June / juin 2010 Volume/volume 104 Number/numéro 3 [742]

SUPPORT SCIENCE

Journal

The Journal of The Royal Astronomical Society of Canada

Le Journal de la Société royale d'astronomie du Canada

INSIDE THIS ISSUE

Newton's Manuscripts • Extragalactic Spectra

Jupiter's Moons • Signs and Constellations of the Zodiac

Solar Observing Results

PROMOTING ASTRONOMY IN CANADA

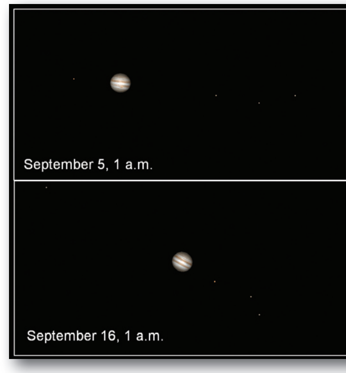
June / juin 2010

Journal

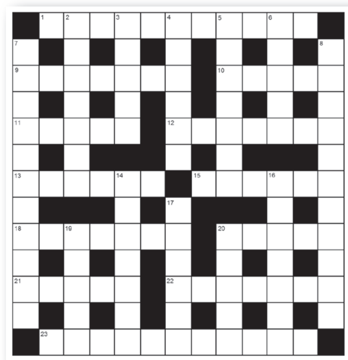
Vol. 104, No. 3 Whole Number 742

contents

table des matières

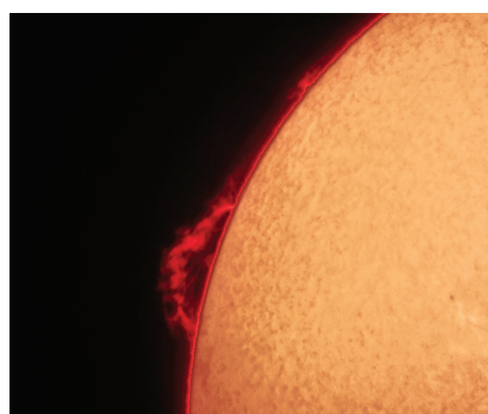


Glimpsing Jupiter's Moons
p. 101



Astrocryptic
p. 117

On Another Wavelength
p. 109



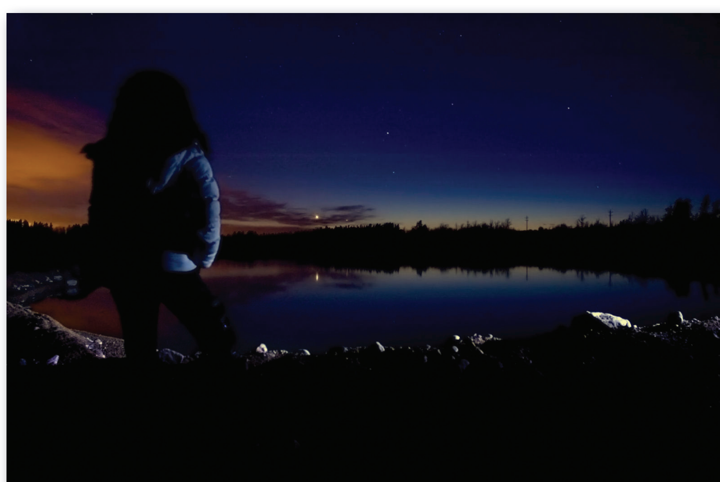
Pen & Pixel
p. 106

The Signs and Constellations of the Zodiac
p. 103

Royal Astronomical Society of Canada
Société Royale d'Astronomie du Canada

DEPARTMENTS

COLUMNS



On the Front Cover:
Ron Berard likes to play with trees, lakes, and people in his astronomical images, and the April conjunction of Mercury and Venus provided the perfect setting. Image exposure was 15 seconds at ISO 800, f/3.5 using an 18-mm Nikon D70 with noise reduction off. A flash was used to illuminate the foreground.

News Notes/ *En manchettes*

Compiled by Andrew I. Oakes (copernicus1543@gmail.com)

Saturn's Enceladus Displays Plumes and Hotspots

NASA's *Cassini* spacecraft has captured the most detailed images yet of new jets spraying from prominent fractures crossing the south polar region of Enceladus, an icy moon orbiting Saturn. The images, released in late February 2010, have resulted in the best temperature map to date of one fracture — a "tiger stripe" known as *Baghdad Sulcus,* a fissure that sprays icy particles, water vapour, and organic compounds into space.

Cassini's cameras have also captured views of regions not well mapped previously on Enceladus, including a southern area with crudely circular tectonic patterns.

The *Cassini* flyby — the mission is known as *Cassini-Huygens* — occurred on 2009 November 21, the eighth-targeted encounter with Enceladus. It provided the spacecraft's visible-light cameras with the last look at Enceladus's south polar surface before that region of the moon went into 15 years of darkness. The spacecraft flew to within some 1600 kilometres of the moon's surface, at around 82 degrees south latitude.

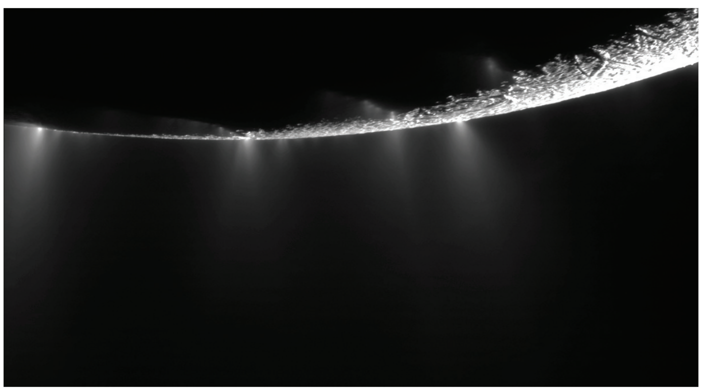


Figure 1 — Viewed from approximately 14,000 km at an image scale of 81 metres per pixel, this mosaic shows dramatic plumes spraying water ice out from many locations along the famed "tiger stripes" near the south pole of Saturn's moon Enceladus. Credit: NASA/JPL/Space Science Institute

Journal

The *Journal* is a bi-monthly publication of The Royal Astronomical Society of Canada and is devoted to the advancement of astronomy and allied sciences. It contains articles on Canadian astronomers and current activities of the RASC and its Centres, research and review papers by professional and amateur astronomers, and articles of a historical, biographical, or educational nature of general interest to the astronomical community. All contributions are welcome, but the editors reserve the right to edit material prior to publication. Research papers are reviewed prior to publication, and professional astronomers with institutional affiliations are asked to pay publication charges of $100 per page. Such charges are waived for RASC members who do not have access to professional funds as well as for solicited articles. Manuscripts and other submitted material may be in English or French, and should be sent to the Editor-in-Chief.

The *Journal of The Royal Astronomical Society of Canada* is published at an annual subscription rate of $94.50 (including tax) by The Royal Astronomical Society of Canada. Membership, which includes the publications (for personal use), is open to anyone interested in astronomy. Applications for subscriptions to the *Journal* or membership in the RASC, and information on how to acquire back issues of the *Journal* can be obtained from:

The Royal Astronomical Society of Canada
203 – 4920 Dundas St W
Toronto ON M9A 1B7, Canada
Internet: nationaloffice@rasc.ca
Web site: www.rasc.ca
Telephone: (416) 924-7973
Fax: (416) 924-2911

Canadian Publications Mail Registration No. 09818
Canada Post: Send address changes to 203 - 4920 Dundas St W, Toronto ON M9A 1B7

Canada Post Publication Agreement No. 40069313
We acknowledge the financial support of the Government of Canada, through the Publications Assistance Program (PAP), toward our mailing costs.

Canada

The *Journal* is printed on recycled stock.

