URANUS OPPOSITION 2012-2013

(Opposition on last 2012.09.29th)

1- Abstract :

91 drawings (36nights) were performed this present opposition with
150-305mm apertures (July 2012-February 2013).
Uranus exhibited from the August 2012 to February 2013 period
some variabilities accessible visually with the help of light coloured filters (light yellow W8 and sometimes the light blue W82A).
Almost featureless at the beginning with moderate apertures (except the 150mm refractor) where EZ was only accessible faint fuzzy, then more consistently clearer in yellow light and with more contrasty and bigger apertures.
Brightenings were collected at some periods in relation with the emergence of a third south hemisphere band.
On October 2012, EZ seemed to reconstitute but faintly, then deemer on December and getting a clearer appearance on January 2013.
Clear bright patches appeared brighter on the planet during the emergence of the third south hemisphere band that was reported on November 2012.

2- Main topics:

2.1- **Events**:

South polar cap:

always captured clearer except on the 23th October 2012, the cap was seen clear bordered by a thin lighter band and bordered by a darker collar.

South hemisphere:

At the beginning only 2 bands were reported until November where on 21st Nov; 12, then on 2nd-8th Dec.12, 3 bands were reported with brightenings in relation.
On 17th-30th Dec.12 and 1st Jan. 13 the south equatorial band that appeared double on the 11th Dec.12 seemed to fade and dilute into the south hemisphere sothat this became faint and fuzzy, light grey.
At the beginning on 15thNov.12 albedo variations were collected on the south equatorial band in relation with a brightening presence in EZ.
On 11th-16th and 17th, the 3 south hemisphere bands were again collected clearly and distinctly separated. Still brightenings in relation (probably spot for some).
The last observations 30th Jan.13 and 14th Feb.13 didn't confirm the 3 bands pattern with regards to the viewing conditions.

EZ, equatorial zone:

Appeared clear on some periods.
EZ also get the tendency to fade with the fading of the 3 bands pattern reported during end Dec.12 until begin Jan.13.
Except with the use of moderate aperture (150mm refractor excluded) EZ was reported more or less.

North hemisphere:
The north equatorial band was seen darker, as dark as the polar south cap collar. With EZ, these are the main features on the planet accessible in first, even with the moderate aperture (as the C8 or the DK180).

Brightenings:
Some of the brightenings could be probably spots (on 24th-25th Jul.12, 11th -17th Jan.13, 26th Jan.13) but mainly zones between bands exhibit brightenings or albedo variations in relation sometimes with band albedo variations (15th Nov.12).

Blue colour observations:
Normally the planet disk is featureless in that field; however, on some period the south polar cap collar and the north equatorial band were reported faintly. This is probably in correlation with the planet activity.

2.2- **Comments**:
In spite of the few reports, the coverage needs to be improved in order to verify some assessments suggested above through the "events" observed. This would make stronger the conclusions brought here.
What is obvious:
- Uranus is not a featureless planet in visual mode,
- Uranus exhibits pattern variations that are obvious,
- Uranus pattern changes involve some albedo variations and contrast variations that need to be followed narrowly through a larger coverage.

Hope the next opposition will occur in relation with more better weather local conditions. Only 10-20% of the time was usable for the survey. This is not enough as for some periods a daily basis observation program is needed (during the emergence of the third south hemisphere band) for understanding what is happening more exactly.

3- Reference documents:
Please refer to the attachments:
- The scope factor,
- Uranus spectrum (from Mr Sromovsky),
- Uranus results (.xls file), present opposition 2012-2013 and the 91 drawings,
- F20 pictures (IL, Yellow, IR742), Jul.2012,
- "Viewing Uranus dual tests",
- Necessary conditions for capturing features on Uranus with annexes,
- Comparatif scopes-Uranus,
- Uranus methane bands for visual CCD,
- GraphspectraKarkoschka,
- Uranus resume 2010-2011.

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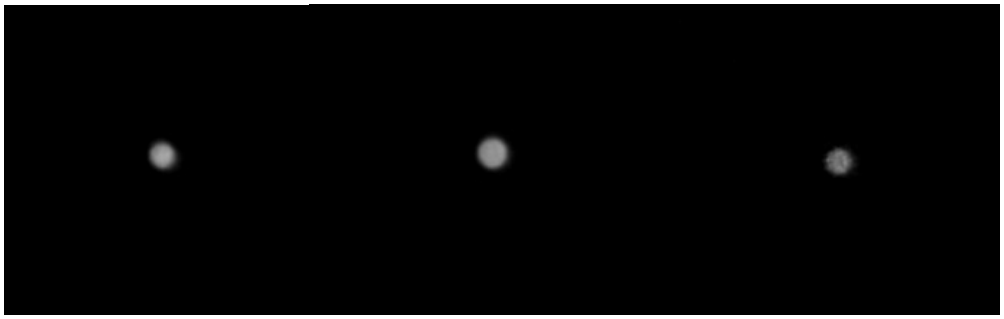

