Feature Story:
ALPO Observations of the Remote Planets in 2012-2013

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Abstract

This report summarizes observations of Uranus and Neptune which were submitted to the writer in late 2012 and early 2013. Several near-infrared images of both planets show albedo features. Uranus shows bright belts whereas Neptune shows a large bright area south of 32° S. The selected normalized magnitude values of Uranus are: B(1,0) = -6.645 ± 0.009, V(1,0) = -7.117 ± 0.007, R(1,0) = -6.81 ± 0.02 and I(1,0) = -5.63 ± 0.05. The corresponding values for Neptune are: B(1,0) = -6.621 ± 0.009 and V(1,0) = -7.005 ± 0.009.

Introduction

During 2012, professional astronomers reported several new Uranus and Neptune findings. For example, Irwin and coworkers (2012) report that the CH_3D/CH_4 ratio on Uranus is 2.9 x 10^{-4} with an uncertainty of about 25%.

This is significant because it gives us information on the deuterium to hydrogen ratio. Deuterium is an isotope of hydrogen having one neutron (instead of zero neutrons for normal hydrogen). The CH_3D/CH_4 ratio will give astronomers a better understanding of Uranus's atmosphere.

In a second report, Sromovsky and coworkers (2012) report the drift rate of features between 60° N and 78° N is 4.3°/hour westward with respect to Uranus's interior. They also report that the bright spots south of 60° N appear as streaking bands whereas those farther north are bright spots resembling cumulus clouds. This group bases this finding on Hubble, Gemini and Keck telescope images.

In a third study, French and Showalter (2012) carried out a computer simulation of the movement of the inner moons of Uranus. They report the moons Cupid and Belinda will cross orbits within 10^3 to 10^7 years. They also report two more moons, Cressida and Desdemona, will cross orbits within the next 10^7 years.

Members of the Association of Lunar & Planetary Observers also made important contributions to our knowledge of the remote planets. I will summarize these.

Table 1 lists characteristics of Uranus and Neptune during their 2012-2013 apparitions. Those who submitted observations of these planets are summarized in Table 2. This report summarizes brightness measurements and images made during 2012 and early 2013.

Table 1: Characteristics of the 2012 - 2013 Apparitions of Uranus and Neptune[a]

Parameter	Uranus	Neptune
First conjunction date	Mar. 24, 2012	Feb. 19, 2012
Opposition date	Sept. 29, 2012	Aug. 24, 2012
Angular diameter (opposition)	3.7 arc seconds	2.4 arc-seconds
Sub-Earth latitude (opposition)	19.5° N	27.9° S
Right ascension (opposition)	00h 25m	22h 15m
Declination (opposition)	+01° 50m	-11° 30m
Second conjunction date	Mar. 29, 2013	Feb. 21, 2013

[a]Data are from the Astronomical Almanac for the years 2012 - 2013 and from the JPL Ephemeris located at *http://www.alpo-astronomy.org*

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Brightness Measurements: Photoelectric Photometry

Jim Fox and the writer made brightness measurements with an SSP-3 solid state photometer along with filters transformed to the Johnson B, V, R and I system. More information on the equipment is located elsewhere (Optec., Inc, 1997), (Schmude, 1992, 20; 2008, Chapter 5). The transformation coefficients for Jim Fox's equipment are 0.0749 and –0.050 for the B and V filters, respectively. The transformation coefficients for the writer's equipment are –0.0555, –0.024 and –0.117 for the V, R and I filters, respectively. The comparison stars and their brightness values are summarized in Table 3.