The flyby's objective was to look for new or smaller jets not visible in previous images. One mosaic revealed more than 30 individual geysers, and at least 1 jet spouting prominently in previous images, and that now appears less powerful.

"This last flyby confirms what we suspected," said Carolyn Porco, imaging team lead based at the Space Science Institute in Boulder, Colorado. "The vigor of individual jets can vary with time, and many jets, large and small, erupt all along the tiger stripes."

The science team developed a new map that combines heat data with visible-light images, and that shows a 40-kilometre segment of *Baghdad Sulcus,* the longest tiger stripe. The map illustrates the correlation between the geologically youthful surface fractures and the anomalously warm temperatures that have been recorded in the south polar region. The broad swaths of heat previously detected by the infrared spectrometer appear to be confined to a narrow, intense region no more than a kilometre wide along the fracture.

Peak temperatures along *Baghdad Sulcus* exceed 180 K, and may be higher than 200 K. They are described as "a cozy oasis" compared to the numbing 50 K of their surroundings. Scientists speculate that these warm temperatures probably result from heating of the fracture flanks by warm, upwelling water vapour that propels the ice-particle jets seen by *Cassini's* cameras.

Some of *Cassini's* scientists infer that the warmer the temperatures are at the surface, the greater the likelihood that jets erupt from liquid. "And, if true, this makes Enceladus's organic-rich, liquid sub-surface environment the most accessible extraterrestrial watery zone known in the solar system," Porco said.

[Note: See book review in this *JRASC* issue on *Titan Unveiled: Saturn's Mysterious Moon Explored,* which deals with the *Cassini-Huygens* exploratory mission.]

Evidence Shows a Binary Quasar Result of Merging Galaxies

Astronomers have captured the first "smoking gun" evidence for the presence of a binary quasar in a pair of merging galaxies.

In a paper co-authored by a past Editor-in-Chief of the *Journal* and published in the 2010 February 20 issue of *The Astrophysical Journal (ApJ),* the presence of tidal tails — which was followed up with spectroscopic observations — demonstrates that the radio-quiet quasar pair and the merging galaxies are in close proximity to each other.

Wayne A. Barkhouse of the Department of Physics and Astrophysics, University of North Dakota and former *JRASC* Editor-in-Chief, and colleague Adam D. Myers, Department of Astronomy, University of Illinois at Urbana-Champaign, made the discovery of the tidal tails on 2009 March 18, during a three-night observing run using the 4-metre Mayall telescope at the Kitt Peak National Observatory in Arizona. Follow-up observations were obtained using the *Chandra X-ray Observatory,* the Magellan telescope in Chile, and the Very Large Array in New Mexico.

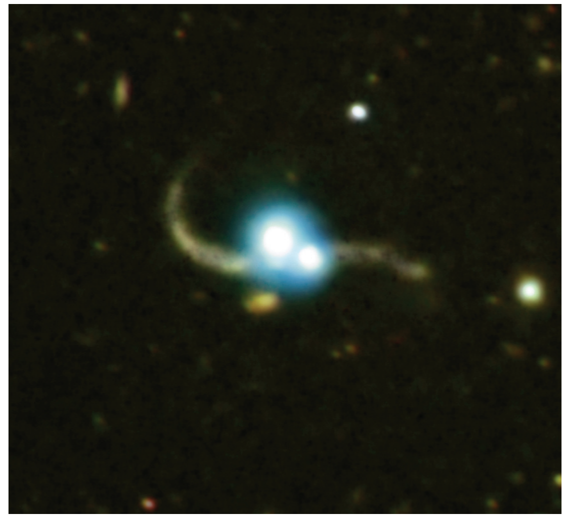


Figure 2 — Astronomers find the first clear evidence of a binary quasar within a pair of actively merging galaxies. Former *JRASC* Editor-in-Chief Wayne A. Barkhouse is one of the co-authors of the research paper recently published in *The Astrophysical Journal.* Photo: X-ray (NASA/CXC/SAO/P. Green *et al.*), Optical (Carnegie Obs./Magellan/W. Baade Telescope/J.S. Mulchaey *et al.*)

The binary quasar is approximately 4.5 billion light-years away and displays very prominent tidal tails from a pair of merging galaxies. In the abstract to the *ApJ* research paper, titled *SDSS J1254+0846: A Binary Quasar Caught in the Act of Merging,* Barkhouse and co-authors write:

> We present the first luminous, spatially resolved binary quasar that clearly inhabits an ongoing galaxy merger. SDSS J125455.09+084653.9 and SDSS J125454.87+084652.1 ... are two luminous z = 0.44 radio-quiet quasars, with a radial velocity difference of just 215 km s^{-1}, separated on the sky by 21 kpc in a disturbed host galaxy merger showing obvious tidal tails....
>
> We present follow-up optical imaging which shows broad,

The Royal Astronomical Society of Canada is dedicated to the advancement of astronomy and its related sciences; the *Journal* espouses the scientific method, and supports dissemination of information, discoveries, and theories based on that well-tested method.

symmetrical tidal arm features spanning some 75 kpc at the quasars' redshift. Previously, the triggering of two quasars during a merger had only been hypothesized, but our observations provide strong evidence of such an event.

SDSS J1254+0846, as a face-on, pre-coalescence merger hosting two luminous quasars separated by a few dozen kpc, provides a unique opportunity to probe quasar activity in an *ongoing* gas-rich merger.

Until this recent discovery, binary quasars have not been seen in galaxies that are unambiguously in the act of merging. The research paper's co-authors conclude with the optimistic prediction that "[m]ore such mergers should be identifiable at higher redshifts using binary quasars as tracers."

WISE Instruments Hard at Work in Earth Orbit

The Wide-field Infrared Survey Explorer (WISE) is now six months into its mission to map the whole sky in infrared light. *WISE* began its official survey of the entire sky on 2010 January 14, one month after the instrument package rocketed into a polar orbit around Earth from Vandenberg Air Force Base in California.

Two days prior to the official start of its mission, the NASA spacecraft spotted its first, never-before-seen near-Earth asteroid.

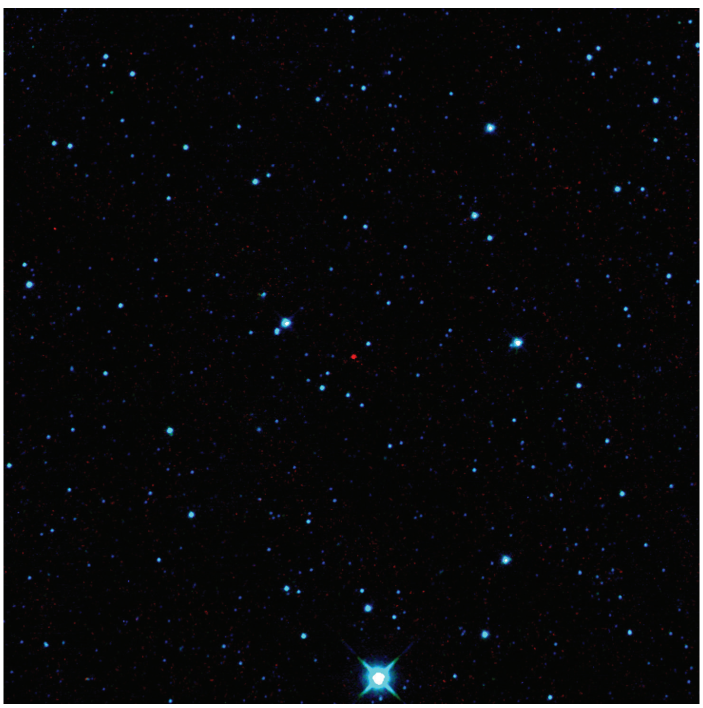


Figure 3 — The dot at the dead-centre of this image (the dot appears red in colour photographs) is the first near-Earth asteroid discovered by NASA's *Wide-Field Infrared Survey Explorer (WISE)*. The asteroid appears redder than the rest of the background stars because it is cooler and emits most of its light at longer infrared wavelengths. Image: NASA/JPL-Caltech/UCLA

The near-Earth object, designated 2010 AB78, was located by the mission's sophisticated software, which picked out the moving object against a background of stationary stars. It observed the asteroid several times during a period of one-and-a-half days before the object moved beyond its view. When alerted to the object's existence, astronomers used the University of Hawaii's 2.2-metre telescope near the summit of Mauna Kea to follow up and confirm the discovery.