Uranus on July 2012 SC305mm F20

Without filter Yellow W12 filter NIR 742 filter

Date	Scope mm	Gx	Heigth °	Seeing/10	Transp./6	D equiv.	CM °	Bands n°	Band south	Band equa.	Band north	Brightenings	Location	South clear polar regio
23.7.12	DK180	360/ 432	39	8	5	124	293/303	3	2	faint	discret	2	limbs at equa	yes
24.7.12	SC305	435/ 506	42	7	5	172	88/97	3	2	faint	yes variations	3	limb equa near meridian	yes dark collar
25.7.12	SC305	506	37	8	6	172	217/226	3	2	faint	yes variations	4	limb equa south meridian	yes dark collar
1.8.12	N200	333/ 400	44	7	5	114	141/150	2 fuzzy	hemisphere	not seen	fuzzy darker	0	N/A	yes with collar
8.8.12	N200	333/ 400	42	7	5	114	32/42	2 fuzzy	hemisphere	very faint	fuzzy darker	0	N/A	yes with collar
10.8.12	N200	333/ 400	44	7	5	114	326/337	2 fuzzy	hemisphere	not seen	fuzzy darker	0	N/A	yes with collar
11.8.12	DK180	360	34	6	5	124	50/64	2	hemisphere	very faint	fuzzy darker	0	N/A	yes with collar
17.8.12	SC203	333	30	6	6	115	84/91	2 fuzzy	hemisphere	very faint	fuzzy darker	0	N/A	yes with collar
25.8.12	SC203	333	35	7	5	115	290/298	2 fuzzy	hemisphere	very faint	fuzzy darker	0	N/A	yes with collar
8.9.12	SC203	333	40	8	4	115	139/164	2 fuzzy	hemisphere	very faint	fuzzy darker	0	N/A	yes with collar
15.9.12	R150	375	40	10	6	138	46/63	3	2	faint	fuzzy variations	2	limbs equa meridian	yes dark collar
29.9.12	SC305	339	36	6	4	172	203/215	3	2	seen	yes variations	2	limbs	yes collar fainter
12.10.12	Cass 235	375	42	5	6	146	260/266	3	2	seen	yes	3	limbs eaqua, south hemi	yes collar fainter
15.10.12	Cass 235	375	32	6	5	146	280/284	2	2 faint	seen	yes darker	2	limb, south hemi	yes collar fainter
22.10.12	MC150	313	25	9	5	100	160	2 fuzzy	hemisphere	very faint	fuzzy darker	0	N/A	not seen
23.10.12	SC305	435	39	7	4	172	340/344	3	2	seen	yes	2?	between hemi bands south	yes dark collar and clear band
27.10.12	SC305	339/ 435	42	6	5	172	205/209	3	2 fainter	seen faint	yes darker	0	N/A	yes collar fainter
1.11.12	SC305	381	42	6	6	172	193	2	hemisphere	seen faint	yes darker	0	N/A	yes collar not seen
2.11.12	SC305	339/ 435	42	5	6	172	332/336	3	2 fainter	seen faint	yes darker	0	N/A	yes collar not seen
4.11.12	SC305	339	28	6	4	172	185/189	3	2 fainter	seen	yes darker	0	N/A	yes collar fainter
15.11.12	SC305	435	32	7--8	4	172	294/296	3	2 variations	seen	yes less dark	1	limb rise equa	yes collar fainter
21.11.12	SC305	435	39	6	6	172	78/81	4	3	seen	yes less dark	0	N/A	yes collar fainter
25.11.12	Cass 235	375	34	6	5	146	254/258	3+1?	2+1?	seen	yes less dark	1	after meridian equa	yes collar darker
29.11.12	Cass 235	375	40	6	5	146	170	3	2	seen	yes less dark	0	N/A	yes collar darker
2.12.12	SC305	435	36	7	4	172	158/166	4	3	seen	yes less dark	1	limb rise equa	yes dark collar variations
8.12.12	Cass 235	375	40	10	4	146	284/308	4	3	seen	yes less dark	1	limb to meridian equa	yes dark collar
11.12.12	SC305	435/ 506	42	10	5	146	1--10	4	3	seen	yes less dark	2	limbs to meridian equa	yes dark collar also in blue co.
17.12.12	SC280	400	41	6	5	158	121/124	3	2	seen	yes darker	2	limb set south, hemi rise	yes dark collar
30.12.12	Cass 235	375	39	6	4	146	180/192	2	1+hemisphere	seen faint	yes darker	1	limb set	yes dark collar
1.1.13	SC280	400	36	6	5	158	117	3	2, 1 equa faint	seen very faint	yes less dark	1	limb set south, hemi rise	yes dark collar
11.1.13	SC280	400	40	6	5	158	61	4	3	seen faint	yes darker	1	meridian equa	yes dark collar variations
16.1.13	Cass 235	375	34	8	5	146	62/64	4	3	seen faint	yes less dark	2	limb rise, meridian hemi south	yes dark collar
17.1.13	SC280	400	35	7	4	158	175/182	4	3	seen	yes variations	2	limb rise, limb hemi south	yes dark collar
26.1.13	SC280	400	36	6	4	158	16	4	3	seen	yes variations	3	limbs equa, limb hemi south	yes dak collar variations
30.01.13	Cass 235	375	34	5	6	146	222	3	2	seen	yes darker	2	limbs equa	yes dark collar
14.02.13	SC280	350	27	6	6	158	179	3+1?	2+1?	seen faint	yes darker	0	N/A	Yes dark collar

	CM °	Nights
	1--91	10
	117--193	12
	203--258	5
	260--344	9

	July 12	August	Sept.12	Oct.12	Nov.12	Dec.12	Jan.13	Feb.13
Nights	3	6	3	5	7	5	6	1
rate	10%	20%	10%	15%	25%	15%	20%	3%
DWGs	8	19	13	9	15	15	11	1

Necessary conditions for capturing features on Uranus.

1- Requested conditions:

Data are extracted from the publication
"Observing the moon, planets and comets"
By Clark R. Chapman and Dale P. Cruikshank.