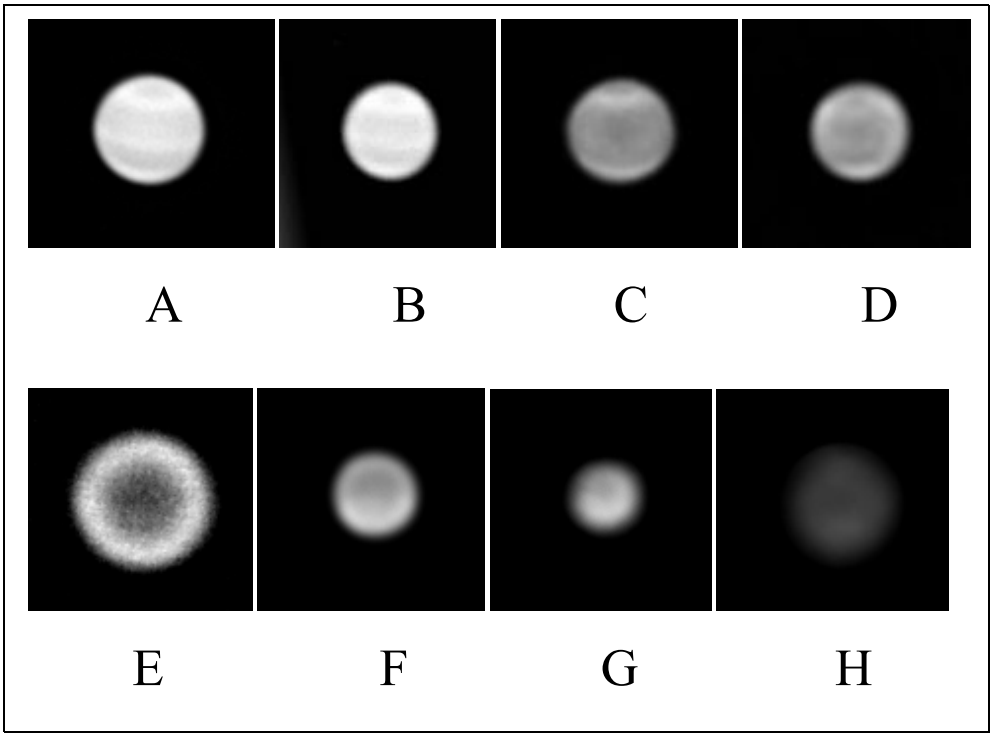

Figure 1: Images of Uranus and Neptune. A: Uranus taken on August 8, 2012 at 1:39.5 UT at wavelengths greater than 685 nm by F. Colas, J.L. Dauvergne, M. Delcroix, T. Legault and C. Viladrich using a 1.0 m telescope at Pic du Midi Observatory; B: Uranus taken on August 10, 2012 at 2:33.1 UT at wavelengths greater than 685 nanometers by F. Colas, J.L. Dauvergne, M. Delcroix, T. Legault and C. Viladrich using a 1.0 m telescope at Pic du Midi Observatory; C: Uranus taken on September 8, 2012 by Damian Peach with a 0.36 m Schmidt-Cassegrain telescope at wavelengths greater than 685 nm; D: Uranus taken on September 14, 2012 by Flavius Isac with a 0.25 m Schmidt-Cassegrain telescope with an IR 685 nm filter; E: Uranus taken on August 7, 2012 at 1:17.6 UT with a methane band filter by F. Colas, J.L. Dauvergne, M. Delcroix, T. Legault and C. Viladrich using a 1.0 m telescope at Pic du Midi Observatory; F: Neptune taken on August 7, 2012 at wavelengths greater than 685 nanometers by F. Colas, J.L. Dauvergne, M. Delcroix, T. Legault and C. Viladrich using a 1.0 m telescope at Pic du Midi Observatory G: Neptune taken on August 9, 2012 at 0:10.7 UT at wavelengths greater than 685 nanometers by F. Colas, J.L. Dauvergne, M. Delcroix, T. Legault and C. Viladrich using a 1.0 m telescope at Pic du Midi Observatory; H: Neptune taken on August 27, 2012 at 22:30 UT by G. Maravelias and M. Kardasis with the 1.29 meter telescope at Skinakas Observatory in Greece.

Tables 4 and 5 summarize brightness measurements of Uranus and Neptune. The date, observer's initials, filter, measured brightness value and normalized magnitude value are listed in columns 1-5 and 6-10. Values of the normalized magnitudes, B(1,α) and V(1,α) are computed in the same way as in Schmude (2012, pp. 33-38). Extinction and color transformation corrections are included in all brightness measurements in the same way as is described in Schmude (2008, pp. 161-168).

Jim Fox and the writer used specific comparison and check stars for their Uranus measurements. Jim and Richard used 44-Piscium and lambda-Piscium as the comparison star, respectively. Jim used HD1367 as a check star. The writer computed brightness values of 7.112 ± 0.005 and 6.193 ± 0.002 for the B and V filter magnitudes of this star based on Jim's data. These values are in excellent agreement with those in Table 3.