In January 2010, the asteroid was about 158 million kilometres from Earth. It is estimated to be roughly 1 kilometre in diameter. According to astronomers, the object comes as close to the Sun as Earth is, but because of its tilted orbit, it will not pass very close to our planet for many centuries and does not pose any foreseeable impact threat to Earth.

During its mapping mission, *WISE* is expected to find about 100,000 previously unknown asteroids in the Solar System's main asteroid belt. It is also expected to spot hundreds of previously unseen near-Earth objects. Professional and amateur astronomers provide follow-up observations, establishing firm orbits for the previously unseen objects.

WISE has been described as issuing mission scientists "...a fire hose of data pouring down from space."

Dr. Helen Kirk Awarded Plaskett Medal

The RASC and CASCA have announced that Dr. Helen Kirk of the Harvard-Smithsonian Center for Astrophysics has been awarded the Plaskett Medal for 2010.

Dr. Kirk obtained her Ph.D. at the University of Victoria. Her thesis on star formation within the Perseus Molecular Cloud was supervised by Dr. Doug Johnstone. Dr. Kirk and her collaborators combined observational data from the JCMT and IRAM observatories with numerical simulations to explore the physical processes of star formation within molecular clouds. Her thesis publications have already had a significant impact on star-formation studies.

She is presently an NSERC Post-Doctoral Fellow at the Harvard-Smithsonian Center for Astrophysics.

The Plaskett Medal was established in 1988 in recognition of the pivotal role played by John Stanley Plaskett in the establishment of astrophysical research in Canada. The medal is awarded annually, by The Royal Astronomical Society of Canada and CASCA, to the Ph.D. graduate from a Canadian university who is judged to have submitted the most outstanding doctoral thesis in astronomy or astrophysics in the preceding two years.

Darwin's Impact Crosses Science Disciplines

Darwin's influence can be felt across a number of science disciplines, as the National Science Foundation's special electronic tribute to Darwin *(Evolution of Evolution: 150 Years of Darwin's "On the Origin of Species")* shows.

The multi-disciplinary, one-stop-shop of resources on evolution and Darwin himself goes "wide and deep," providing a uniquely sweeping, at-a-glance explanation of how *Origin* cut an intellectual swath through anthropology, biology, the geosciences, polar sciences, and even astronomy, says the National Science Foundation..

The resources, which inform readers about the scientific advances enabled by the theory of evolution, can be found at `www.nsf.gov/news/special_reports/darwin`. The special site went live on the date of the 150th anniversary of the publishing of *Origin* — 2009 November 24.

Throughout 2009, a number of scholarly celebrations took place around the world commemorating the 150th publishing anniversary, including a four-day conference at Victoria College, University of Toronto, which was hosted by the Institute for the History and Philosophy of Science and Technology, a graduate studies and research institute. The gathering brought together scholars from across Canada, the United States, and Europe, who focused their research presentations on the conference's theme: *150 Years After Origin: Biological, Historical and Philosophical Perspectives.*

There was a second importance to the year 2009. It marked the 200th anniversary of Darwin's birth — 1809 February 2. Darwin died on 1882 April 19.

Andrew I. Oakes is a long-time Unattached Member of RASC who lives in Courtice, Ontario.

Research papers
Articles de researche

Dating Newton's Manuscripts from the Jerusalem Collection

Ari Belenkiy
Mathematics Department, Bar-Ilan University, Ramat Gan 52900 ISRAEL
and
Eduardo Vila Echagüe
IBM-Chile, Providencia, Santiago, CHILE

Abstract: The Jewish National & University Library in Jerusalem contains two undated drafts in Latin by Newton under the same title, *Rules for the Determination of Easter*, grouped as Yahuda MS 24E. Each draft contains an astronomical table with the solar and lunar positions for for ten specific dates in years AD 30-37, which Newton used to decide on the year and date of the Passion. We argue that the astronomical data comes from the 1669 *Astronomia Britannica* by Vincent Wing (1669), a semi-forgotten astronomer of the 17th century. These "astronomical exercises," announced in a 1673 note in the *Catalogue of Eminent Astronomers* (1675) composed by Edward Sherburne, were likely intended to appear as an appendix to Nicholas Mercator's 1676 book. This makes the first draft, written in John Wikins' hand, one of the earliest of Newton's drafts, likely written in 1669-73 and certainly not later than 1683.

Résumé: La bibliotèque nationale juive et de l'université à Jérusalem contient deux projets en latin sans dates par Newton sous le même titre, soit "Règles pour déterminer le jour de Pâques", groupés sous la rubrique Yahuda MS 24E. Ces deux projets contiennent un tableau astronomique dans lequel on retrouve les positions solaires et lunaires pour les années 30-37, lesquelles Newton s'est servi pour établir l'année et la date de la Passion. Nous maintenons que ces données astronomiques sont tirées de "l'Astronomia Britannica" de 1669 par Vincent Wing, un astronome peu connu du dix-septième siècle. Ces "exercises astronomiques", indiqués dans une note de 1673 tirée du "Catalogue d'astronomes éminents" (1675) rédigé par Edward Sherburne, devaient vraisemblablement être incluses en annexe dans le livre de Nicholas Mercator de 1676. Le premier projet est donc un des tous premiers de Newton, sans doute écrit entre 1669 et 1673, mais certainement pas plus tard que 1683.

Key words: Isaac Newton, Nicolas Mercator, Vincent Wing

1. Introduction

The Jewish National & University Library in Jerusalem hosts quite a few Newton manuscripts. Several are grouped as Yahuda MSS 24. While Yahuda MSS 24 A-D could be dated to 1700 (Belenkiy & Vila Echagüe 2005), and Yahuda MSS 24F to 1713, two others, known as Yahuda MS 24E (Newton Project 2009), have no dates upon them and give no clues how to establish the time of their writing. The so-called "fair copy" (further denoted as W) is written in the hand of Newton's roommate John Wickins. The so-called "rough draft" is written in Newton's own hand (further denoted as N). Each draft carries a table (Figures 1 and 2) with the results of astronomical computations.

The astronomical data in both tables basically are identical except for two extra entries for years 33 (March 19) and 37 in W compared to the entry for year 34 (April 8) in N. The latter year appears in W as well, though as a separate line in a different place than in the major table (Figure 3).

Both tables compute several solar and lunar parameters for the night of the first visibility in Jerusalem of the last-winter or first-spring Moon in years AD 30-37. They include the Sun's and the Moon's true longitudes and the Moon's latitude, computed for 3 p.m. London time, roughly equivalent to 6 p.m. Jerusalem time, a sunset time in the spring. The single exception is the entry for year

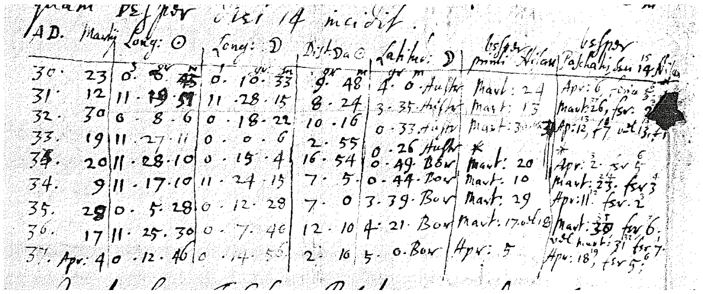


Figure 1 — Table of Paschal Crescent Visibility in W "Fair Copy" in Wickins' Hand, with Corrections in a Different Hand. (Courtesy of JNUL)

34, where the time is specified as "18h 16m," likely a direct reference to Jerusalem local time for an April sunset in Jerusalem.