1.1- Uranus surface brightness (B)

Albedo: 0.509 Surface brightness: 54 cd/m2
Saturn albedo: 0.461 Surface brightness: 180 cd/m2

Sky transparency: μ
Minimal visual sky transparency: usually m: 4.0 to 5.0 well accessible,
Filter in use (usually: W82A, W8, W12, W.F.): coefft.>0.80,
Clean optics: coefft.>0.80 (including refelectivity and CO optical).

Britghtness through the telescope: B+ = D2.Bf / d2.M2 or 25.D2.μ.B / M2
D: aperture (here 8" or 200mm),
d: eye pupil diameter,
Bf: brightness at scope exit Bf = μ.B
m = 4.0 μ = 0.05 Tr (sky) 0.4 to 0.8
m = 5.0 μ = 0.25

B+ for D 8" M = 360x μ = 0.05 Bf = 2.5 cd/m2
d = 0.55mm or 0.022" μ = 0.25 Bf = 12.5 cd/m2

B+ = 0.15cd/m2 D 8" M 360x m: 5.0
B+ = 0.03 cd/m2 D 8" M 360x m: 4.0

Needed optimum magnification P = M/D (magnification per inch aperture) or
SQR(25.μ.B/B+)

1.2- **Optimal conditions**:

For 8" aperture 360x magnification m:5.0:
Brightness at the eyepiece: 0.15 cd/m2
Brightness of planet: 50 cd/m2
Requested magnification per inch: 45.6x therefore 365x for 8"
Mesopic vision: Lighting level from 0.001 cd/m2 until 10 cd/m2
FOR A STANDARD EYE.

Observation of Uranus features mainly for 619nm area.
Represents about 40% of the max eye sensitivity for a mesopic vision
So the planet brightness at the eyepiece of 0.15 cd/m2 becomes 0.06 cd/m2.
The use of a W8 filter represents the ratio of the 40% under eye senvitivity curve.
0.06 cd/m2 level preserve well the mesopic vision abilities with the scope conditions not affected.

1.3- Contrast perception:

a- Uranus exhibits clouds on a tiny 3.60" disk size.
Width of the cloud bands, say: about 1.0"
1.0" x 360 (magnification) = 360" or 6' arc apparent size at eyepiece,
Therefore 10 cycles/ °,

The standard eye contrast sensitivity function at 10 cycles/°:
- mesopic vision: 1-2%
- photopic vision: 0.6-0.7%
for the planet on subject.

b- Scope effect:
- Strehl ratio: contrast through scope = actual contrast of feature x strehl ratio
Strehl 99% not affecting results.

c- CO, central obstruction:
For a RC200 with CO 35 and 42%, resolution limit remains 0.60",
FTM curves exhibit the fact that contrast are kept in comparison with a perfect scope of no CO near the ultimate resolution ability (right part of the curve).

d- Maximisation of the magnification for the contrast perception at low light levels
should be at about 10 cd/m2,
but performance (contrast versus feature size) can be kept with the proper increased magnification.
8" scope with 400x
M: 5.0, clean optics, μ: 0.25
Seeing good to excellent (Danjon scale 10/10 to 7-8/10),

Contrast through the 8" scope
For features as lines: $c+ = c.(w/(w+5.6/D))$
w: line width
c: actual feature contrast
c+: observed contrast

for 1.0" width line, c = 1%, c+ = 0.59%
for 1.2" width line, c = 1%, c+ = 0.63%

for a 12" scope and c = 1% c+ = 0.68%
for a 16" scope and c = 1% c+ = 0.74%
for a 40" scope and c = 1% c+ = 0.88%

e- Optimum observational conditions including the seeing for contrast perception:
- 10" scope perfect, μ 0.1, m 4.5, M 540x seeing 1/3" (Danjon 7-8/10),
M 280x seeing 1" (Danjon 3-4/10),
- 16" scope perfect, μ 0.1, m 4.5, M 710x seeing 1/3" (Danjon 7-8/10),
M 325x seeing 1" (Danjon 3/10),
- 8" scope, 360x seeing <1/3" (Danjon 9-10/10)
Apparent size at the eyepiece about 22' arc, surface apparent brightness 0.15-0.20 cd/m2
The contrast perception can be 1.50%.

- 8” scope, 400x seeing < 1/3”,
Apparent size 24’ arc: the contrast perception can 1.30%.

2- **Tests performed:**

2.1- Distanced targets:
Creation of targets.
Software word can ceate features until 5% contrast level.

Disk size at 1000m distance: 17mm
a- Background color of the disk: light grey (10% contrast with a whitish paper)
b- Feature levelled at 15%
See the specimen.
c- Same specimen with 2-3% contrast level.
d- Lighting conditions of the target:
Day light with no sun,
Twiglight,
Moon light (full moon as 0.5-1.0 Lux lighting).
e- Seeing evaluation:
An artificial star was installed just near the target panel.
Worked well in twilight and moon light.
f- Results:

	C=5%		C=2-3%		M	
L110	Y.Y.Y	Y.Y.N	Y.Y.N	Y.(Y).(N)	308x	apochromat
L150	Y.Y.Y	Y.Y.Y	Y.Y.Y	Y.Y.(Y)	313_350x	achromat
RC200	Y.Y.Y	Y.Y.Y	Y.Y.Y	Y.Y.Y	360x	Ritchey
Seeing	10/10	7-8/10	10/10	7-8/10	S	

Results were aleatory when S < 7/10 continuous.
Answers formatted as: Y.Y.N (daylight, twilight, moon light), Y: yes pass, N: not pass.

2.2- Personnal eye evaluation:
Performed at a famous Engineering Body for oil and gas activities.
Divers can be tested under US standards.
The tests were conducted in B G R colors, low light levels, FTM grids for some.
Results:
50” resolution ability at few lux illumination of examined targets of very low contrast levels (<5%).