Jim used 38-Aquarii and Iota-Aquarii as the comparison and check star for his Neptune measurements, respectively. Once again, the writer computed average B and V filter magnitude values for Iota-Aquarii from Jim's data. The corresponding values are 4.203 ± 0.002 and 4.277 ± 0.002 for the B and V filters, respectively. These values are in good agreement with those in Table 3. The close agreement between measured and literature magnitude values of the check stars for the Uranus and Neptune measurements is evidence that Jim's brightness values have a high degree of accuracy.

Table 6 lists selected normalized magnitudes for Uranus and Neptune. As in previous studies, the effect of the solar phase angle was assumed to be negligible. The V-filter normalized magnitude value of Uranus in 2012-2013 is dimmer than in the previous year (Schmude, 2013). The B-filter value, however, is brighter in 2012-2013 than in the previous year. It will be interesting to see if this trend continues in 2013-2014. The normalized magnitudes of Neptune are nearly the same as in 2011-2012 (Schmude, 2013).

Linear fits of B(1,α) and V(1,α) versus α for Uranus and Neptune based on data in Tables 4 and 5 are:

$B(1,a) = -6.582 - 0.02\alpha$ Uranus (1)

$V(1,a) = -7.092 - 0.0132\alpha$ Uranus (2)

$B(1,a) = -6.657 + 0.0258\alpha$ Neptune (3)

$V(1,a) = -7.016 + 0.0086\alpha$ Neptune (4)

Brightness Measurements: Visual Photometry

Patrick Abbott and the writer made brightness estimates of Uranus and Neptune. The selected $V_{vis}(1,0)$ values for the 2012-2013 apparition are –7.2 (Uranus) and –7.2 (Neptune). These values are based on 33 brightness estimates of Uranus and 19 estimates of Neptune. The value of $V_{vis}(1,0)$ is computed in the same way as in Schmude, 2012, pp. 33-38.

Table 2: Contributors to the ALPO Remote Planets Section in 2012-2013[a]

Name (location)	Type of Observation[b]	Telescope[c]	Name (location)	Type of Observation	Telescope
P. Abbott (Canada)	VP	B	T. Legault (France)	I	1.0 m
K. Bailey (UK)	D, DN	0.25 m RL	S. Maksymowicz (France)	D, DN	0.15 to 0.31 m
J. Boudreau (USA)	I	0.28 m	G. Maravelias (Greece)	I	1.29 m
F. Colas (France)	I	1.0 m	M. Mattei (USA)	I	---
J. L. Dauvergne (France)	I	1.0 m	F. Melillo (USA)	I	---
M. Delcroix (France)	I	1.0 m	C. Pellier (France)	I	0.25 m
F. Emond (France)	I	---	J. P. Prost (France)	I	0.35 m SC
J. Fox (USA)	PP	0.25 m SC	R. Schmude, Jr. (USA)	PP, VP	Several
M. Kardasis (Greece)	I	1.29 m	C. Viladrich (France)	I	1.0 m

[a]The following people contributed valuable observations to the ALPO Japan Latest website and are not listed above: P. Abel, P. Bayle, G. Bianchi, D. Gray, T. Ikemura, F. Isac, A. Kazemoto, A. Lasala, A. Medugno, S. Mogami, A. Obukhov, D. Peach, J. J. Poupeau, E. Punzo, S. Quaresima, H. Sasse, J. Sussenbach, G. Tarsoudis and A. Yamazaki. The following observer contributed to the Arkansas Sky Observatory archive: P. Maxson.

[b]Type of observation: D = drawings, DN = descriptive notes, I = images, PP = photoelectric photometry, S = Spectra, VP = visual photometry.

[c]Telescope: first quantity lists the diameter and the one or two upper case letters lists the type according to: B = binoculars, C = Cassegrain, DK = Dall Kirkham, RL = reflector, and SC = Schmidt-Cassegrain.

Drawings and Images

Astronomers submitted several images of Uranus and Neptune made in near-infrared light (wavelengths greater than 685 nanometers). Several are shown in Figure 1.

Although albedo features are visible on both planets in near-infrared wavelengths, this was usually not the case in visible wavelengths. Several images of Uranus show two bright belts which I call the Equatorial Belt and the North Temperate Belt. The writer measured the planetographic latitudes of these belts on four images of Uranus made by Marc Delcroix and coworkers (August 8 and 10), Damian Peach (September 8) and Flavius Isac (September 14).