In both tables, there is also a column labelled "Distance between the Moon and the Sun" that contains the difference between their longitudes. In N, there is an additional column with the Moon's altitudes at sunset. This fact, together with the superscripts over the dates in the right column of W and the different placing of the 34 AD, Apr 8 line, indicate that W preceded N and the major data in N was just copied from W

These tables, in principle, can provide a clue for dating drafts W and N — in case their source is identified. We combined astronomical data from Figure 1 with the last line from Figure 2 in one table denoted as W/N (Table 1). It seems certainly plausible to date W from W/N.

AD March	Long. Sun	Long. Moon	Dist. M from S. from S.	Lat. Moon
30 23	0. 0. 45	0.10.33	9. 48	4.0 S
31 12	11.19.51	11.28.15	8. 24	3.35 S
32 30	0. 8. 6	0.18.22	10. 16	0.33 S
33 19	11.27.11	0.0.6	2.55	0.26 S
33 20	11.28.10	0.15.4	16. 54	0.49 N
34 9	11.17.10	11.24.15	7. 5	0.44 N
35 28	0.5.28	0.12.28	7. 0	3.39 N
36 17	11.25.30	0.7.40	12. 10	4.21 N
37 Apr 4	0.12.46	0.14.56	2.10	5.0 N
34 Apr 8 18h 16h	0.16.20	1.3.10	16. 50	3.44 N

Table 1 — W/N astronomical table gathered from Figures 1 and 2.

What sources were available to Newton after his entrance to Cambridge in 1661? For that, we have to look in the 17th century.

2. General State of pre-Newtonian Astronomy

Throughout the 17th century, the theory underlying the motion of the celestial bodies was rapidly evolving. An extensive review is provided by C. Wilson (1989). Since the 1660s, Kepler's *Rudolphine Tables* (1627) (Kepler 1866) had been considered the best for

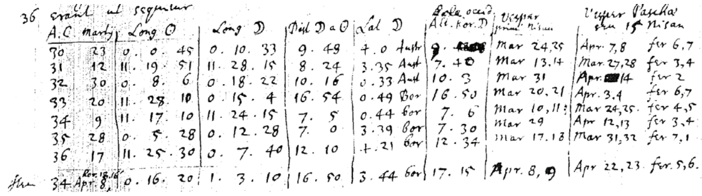


Figure 2 — Table of Paschal Crescent Visibility in N "Rough Draft" in Newton's Hand. (Courtesy of JNUL)

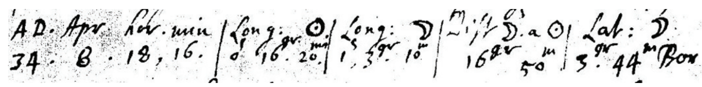


Figure 3 — The single line in W for AD 34, Apr 8.

computing the positions of the planets, but not for the Moon, where many different theories vied for the laurel wreath. In his *Almagestum Novum,* published in 1651, Giovanni Battista Riccioli (1598-1671), in addition to the theory of Johannes Kepler (1571-1630), describes lunar theories of Philip van Lansbergen (1561-1632), Godfroy Vendelin (1580-1667), Johannes Fabricius (1587-1616), Albert Curtz (1600-1671), and Ismael Boulliau (1605-1644), who published extensively during the mid-17th century on the Continent. At the same time, in England, Vincent Wing (1619-1668) and Thomas Streete (1622-1689) suggested rival geometrical theories. Jeremiah Horrocks (c. 1617-1641), who died at a young age, developed his own theory (Horrocks 1678), but it became known to the world only in 1673 through publication by John Wallis, augmented by John Flamsteed's 1672 tables that were based on Horroxian theory. These tables contained some errors; in 1681, Flamsteed, then Astronomer Royal, published corrected tables. Newton's own lunar theory, based on the universal law of gravity conceived in *Principia,* was developed much later and was first published in 1702 by David Gregory.

3. Comparison of the Yahuda Table with Those of Major pre-Newtonian Astronomers

Almagest, al-Battani (Nallino 1977), the *Alphonsines,* the *Prutenics,* Tycho's *Astronomiae Insturatae Progymnasmata,* Kepler's *Rudolphines,* Horrock's *Opera Posthuma,* and Streete's *Astronomia Carolina* — all are possible sources for W/N. All of them were present either in Newton's personal library or in the library of his teacher, Isaac Barrow (d. 1667). Instead of comparing them against W/N tables directly, one by one, we compare all with modern theory (Tables 2 and 3), where the differences are expressed in minutes of arc. Solar data are due to Bretagnon & Simon (1996); lunar data to Chapront-Touzé & Chapront (1991). Data for *Almagest,* al-Battani, Alphonsines, Prutenics, Rudolphines, Tycho, and Streete came from Lars Gislén's Astronomical Freeware; while Horrocks, Flamsteed, and Newton's 1702 lunar theory, from Kollerstrom's (1998) astronomical software[1].

Apart from the absolute size of errors coming from the different values assigned to the Sun's mean motion, W/N solar positions show sample standard deviation = 1.4, of the same order as those of Tycho and Streete, and higher than those of 1681 Flamsteed and 1702 Newton. The correlation coefficients in the Sun's longitude between W/N and all other astronomers' tables are very low. Even the two

Date	Yahuda	Alma-gest	Al-Battani	Alphon-sines	Prutenics	Tycho	Rudol-phines	Streete	Flamsteed	Newton 1702
30 Mar 23	6	-20	-90	38	-22	-6	4	7	-1	-3
31 Mar 12	11	-17	-89	38	-19	-8	5	5	0	-3
32 Mar 30	8	-24	-89	38	-25	-4	4	8	-1	-3
33 Mar 19	10	-20	-89	38	-22	-6	4	6	-1	-3
33 Mar 20	10	-21	-89	38	-22	-6	4	6	-1	-3
34 Mar 9	10	-18	-89	38	-20	-9	4	4	0	-3
35 Mar 28	9	-24	-90	38	-25	-5	3	7	-1	-3
36 Mar 17	9	-21	-90	37	-23	-7	4	5	-1	-3
37 Apr 4	10	-27	-89	38	-28	-4	3	9	-1	-3
34 Apr 8	*8*	*-27*	*-89*	*38*	*-28*	*-3*	*3*	*10*	*-1*	*-3*
Std. Dev.	1.4	3.4	0.2	0.2	3.2	1.7	0.5	1.8	0.3	0.3
ρ (X,Yahuda)		0.20	0.38	-0.23	0.24	-0.40	0.23	-0.39	0.18	-0.01
σρ (X, Yahuda)		0.32	0.29	0.32	0.31	0.28	0.32	0.28	0.32	0.33

Table 2 — Solar positions of W/N and other astronomers versus modern theory

largest in absolute value correlation coefficients — Tycho (ρ = -0.4) and Streete (ρ = -0.39) — are significant only at the 20-percent level! However, it is not that easy to decide on which correlations are significant, since the sample of 10 is rather small and one or two accidental computational errors could reverse the picture. The poor correlation between W/N and the Rudolphines seem to exclude Kepler.

Not only do W/N lunar positions have large differences when compared with the modern values, stretching within the range between +10′ and +58′, but the sample variance is too great (see Table 3). Even *Almagest* performs better in this respect. The correlation coefficients in the Moon's longitude between W/N and all others are very low. The notable exception is the *Prutenic* tables, which shows a very high correlation (ρ = 0.85), significant at < 0.0001 level! The next two, by comparison, are Tycho (ρ = 0.59) and Streete (ρ = -0.61), significant only at the 2-percent level. However, the *Prutenics* disagree with W/N in absolute values too much to be considered seriously as its source.