3- Works performed:
3.1- Observations since the 2009 opposition,
Results published at the Japanese Alpo and the BAA Uranus section
http://alpo-j.asahikawa-med.ac.jp/Latest/Uranus.htm
The results shows some variabilities of the planet (especially last opposition 2010-2011)
- slight contrast variabilities,
- cloud activity accessible in visual fields.

3.2- Uranus requested conditions:

The spectrum of Uranus exhibits absorption rays in visual area (especially at the 619nm), but other lighter rays are existing in other visual fields.
Rather than the direct visual observations, some US amateur observers (Schmude, Mellilo, …) suggested the follow-up of the activity of Uranus though the collection of spectrum (absorption rays variation).
Some polarimetric observations for investigation should be undertaken also, being a not negligeable parameter at priori (having owned a C8 with a light polarimetric effect, that may false some data).
Think that the features collection remains accessible directly visually but to-day at the margin of a 150-200mm scope aperture.
The pertinence of the result is:

- lightly improved with the aperture increase, the seeing parameter becoming the more influent parameter quickly,
- at the best when the global transparency and transmission are at the best possible,
- at the best when the scope strehl ratio is high (>95% actual and global),
- at the best when the exit pupil diameter is fixed to 0.50-0.55mm, where the mesopic vision potential is at the best conditions.

4- **Conclusion**:

The present study may involve a good pertinence and reliability of the given results by:

- the respected best mesopic vision conditions,
- the results get on distanced targets,
- the personnal vision control.

If visual observations are faced to difficult conditions, what is sure is

- average trained observers cannot do something fruitfully,
- imagers are also faced by these observational conditions, features being washed quickly by the site observation condition and the lack of scope quality (as a preliminary approach).

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BAA member
Uranus observer.

Annexes:

- article from www.telescope-optics.net/eye_spectral_response.htm,
- fig.1 from the Chapman and Cruikshank publication
- tablesheet from the Chapman and Cruikshank publication, sheet 182-183,
- table 2 from the Chapman and Cruikshank publication, sheet 145,
- table 3 from the Chapman and Cruikshank publication, sheet 146,
- table 4 from the Chapman and Cruikshank publication, sheet 152.

