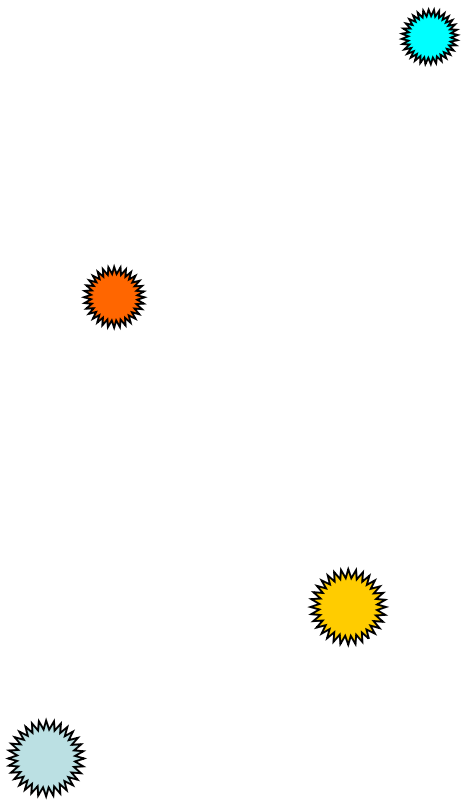

R Centauri
5.2
6.0
6.8
7.6
8.4
9.2
V
JD
11250
11650
12050
12450
12850
13250
13650
ASAS-3
Otero
S. Spring V

THANKS !!

DISCUSSION

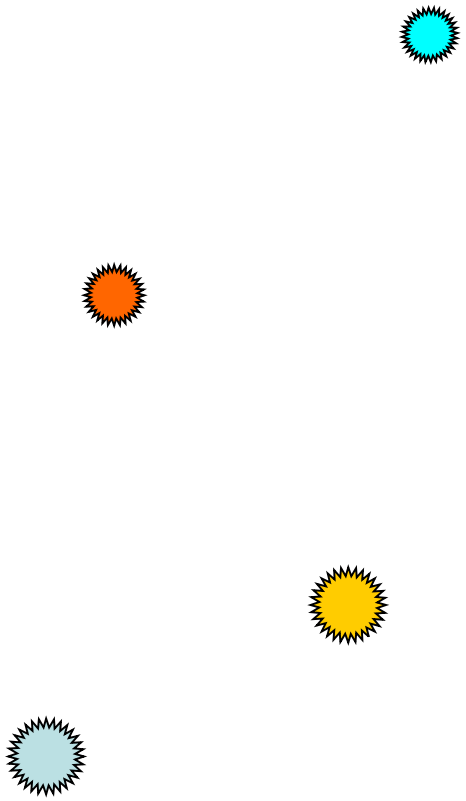
- BONUS SLIDES… for further discussion =

Applying V = v + 0.21(B-V) to a visual binocular observation of a red star (faint) from an observer using comp stars with B-V <1 and averted vision.



* **Estimate= 80 (1)V(9) 84**
* **Reported mag. = 8.0**
* **Corrected by formula = var V= 7.66**
* **Actual "v" estimate = 822 (1) V (9) 832 = 8.23**
* **var V= 7.89**
* **The uncorrected reported mag. turned out to be closer to V (by chance)**

Applying V = v + 0.21(B-V) to a telescopic observation of the same red star (bright) using comp stars with B-V <1 and direct vision.



* **Estimate= 77 (1)V(7) 80**
* **Reported mag. = 7.7**
* **Corrected by formula = var V= 7.36**
* **Actual "v" estimate = 775 (1) V (7) 80 = 7.78**
* **var V= 7.89**
* **The reported uncorrected mag. is by far closer to V.**

PROBLEMS to face no matter the observing technics used

- **Very red stars** (carbon stars)
- *Possible solution*: deriving a correction coefficient depending on star's brightness using V data.
- **Stars with emission lines** (the eye tends to see them fainter, and the difference between V and v varies depending on the emission changes)
- *Possible solution*: Correlating the active states with changes in the difference between V and v.
- **Bad sequences** (no proper comp stars nearby)
- *Possible solution*: Pray to God that the estimate turns out to be okay… No solution for not believers.