A direct identification of sources seems the only way to solve the problem. Special attention must be given to Newton's older contemporaries: Nicholas Mercator (1620-87) and Vincent Wing (1619-1668).

Date	Yahuda	Alma-gest	Al-Battani	Alphon-sines	Prutenics	Tycho	Horrocks	Streete	Flam-steed	Newton 1702
30 Mar 23	10	-40	-81	22	-52	-3	11	69	10	-8
31 Mar 12	10	-41	-82	10	-46	2	19	34	10	-14
32 Mar 30	19	-37	-78	11	-39	2	17	22	10	-21
33 Mar 19	34	-18	-61	21	-15	8	12	18	11	-25
33 Mar 20	37	-42	-84	-2	-28	7	15	18	14	-22
34 Mar 9	31	-34	-77	6	-18	7	5	20	6	-22
35 Mar 28	58	-32	-74	14	-17	7	10	23	10	-18
36 Mar 17	26	-36	-76	21	-33	10	3	24	12	-14
37 Apr 4	32	-25	-65	37	-27	0	15	16	16	-11
34 Apr 8	48	-41	-83	-3	-20	7	17	18	15	-20
Std. Dev.	15.4	7.7	7.8	12.1	12.8	4.2	5.4	16.0	2.9	5.5
ρ (X,Yahuda)		0.25	0.17	-0.27	0.85	0.59	-0.10	-0.61	0.26	-0.47
σρ (X,Yahuda)		0.31	0.32	0.31	0.09	0.22	0.33	0.21	0.31	0.26

Table 3 — Lunar positions of W/N and others astronomers versus modern values

Table Date yy-mm-dd	London Time h:mm	Sun's Longitude			Moon's Longitude			Moon's Latitude		
		Yahuda 24	Wing 1669	Wing 1651	Yahuda 24	Wing 1669	Wing 1651	Yahuda 24	Wing 1669	Wing 1651
30-03-23	15:00	0°45′	0°49′	0°50′	10°33′	10°43′	10°42′	-4°00′	-3°59′	-3°58′
31-03-12	15:00	349°51′	349°51′	349°51′	358°15′	358°29′	358°31′	-3°35′	-3°37′	-3°36′
32-03-30	15:00	8°06′	8°06′	8°08′	18°22′	18°28′	18°33′	-0°33′	-0°30′	-0°30′
33-03-19	15:00	357°11′	357°11′	357°11′	0°06′	0°04′	0°13′	-0°26′	-0°28′	-0°28′
33-03-20	15:00	358°10′	358°10′	358°11′	15°04′	14°57′	15°07′	0°49′	0°50′	0°50′
34-03-09	15:00	347°10′	347°10′	347°11′	354°15′	354°15′	354°20′	0°44′	0°40′	0°40′
35-03-28	15:00	5°28′	5°28′	5°29′	12°28′	12°01′	12°02′	3°39′	3°35′	3°33′
36-03-17	15:00	355°30′	355°30′	355°30′	7°40′	7°49′	7°50′	4°21′	4°21′	4°20′
37-04-04	15:00	12°46′	12°45′	12°46′	14°56′	14°49′	14°52′	5°00′	5°00′	5°00′
34-04-08	15:00		16°20′	16°22′		33°10′	33°02′		3°44′	3°44′
18:16 Jeru-	15:11	16°20′		16°22′	33°10′		33°08′	3°44′		3°44′
salem Time	15:14		16°21′			33°02′			3°44′	

Table 4 — Solar and lunar positions of W/N and Wing's 1669 and 1651 books

4. Nicholas Mercator

The following entry, dated to 1673, is extracted from the Appendix, entitled *Catalogue of Eminent Astronomers,* of Edward Sherburne's *The Sphere of Manilius* (1675):

> *1673. Mr. ISAAC NEWTON Lucasian Professor of Mathematicks in the University of Cambridge, and Fellow of Trinity Colledge, hath lately published his reflecting Telescope; New Theories of Light and Colours; hath already for the Press a Treatise of Dioptricks, and divers Astronomical Exercises, which are to be subjoyned to Mr. Nicholas Mercator's Epitome of Astronomy, and to be Printed at Cambridge. From him besides is to be expected a New General Analytical Method by infinite Series for the Quadrature of Curvilinear Figures, the finding of their Centers of Gravity, their Round Solids, and the Surfaces thereof, the straitning of curved Lines; so that giving an Ordinate in any Figure as well such as Des Cartes calls Geometrical, as others, to find, the Length of the Arch Line, and the Converse; Such an Invention, to wit, but in one particular Figure the Circle, the Learned Snellius thinks transcendent to any thing yet published; and how much conducing to the Benefit of Astronomy, and the Mathematical Sciences in General, such an Universal Method is, I leave others, together with my self to admire, and earnestly expect.*

Westfall (1980, p. 258) comments:

> *Whatever the source of Sherburne's information, we know nothing more about the astronomical exercise. They did not appear in Mercator's book when he published it in 1676, though a reference to Newton, who had shown the author a very elegant hypothesis on moon's libration, establishes that the two had met.*

Nicholas Mercator (born Kauffmann), once a lecturer at the University of Copenhagen (1648-54), resided in London in 1658-82. His "Epitome" (1676) contains handy solar tables based on Tycho and Kepler and lunar tables based on Tycho.

Several arguments can be adduced against this book as a source for W/N. We owe them to Lars Gislén (personal communication, 2006 June 24):

First: Mercator arranged the tables in a strange fashion; he used the Julian (Scaliger's) period as an epoch (year -4712) and "decimals of a circle" instead of traditional signs, degrees, minutes, and seconds, while W/N uses traditional notation and reference point. The matter of conversion forth-and-back might be an unpleasant one;

Second: if Newton had used Mercator, the W/N table would be close to Tycho or Kepler, which is not the case, as we saw earlier. This means Mercator is an unlikely source for W.

On the other hand, Newton hardly would discard Mercator unless his own work had already been completed sometime earlier. This suggests the table in the W was composed before 1676. To find the precise time of its composition, we must discover the original source.

5. Vincent Wing

Harrison (1978, p. 300) lists the copy of Wing's 1651 *Harmonicon Coeleste* (Wing 1651) as well-read and the copy of Wing's 1669 *Astronomia Britannica* (Wing 1669) as heavily perused and dog-eared, in Newton's manner, and it is most probable that Newton used either for his solar data (see Table 4). In eight cases out of ten, Wing's 1669 procedure — a correction equivalent to the 2nd equation of centre — gives exactly the same result for Sun's longitude as W/N, if rounded to a whole number of arcminutes. In one case, AD 37 April 04, the difference is 1′, while in the other case, AD 30 March 23, it is 4′ — but in the latter case the 45′ in W/N could be just a slip of the pen for 49′, in which case the match with Wing 1669 is perfect. Replacing 45′ with 49′ gives also an almost perfect correlation between the W/N and *Rudolphines'* solar positions, which is not surprising, since Wing's 1669 procedure approximates Kepler's area law very closely ((Whitehead 1962, p. 125, n. 31; Wilson, 1989,

p. 178). Though the 1651 positions deviate from W/N more seriously, — three times by 1′ and twice by 2′ — they are still within the error margin and the 1651 book cannot be discarded outright.

The Moon could demonstrate the true source, but the Moon's differences between W/N and Wing are much greater than for the Sun, amounting to 14′-16′ (in year 31) and even to 26′-27′ (for year 35), and obviously need an explanation.

Lars Gislén in another personal communication suggested three options that Newton could have used for his Moon calculations from Wing. First, he could have skipped the *annual equation.* Sometimes calculating according to Wing's procedure without that equation seems to give a closer fit to W/N table. True, the coefficient in the annual equation was widely debatable at that time — Tycho argued for 4.5′; Kepler argued for 11′; Boulliau neglected it altogether; and Wing in 1669 sided with Tycho (Wilson 1989, pp. 194-7). Newton could have chosen another figure than the one to which Wing adhered.