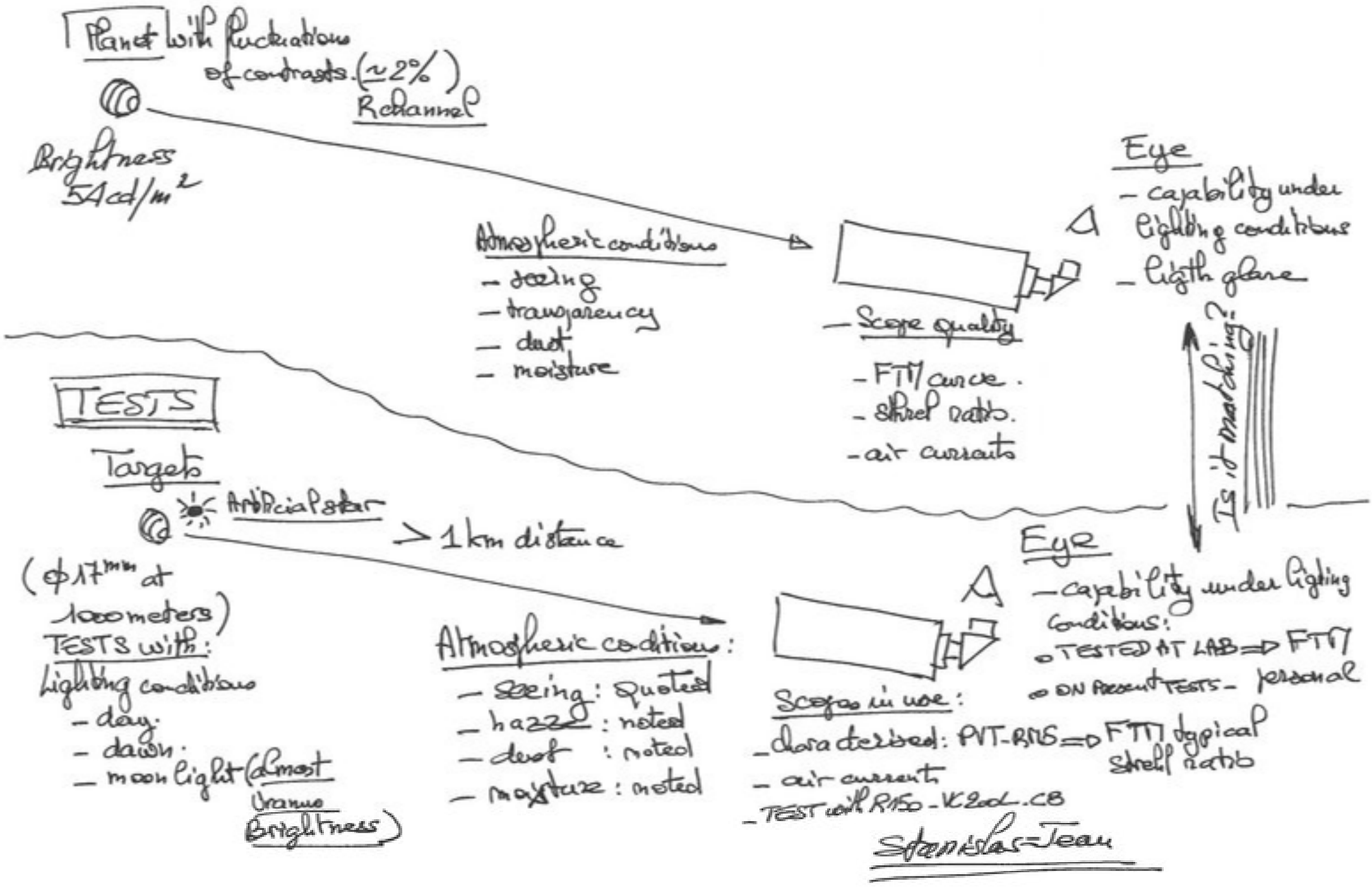

Planet with fluctuations of contrasts. (≈2%)
R channel
Brightness 54 cd/m²
Atmospheric conditions
- seeing
- transparency
- dust
- moisture
Scope quality
- FTM curve.
- Strehl ratio.
- air currents
Eye
- capability under lighting conditions
- Light glare
Is it marketing?
TESTS
Targets
Artificial star
> 1 km distance
(ϕ 17 mm at 1000 meters)
TESTS with:
Lighting conditions
- day.
- dawn.
- moon light (almost Uranus Brightness)
Atmospheric conditions:
- seeing: Quoted
- haze: noted
- dust: noted
- moisture: noted
Scopes in use:
- characterised: PVT-R150 => FTM typical Strehl ratio
- air currents
- TEST with R150 - K2 ed. CB
Eye
- capability under lighting conditions:
- TESTED AT LAB => FTM
- ON PRESENT TESTS - personal
Stanislas-Jean

Table 1. The Planets and their Surface Brightnesses

Planet	Radius R (A.U.)	Geometric Albedo, p_v	Phase Angle, i	Phase Factor	Effective Albedo, A_v	Brightness B (cd/m^2)	Brightness Ratio Perihelion/Aphelion
Mercury	0.39	0.100	90°	0.17	0.017	4,200	2.3
			50	0.32	0.032	7,700	
			130	0.072	0.0072	1,800	
Venus	0.72	0.586	90°	0.48	0.28	20,000	
			50	0.73	0.43	29,000	
			130	0.45	0.26	18,000	
Moon	1.00	0.115	0°	1.	0.115	4,100	
			90	0.17	0.020	700	
			50	0.34	0.039	1,400	
			130	0.084	0.0095	340	
Mars	1.52	0.154	0°	1.0	0.154	2,350	1.5
			47	0.62	0.095	1,400	
Jupiter	5.20	0.445				585	1.2
Saturn	9.58	0.461				180	
Uranus	19.14	0.565				54	
Neptune	30.2	0.509				20	

(Note: Jupiter's satellites I and II are about twice as bright as Jupiter, III about equal, and IV about half as bright. Also, it is of interest to note that a typical brightness for the daylit sky is 8,000 cd/m^2.)