The average latitude range for the Equatorial Belt is 2° S to 13° N and the corresponding range for the North Temperate Belt is 45° N to 59° N. An uncertainty of 3° is selected for these values.

Neptune had a different appearance than Uranus. Unlike Uranus, Neptune did not display bright belts. Instead it had a large bright area south of 32° S. The estimated uncertainty is 6°.

Table 3: Comparison and Check Stars Used in Photometric Studies of Uranus and Neptune

Comparison Star	Brightness (in stellar magnitudes)				Source
	B filter	V filter	R filter	I filter	
44-Piscium	6.606	5.778	—	—	a
HD1367	7.114	6.19	—	—	a
Lambda-Piscium	4.71	4.49	4.30	4.20	b
38-Aquarii	5.314	5.431	—	—	a
Iota-Aquarii	4.200	4.266	—	—	a

[a] *http://simbad.harvard.edu/simbad/*

[b] Iriarte et al (1965).

Satellites

Frank Melillo recorded an unfiltered CCD image of Uranus and its moons Titania and Oberon on September 24, 2012. He reports that Titania is 0.25 magnitudes brighter than Oberon. He bases this on an analysis of the image he took.

Acknowledgements

The writer is grateful to Truman Boyle for his assistance. He is also grateful to all of the people who submitted observations in 2012-2013.

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Table 4: Brightness Measurements of Uranus Made in 2012 and Early 2013

Date	Obs.[a]	Filter	Brightness (magnitudes)[b]		Date	Obs.[a]	Filter	Brightness (magnitudes)	
			Meas. (+)	Normalized (–)				Meas. (+)	Normalized (–)
Aug. 9.308	JF	V	5.861	7.092	Nov. 3.071	RS	I	7.310	5.624
Aug. 9.308	JF	B	6.349	-6.604	Nov. 3.083	RS	R	6.069	6.865
Aug. 16.311	JF	V	5.891	-7.052	Nov. 3.095	RS	R	6.126	6.808
Aug. 16.312	JF	B	6.404	-6.539	Nov. 8.149	JF	V	5.828	7.112
Sept. 16.210	JF	V	5.811	7.104	Nov. 8.149	JF	B	6.295	6.645
Sept. 16.210	JF	B	6.292	-6.623	Nov. 12.139	JF	V	5.824	7.121
Sept. 20.185	JF	V	5.819	-7.095	Nov. 12.140	JF	B	6.304	6.641
Sept. 20.186	JF	B	6.299	-6.615	Nov. 20.131	JF	V	5.834	7.123
Oct. 5.156	JF	V	5.814	-7.100	Nov. 20.132	JF	B	6.313	6.644
Oct. 5.157	JF	B	6.311	-6.603	Dec. 7.186	JF	V	5.833	7.152
Oct. 8.190	JF	V	5.804	-7.110	Dec. 7.186	JF	B	6.294	6.691
Oct. 8.190	JF	B	6.274	-6.640	Dec. 8.115	JF	V	5.858	7.129
Oct. 9.191	JF	V	5.817	-7.098	Dec. 8.116	JF	B	6.327	6.660
Oct. 9.192	JF	B	6.283	-6.632	Dec. 13.110	JF	V	5.864	7.132
Oct. 14.116	RS	R	6.125	6.792	Dec. 13.111	JF	B	6.324	6.672
Oct. 14.135	RS	R	6.169	6.748	Dec. 14.062	RS	R	6.152	6.846
Oct. 14.162	RS	I	7.47[b]	5.45[b]	Dec. 14.076	RS	R	6.201	6.797
Oct. 14.166	JF	V	5.810	-7.107	Dec. 14.092	RS	I	7.394	5.604
Oct. 14.167	JF	B	6.286	-6.631	Dec. 14.106	RS	I	7.386	5.612
Oct. 16.109	RS	V	5.786	7.132	Dec. 18.077	JF	V	5.888	7.117
Oct. 16.130	RS	V	5.774	7.144	Dec. 18.078	JF	B	6.347	6.658
Oct. 19.163	JF	V	5.829	7.091	Dec. 24.101	JF	V	5.888	7.129
Oct. 19.163	JF	B	6.294	-6.626	Dec. 24.101	JF	B	6.351	6.666
Oct. 20.178	JF	V	5.806	7.115	Dec. 29.083	JF	V	5.896	7.130
Oct. 20.178	JF	B	6.275	6.646	Dec. 29.083	JF	B	6.355	6.671
Oct. 23.143	JF	V	5.818	7.105	Jan. 28.092	JF	V	5.923	7.155
Oct. 23.144	JF	B	6.288	6.635	Jan. 28.093	JF	B	6.361	6.717
Nov. 3.045	RS	I	7.279	5.655	Jan 31.090	JF	V	5.930	7.152
Nov. 3.057	RS	I	7.287	5.647	Jan. 31.090	JF	B	6.361	6.721