Second, Newton could have chosen between Wing's orbital and ecliptic longitude for the Moon. Generally, it seems that Wing's orbital longitudes give a better fit to W/N, but not always. Third, Newton could have simplified the interpolation or calculation scheme. The evection in Wing 1969 is interpolated in a double-entry table and the result of the interpolation can differ by up to 30″- 50″ from an exact calculation. In addition, the sheer number of different steps in the Moon calculations can cause truncation errors.

All this, however, can explain a discrepancy between Wing's 1669 procedure and W/N of 11′-13′ maximum, but not of 27′ unless the latter author did his computations carelessly or just neglected all the terms in the lunar longitude's expansion beyond the equation of time and evection. The variation, 38′ *sin 2D,* must be the major among the neglected terms. Since elongation D in W/N does not exceed 17°, the *sin 2D* for each entry is not greater than 0.56, and therefore the variation does not exceed 21′. Combined with several minor terms in lunar longitude expansion, also neglected, it could produce, in principle, a discrepancy as large as 27′.

Since we did not achieve an exact match, it is worthwhile to search for extra clues in Wing's books owned by Newton.

6. 1651 *Harmonicon Coeleste*

A copy of Wing's 1651 book from Newton's library is kept in the Butler Library at Columbia University, New York. There are about 20 marginal notes in Newton's hand. The notes don't show any particular interest in the Moon, but there is a short table for the positions of Jupiter. The manuscript attached to the book, a "loose leaf with Newton's handwritings on both sides," in Harrison's words, was thought to be missing. At our request, librarians at the Butler Library searched for it, and on 2006 December 1, finally recovered the page. Unfortunately, the leaf deals solely with general chronology and is not concerned with the Passion.

7. 1669 *Astronomia Britannica*

Whiteside (1964) noticed that

> *in autograph notes made about 1670 on the rear endpapers of his copy (Trinity College, Cambridge, NQ 18.36) of Vincent Wing's* Astronomia Britannica, *London, 1669, Newton explains the disturbance of the Moon's orbit from its theoretical elliptical shape through the action of the solar vortex (which 'compresses' the terrestrial one bearing the Moon by about 1/43 of its width).*

Our conjecture is that Newton corrected Wing's parameter, say, eccentricity of Moon's ellipse, by the above mentioned "1/43." Such a correction would affect not just the minor terms in the expansion of Moon's longitude, but the major terms as well! The first, equation of center, is $(2e + \varepsilon)$ *sin M,* where e is eccentricity of Moon's ellipse, ε is the radius of the circle on which one lunar focus moves around the Sun, and M is Moon's mean anomaly (Wilson 1989, pp. 195-7). Since Wing assumed $\varepsilon = 0.02158$ and $e = 0.04315$, or equivalently, e = 150′, the 1/43 part of $2e$ alone might lead to an increase in the coefficient by up to 7′.

8. 1651 or 1669 Book? – A Nuisance

The lunar position for AD 34 April 8, which stands alone in W, suggests a major conundrum. It is computed, not for *3 p.m.* London time, but for 18:16 — presumably Jerusalem time — the time of the supposed sunset in Jerusalem. This would correspond to different London times in two Wing books, since Wing assigned different longitudes for Jerusalem in 1651 and 1669. It is probable that the author of W computed the solar position for AD 34 April 08, not for 3 p.m. London time, but for 3:11 p.m. (1651) or 3:14 p.m. (1669). The 1651 position at 33° 08′ is much closer to W/N's 33° 10′ than 1669's 33° 02′. Again, it does not fit precisely. If, however, we set the mysterious 18:16 time for year 34 aside and come back to the standard 3 p.m. London time, then the 1669 book matches W/N precisely.

9. Dating Yahuda 24E

John Wickins' handwriting establishes May 1683, when he finally left Cambridge (Westfall 1980, p. 343), as a firm upper time bound for W.

On the other hand, one of two books by Vincent Wing appears to be Newton's source for computing the lunar and solar positions in W. There remains uncertainty as to which two of Wing's books — 1651 or 1669 — Newton used. The bulk of evidence favours the latter book as: 1) the 1669 solar positions match W/N tables better; and 2) Moon's longitude for year 34 (April 8) exactly coincides with 1669 for 3 p.m. London time. The year 1669 must then be the lower time bound for W.

It is our guess that Newton's "astronomical exercises" mentioned in Edward Sherburne's book in 1673 were the lunar computations seen in the end page of Wing's 1669 book, while the by-product of these exercises are shown in W. Finding how 1/43 coefficient from the end-page of the 1669 Wing book could help to arrive from Wing to the W/N lunar positions will settle the problem for sure.

The fact that Newton did not compute the table from the Flamsteed 1672 tables published by Wallis a year later lends another argument in favour of 1673 as a plausible upper time bound for W.

The table in N contains a column with Moon's altitude computed with the help of Maimonides' lunar visibility theory. This is left for another paper.

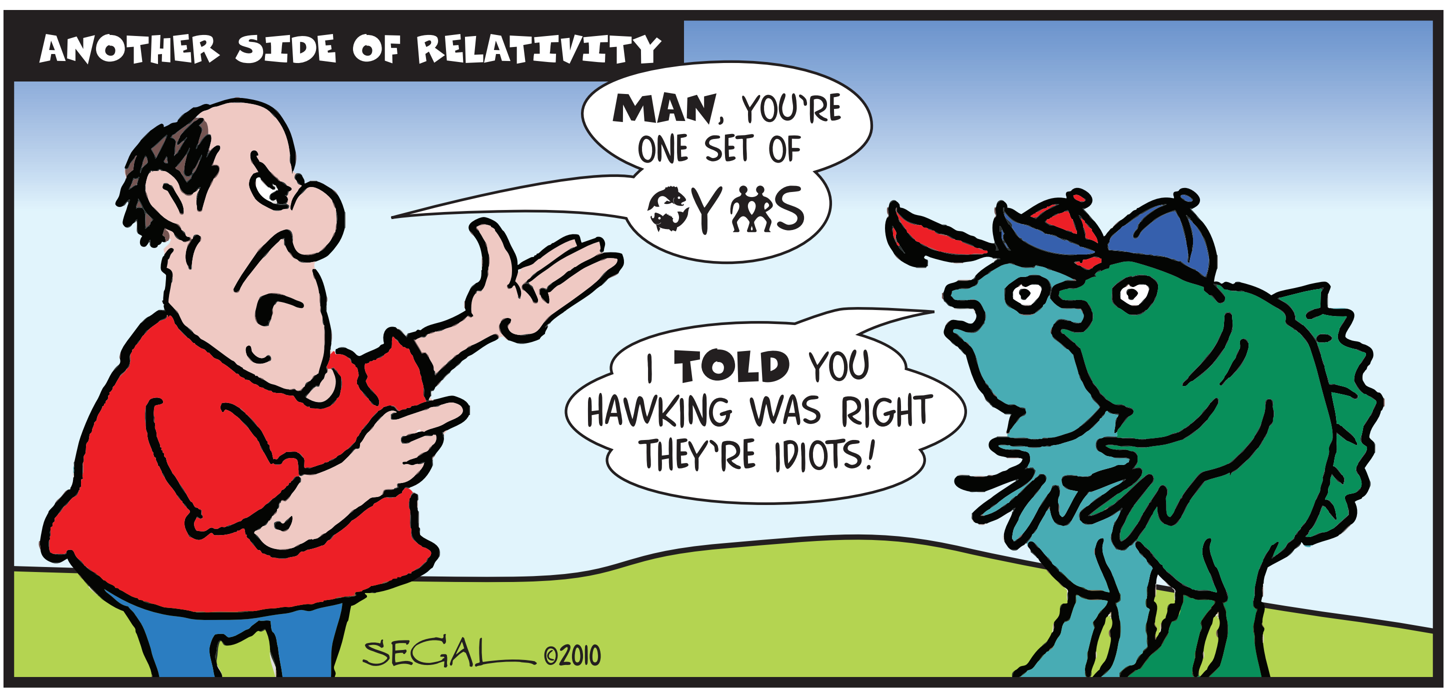
Acknowledgments

The authors are grateful to Dennis Duke (Florida State University); Lars Gislén (University of Lund, Sweden); Joan Griffith (Annapolis, Md.); John T. Young (Newton's Project); Curtis Wilson (St. John's College, Annapolis, Md.); ; and Consuelo W. Dutschke and Jennifer Lee (both Butler Library, Columbia University, N.Y.).