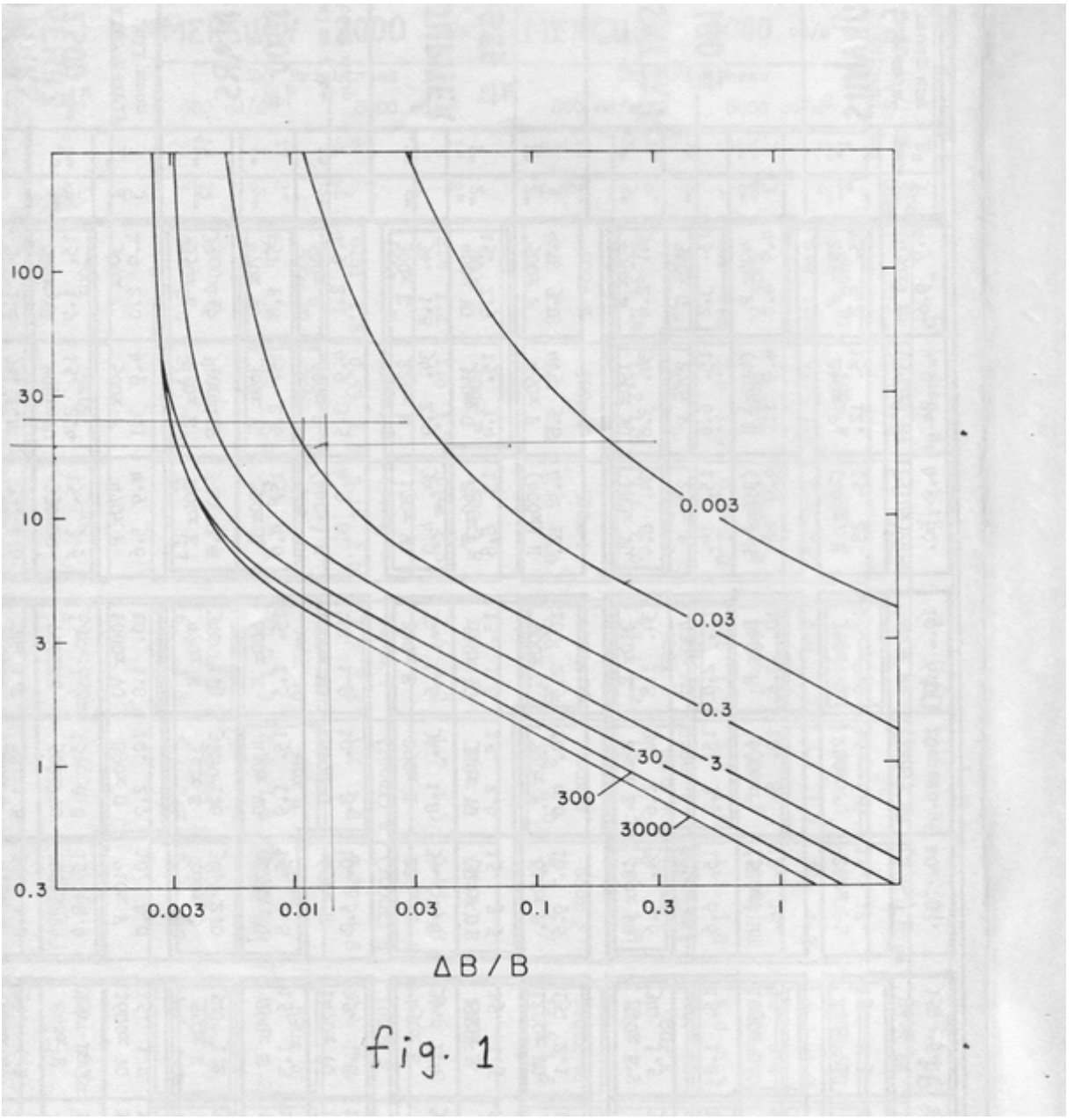
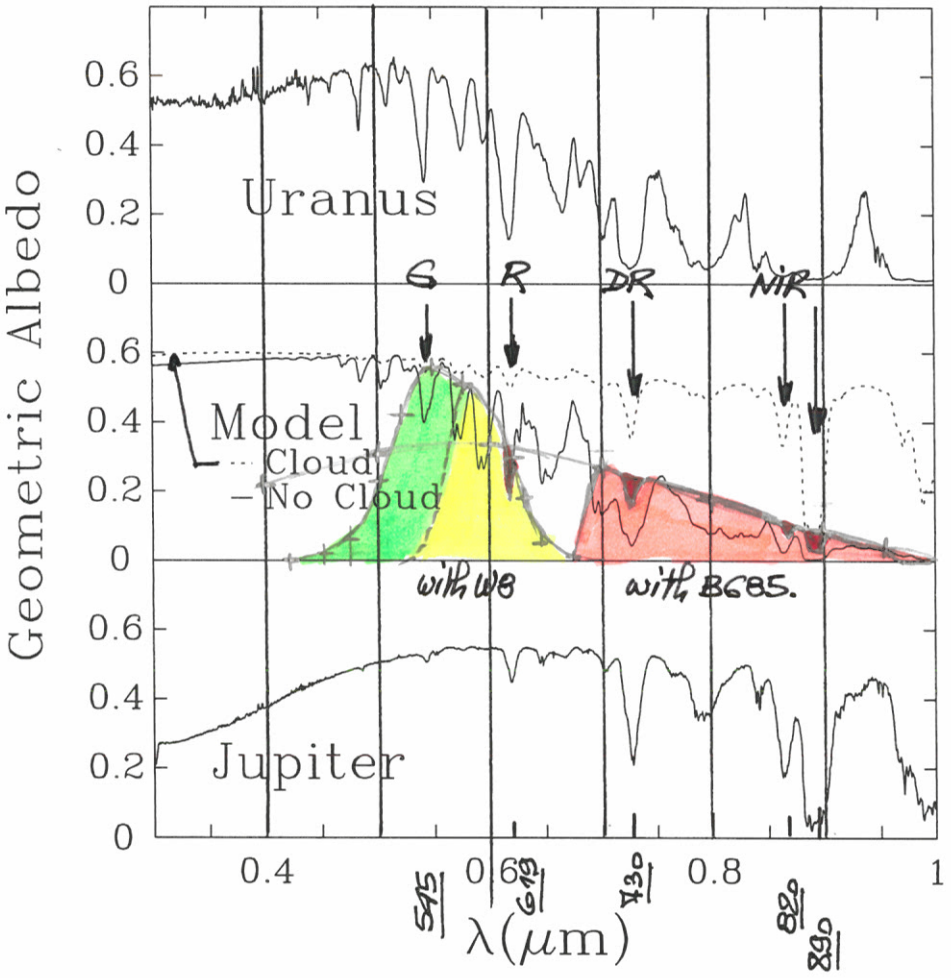


fig. 1

Y axis: disk size in (‘) arc
X axis: contrast image
Curves: for surface brightness image in cd/m2


Geometric Albedo
Uranus
G
R
DR
NIR
Model
Cloud
No Cloud
with W8
with BG85.
Jupiter
0.6
0.4
0.2
0
0.4
0.6
0.8
1
λ(μm)
545
618
730
820
890

Scope	Aperture mm	Dia. Perfect equiv.	Acuracy L/x	CO %	Dia gain	contrast transfert	contrast transfert	apparent c.	apparent c.
Achromat	R150	138	L/6.5	0	0.8				
Mewlon	DK180	124	L/10	30	0.72				
SCT	SC203	115	L/5	33.5	0.67				
Newton	N200	114	L/4	29	0.68				
Newton	N200	150	L/10	23	0.87				
Newton	N250	196	L/10	20	1.14				
Newton	N300	232	L/10	21	1.35	40%	57%		
SCT	SC305	172	L/4.5	33.5	1	29%	50%	0.9-1.50%	<<1%
Newton	N350	270	L/10	22	1.57	45	64%		
Dobson	N406	250	L/4	22	1.45	44%	63%		
Dobson	N406	306	L/10	22	1.78	53%	65%	1.6-2.0%	2.5-4.0%
Newton	N457	350	L/10	22	2	63%	68%		
Clark 9.25"	R235	210	L/6	0	1.22	32%	53%	1.0-1.6%	xx
SCT 11"	SC280	158	L/4.5	33.4	0.92				
Newton	N600	407	L/5	22	2.36	66%	74%	1.8-2.2%	5.3-6.3%
Newton	N600	455	L/10	22	2.64				
SCT 14"	SC355	200	L/4.5	33.5	1.16	31%	55%		
		(mm)				width1" and by FTM	width1" and by formula	Visual 0.56µm	NIR 1.12µm
								3% on planet	10% on planet

For NIR applications at 1.12µm, just reduce aperture by the ratio 2 (0.56µm).