[a]Initials: JF = Jim Fox; RS = Richard Schmude, Jr.

[b]This is probably a bad data point because of clouds.

Table 5: Brightness Measurements of Neptune Made in 2012

Date	Obs.[a]	Filter	Brightness (magnitudes)[b]		Date	Obs.[a]	Filter	Brightness (magnitudes)	
			Meas. (+)	Normalized (–)				Meas. (+)	Normalized (–)
July 16.309	JF	V	7.706	7.006	Oct. 9.161	JF	B	8.099	6.619
July 16.309	JF	B	8.104	6.608	Oct. 14.141	JF	V	7.709	7.014
July 30.261	JF	V	7.691	7.011	Oct. 14.141	JF	B	8.134	6.589
July 30.261	JF	B	8.051	6.652	Oct. 19.136	JF	V	7.722	7.006
Aug. 7.270	JF	V	7.688	7.011	Oct. 19.136	JF	B	8.100	6.628
Aug. 7.270	JF	B	8.055	6.644	Oct. 20.152	JF	V	7.719	7.010
Aug. 9.257	JF	V	7.699	6.999	Oct. 20.152	JF	B	8.130	6.599
Aug. 9.257	JF	B	8.088	6.610	Oct. 23.117	JF	V	7.720	7.013
Aug. 12.246	JF	V	7.682	7.016	Oct. 23.117	JF	B	8.098	6.635
Aug. 12.246	JF	B	8.018	6.680	Nov. 8.081	JF	V	7.755	6.996
Aug. 16.258	JF	V	7.672[b]	7.024[b]	Nov. 8.081	JF	B	8.133	6.618
Aug. 16.258	JF	B	7.826[c]	6.87[c]	Nov. 12.112	JF	V	7.760	6.997
Sept. 16.181	JF	V	7.691	7.011	Nov. 12.112	JF	B	8.142	6.615
Sept. 16.181	JF	B	8.061	6.641	Nov. 23.069	JF	V	7.757	7.013
Sept. 20.159	JF	V	7.729	6.975	Nov. 23.069	JF	B	8.148	6.622
Sept. 20.159	JF	B	8.092	6.612	Dec. 7.094	JF	V	7.824	6.963
Oct. 5.130	JF	V	7.690	7.025	Dec. 7.094	JF	B	8.179	6.608
Oct. 5.130	JF	B	8.083	6.632	Dec. 8.061	JF	V	7.788	7.000
Oct. 8.162	JF	V	7.711	7.001	Dec. 8.061	JF	B	8.210	6.578
Oct. 8.162	JF	B	8.089	6.629	Dec. 13.082	JF	V	7.798	6.996
Oct. 9.161	JF	V	7.706	7.012	Dec. 13.082	JF	B	8.191	6.603

[a]Initials: JF = Jim Fox; RS = Richard Schmude, Jr.

[b]The B-V value is assumed to be 0.40 for the purposes of the color correction since the B values is considered to be unreliable (see the next footnote).

[c]This is a bad data point because it is more than four standard deviations from the mean. This point was not included in the mean value of the normalized magnitude.

Table 6: Selected Normalized Magnitudes for Uranus and Neptune

Filter	Planet	Normalized magnitude (stellar magnitudes)	Number of measurements
B	Uranus	-6.645 ± 0.009	22
V	Uranus	-7.117 ± 0.007	24
R	Uranus	-6.81 ± 0.02[a]	6
I	Uranus	-5.63 ± 0.05[a]	5
B	Neptune	-6.621 ± 0.009	20[b]
V	Neptune	-7.005 ± 0.009	21

[a] Includes measurements made before and after the discovery of a bright spot on Uranus.

[b]The measurement made on August 16 is not included in the average or the number of measurements.