References

1. Belenkiy, A. & Vila Echagüe, E. (2005). History of one defeat: Reform of the Julian calendar as envisaged by Isaac Newton. *Notes & Records Roy. Soc.* 59 (3), 223-254.
2. Bretagnon, P. & Simon, J.-L. (1996). *Planetary Programs and Tables from 4000 to +2800.* Richmond, VA: Willmann-Bell Inc.
3. Chapront-Touzé, M. & Chapront, J. (1991). *Lunar Tables and Programs from 4000 B.C. to A.D. 8000.* Richmond, VA: Willmann-Bell Inc.
4. Dreyer, J.L.E. (1953). *A History of Astronomy from Thales to Kepler.* New York, NY: Dover Publications
5. Gislén, L. *Astromodels* freeware. `www.thep.lu.se/~larsg/download.html`. Based on Ptolemy's *Almagest, The Alphonsine Tables,* Erasmus Reinhold's *Tabulae Prutenicae* of 1551, Thomas Streete's *Astronomia Carolina* of 1665, and Tycho Brahe's models in *Astronomiae Instauratae Progymnasmata.*
6. Harrison, J.R. (1978). *The Library of Isaac Newton.* Cambridge, UK: Cambridge University Press.
7. Horrocks, J. (1678). *Opera posthuma;* viz. *Astronomia Kepleriana,* defensa & promota... J. Flamstedii, de temporis aquatione diatriba. Numeri ad Lunae theoriam Horroccianam. In calce adjiciuntur, nondum editae...4° Londini.
8. Kepler, J. (1866). *Joannis Kepleri astronomi, Opera omnia Volumen VI / ed. Ch. Frisch.* De Tabulis Rudolphinis. Frankfurt. Available at `http://gallica.bnf.fr`.
9. Kollerstrom, N. (1998): Newton's 1702 Theory of the Moon's Motion. A Computer Simulation at URL: `www.dioi.org/kn/newton.htm`. Newton's 1702 lunar theory is also discussed in Kollerstrom: N. (1995). A Reintroduction of Epicycles: Newton's 1702 Lunar Theory and Halley's Saros Correction. *QJRAS,* 36, 357-68.
10. Mercator, N. (1676) *Institutionum Astronomicarum Libri Duo, Londini.* Available at URL: `www.books.google.com`.
11. Nallino, C.A. (1977). Al-Battani, Muhammad ibn Jabir. *Opus Astronomicum.* Translation from Arabic to Latin and commentary by C.A. Nallino. Part 2. (Milano 1907); reprint (Georg Olms Verlag, Hildesheim, N.Y. 1977), p. 72.
12. The Newton Project (2009). URL: `www.newtonproject.sussex.ac.uk/view/texts/normalized/THEM00281`
13. Westfall, R.S. (1980). *Never at Rest: A Biography of Isaac Newton.* Cambridge, UK: Cambridge Univ. Press.
14. Wing, V. (1651). *Harmonicon Coeleste,* London.
15. Wing, V. (1669). *Astronomia Britannica,* London.
16. Whiteside, D.T. (1964). Newton's Early Thought on Planetary Motion, A Fresh Look. *British Journal for the History of Science,* 2, pt.2, 117-37.
17. Wilson, C. (1989). Predictive Astronomy in the Century after Kepler. In René Taton & Curtis Wilson (Eds.), *General History of Astronomy,* (vol. 2A, pp. 161-206). Cambridge, UK: Cambridge University Press.

[1] We were aided in our interpretation by Kollerstrom's computer programs: Flamsteed's 1681 Horroxian Lunar Theory using A Computer Simulation at `www.ucl.ac.uk/sts/nk/zip/flam1.zip` and Newton's 1702 Theory of the Moon's Motion. A Computer Simulation at `www.ucl.ac.uk/sts/nk`. Neither is currently available, but present descriptions and substitutions can be found at Kollerstrom (1998).



Feature Articles/
Articles de Fond

Extragalactic Spectra: Redshifted or Blueshifted?

D. Basu, Department of Physics, Carleton University, Ottawa ON K1S 5B6, e-mail: basu@physics.carleton.ca

Abstract

The single parameter that dominates cosmology is the redshift of extragalactic objects; the latter, in its turn, being comprised of (very) high-redshift galaxies, quasi-stellar objects (QSOs), gamma-ray bursts (GRBs), and supernovae (SNe) type Ia. The redshift is determined by identifying known laboratory (search) lines to lines observed in the spectra. Search lines are available in X-ray, ultraviolet, optical, and infrared regions. However, it is the usual practice of astronomers to match search lines to observed lines that are located at the redside and hence to determine redshifts. No attempt is made to match search lines to observed lines located on the blueside, and hence the blueshift is not considered as an alternative interpretation. It is the purpose of the present article to show that the blueshift is a serious and distinct possibility for spectra of extragalactic objects. Observed blueshifts can be explained in terms of two scenarios, viz. the ejection process by the so-called "slingshot" mechanism and the "multiverse." The impact of the blueshift on modern cosmology, so far based entirely on redshift interpretation, can hardly be underestimated.

1. Introduction

Redshifts (z_r) form the backbone of cosmology, and are determined by matching observed spectral lines in extragalactic objects to lines known in the laboratory called search lines. The correct identification of the observed lines is therefore vital to the determination of z_r. The value of z_r is determined routinely by comparing laboratory search lines in ultraviolet and blue regions to observed lines that are assumed to have been redshifted to longer wavelengths in the spectrum. In most cases, the comparison of observed lines to blueshifted laboratory lines is not considered and the blueshift (z_b) remains undetermined (Figure 1).

A composite spectrum of the IR region from 11,500 Å to 23,000 Å is presented in Figure 2, showing the important IR lines that can be used for the determination of blueshifts. The corresponding composite spectrum of the UV region between 1700 Å to 3400 Å exhibiting important UV lines that are often used for the determination of redshifts is shown in Figure 3.

The possibility that z_b might be a better interpretation of cosmological redshifts has been suggested by several researchers. Small blueshifts could be observed in Hα 6563, Hβ 4861, and [OIII] 5007 (Burbidge and Burbidge 1967). Putsil'nik (1979) speculated that wavelength ratio of two IR lines, Pβ 12818 and Pα 18751, used to determine redshift in quasars, may be better matched with the two UV lines CIII] 1909 and MgII 2798 respectively, which would yield "large violet shifts." Small blueshifts ($z_b \leq 0.5$) are easily detected, although large blueshifts ($z_b > 0.5$), may be observed with less probability (Valtonen & Basu 1991). Narlikar & Subramanian (1983) have noted the possibility of incorrect identification of observed lines, and alternative interpretations of some objects in terms of blueshift have been suggested. Gordon (1980) examined

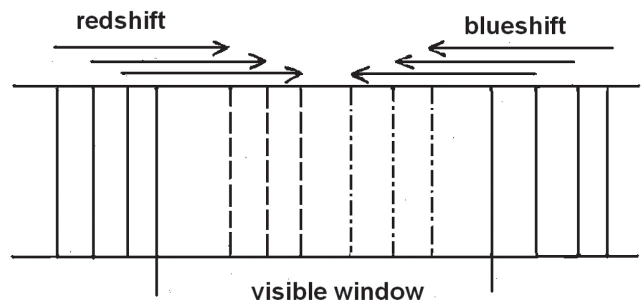


Figure 1 — Schematic diagram to illustrate redshifted (dashed) and blueshifted (dot-dashed) spectral lines (solid) with respect to the visible window (3300 Å to 6900 Å).