Formula: apparent c. (at eyepiece)= actual contrast * w/(w+(5.6/Dequiv."))
w: width in (")
Dequiv.: Perfect diameter equiv.(inch)
FTM curve: FTM curve from a sinusoïdal pattern

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THE SCOPE FACTOR

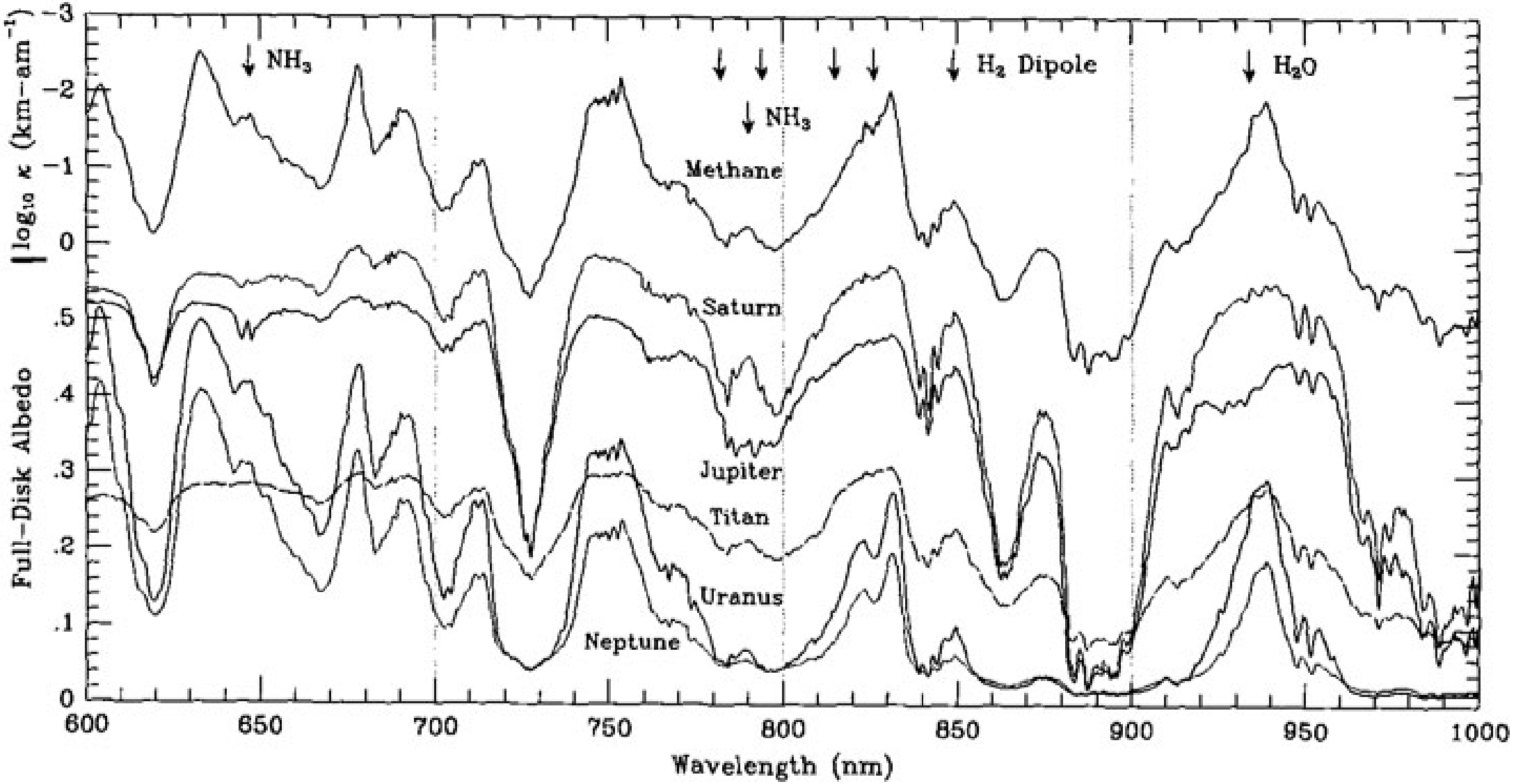
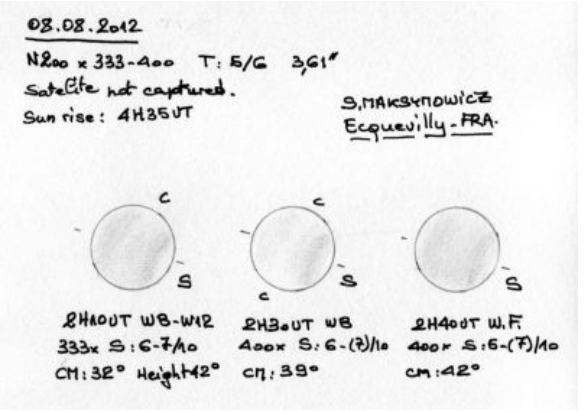
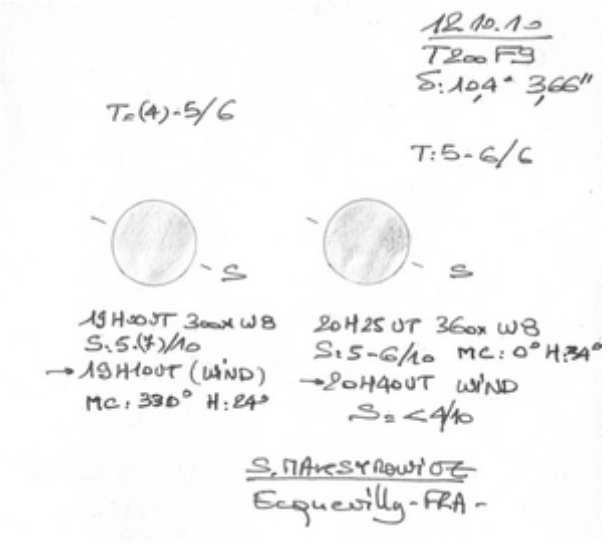


FIG. 3. Full-disk albedo spectra of the jovian planets and Titan. Corresponding phase angles are listed in Table III. For comparison of spectral features, the methane spectrum for the temperatures of the jovian planets is shown too. Solar spectra shown at the top are for comparison of Raman scattering features. Arrows mark theoretical wavelengths of some absorptions bands.

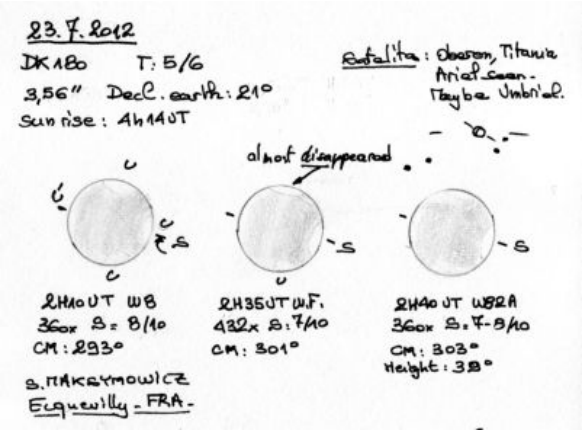


Newton 203mm CO29% L/4

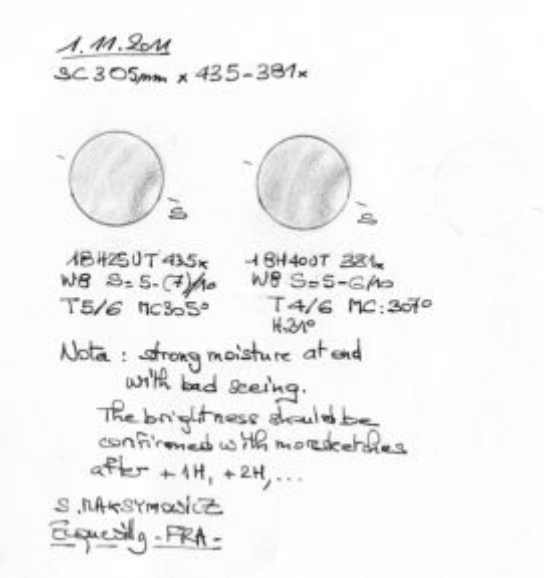
Refractor 150mm L/6.5



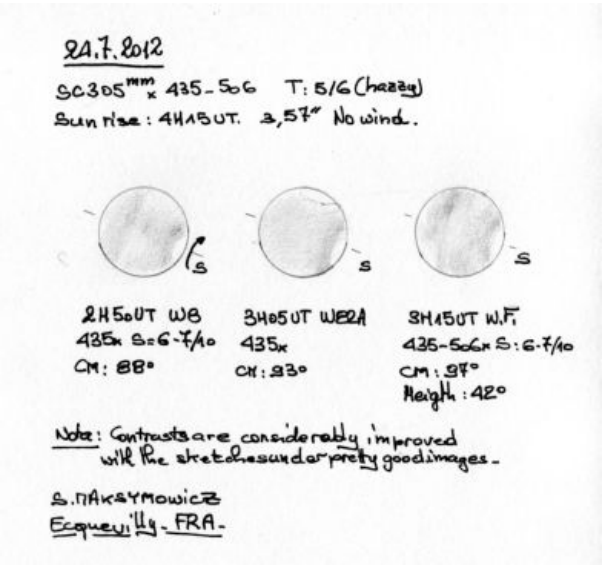
Cassegrain 200mm CO40% L/8



MEWLON 180mm CO30% L/10



Cassegrain 305mm CO33% L/4.5



Cassegrain 305mm CO33% L/4.5

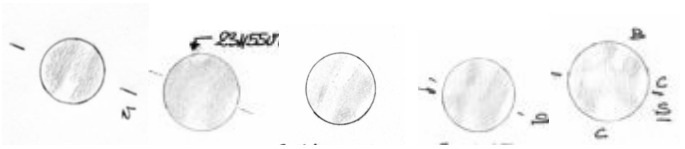
84 drawings (26nights) were performed this present opposition with 200-305mm apertures (July 2010-February 2011).

Uranus exhibited from the August 2010 to February 2011 period some variability accessible visually with the aid of light colored filters.

Almost featureless at the beginning where EZ was only accessible to be captured, then more consistently brighter in yellow-near IR spectra portion on September in EZ and fading and diluting in a bubbling system at the end of December.

On January 2011, EZ seemed to reconstitute but faintly.

Clear bright patches appear brighter at planet edges than at the meridian.



2010.01.30th 2010.08.28th 2010.09.17th 2010.09.18th 2011.01.16th
MC:298° MC:194° MC:83° MC:238° MC:168°
Cassegrain 305mm x381-435, filter W8, S:5-7/10, T:6/6.

Stanislas Maksymowicz
Ecquevilly- France (JN08XW)
BAA member n° 32334
Uranus section.