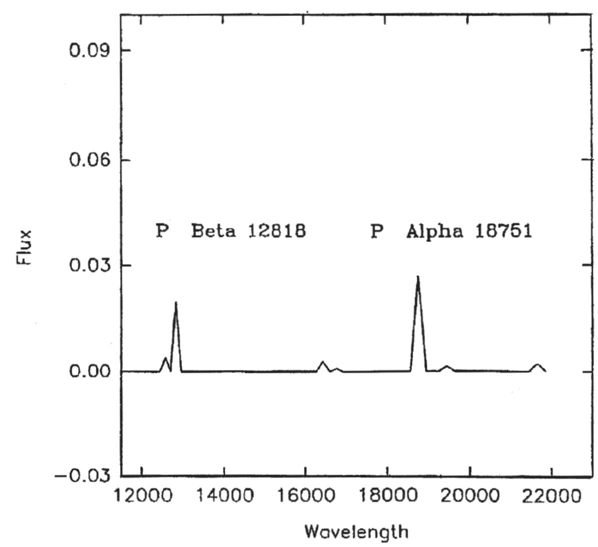


Figure 2 — Composite spectrum of QSOs for the IR region. The lines shown in the figure are [FeII] 12567, Pβ, [FeII] 16440, [FeII] 16770, Pα, Brδ 19445, Brγ 21660 (after Basu *et al.* 2000, with kind permissions of the authors and the World Scientific Publishing Centre).

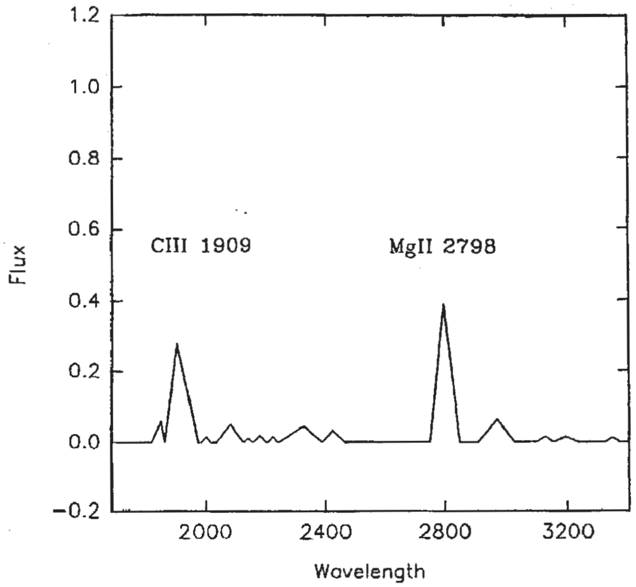


Figure 3 — Composite spectrum of QSOs for the UV region. The lines shown in the figure are AlIII 1858, CIII], 2000, 2080, 2140, 2175, 2225 features, CII 2326, [NeIV] 2423, MgII, 2970, 3139, 3200 features, [NeV] 3346 (after Basu *et al.* 2000, with kind permissions of the authors and the World Scientific Publishing Centre).

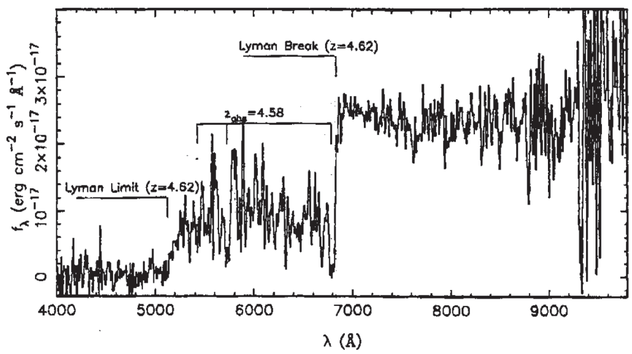


Figure 4 — Optical spectrum of SDSS 1533-00. Positions of Lyman break and Lyman limit are shown. Numerous strong absorption lines typical of Lyα forest are seen blueward of the Lyman break (after Fan *et al.* 1999, with kind permissions of the authors and the American Astronomical Society).

the kinematics of the ejection process and showed that the creation of blueshifted objects was possible.

We discuss the identification of observed lines in Section 2. In Section 3, we show many inconsistencies in present redshift identification. Section 4 deals with the determination of blueshifts in several extragalactic objects, and in Section 5 we show how to distinguish whether a spectrum is redshifted or blueshifted. Two generic scenarios are considered in Section 6 to explain observed blueshifts, and Section 7 provides a summary and conclusion.

2. Identification of Observed Lines

The "shift" (z_r or z_b), as explained above, is determined by the identification of observed emission lines. All emission lines in a given spectrum must have the same value for z_r or z_b. In contrast, absorption lines, if and when present, may be in large numbers, and may not all show the same shift. Multiple absorption lines are created by intervening material between the target and the observer, though one shift may be equal to the emission line value and will correspond to absorbing material embedded in the object itself.

Whether in emission or in absorption, a minimum of two observed lines must be matched with two distinct search lines that yield the same value of the shift for a system. If an object has more than two observed lines, all must be identified with separate search lines that yield the same shift value for a system (Basu 1973a, 1973b). For objects exhibiting a single line, other characteristics of the spectrum have to be considered for the identification, such as the profile of the line (broad or narrow), the strength of the line, and so on.

An important characteristic observed in QSO spectra is a series of absorption lines blueward of a "break" in a strong emission line (Figure 4). In the z_r scenario, the strong emission line is identified with Lyα 1216 and the "break" is called the "Lyman-alpha break" — it is caused by the absorption of high-energy photons by neutral hydrogen surrounding the emitting object. The absorption lines are believed to be due to intergalactic gas clouds along the sight line to a QSO. The absorption lines are identified with Lyα transitions at varying intervening distances and z_r values, and are collectively known as the Lyman-alpha forest. Analysis of the Lyα forest is a powerful tool to explore the distribution of gaseous matter in the Universe. The break represents the onset of the forest.

In the z_b interpretation, depending on the object concerned, the strong emission line is identified with Hα or Pα, the break with "Hα break" or "Pα break," and the forest is the Hα forest or the Pα forest. Also, the Lyman limit of 912 Å in the redshift scenario is identified with the Balmer limit at 3647 Å or the Paschen limit at 8206 Å in the blueshift scenario.

3. Examples of Inconsistencies in Redshift

Detection of one of the two strongest carbon lines, *viz.* CIV 1549 and CIII] 1909, necessitates the detection of the other. However, CIII] has been reported in the QSO Q1115+080B, although CIV is absent (Weymann *et al.* 1980), and CIV has been reported although CIII] is absent in the QSO 2333+019 (Stocke and Arp 1978), in the high-redshift galaxies 53W002, Obj 19, Obj 18 (Pascarelle *et al.* 1996), and 0316-257B (LeFevre *et al.* 1996). The value of z_r has been calculated in QSOs PG 1407+265, where all the four major UV lines — Lyα, CIV, CIII], MgII — appear unusually weak (McDowell *et al.* 1995), and in SDSS1533-00 with almost no emission features (Fan *et al.* 1999). Extraordinary physical conditions were applied for identification of the observed X-ray features in QSOs PKS 0637-752 (Yaqoob 1998), PKS 2149-306 (Yaqoob *et al.* 1999), and in the Type I AGN CXOCDFS J033225.3-274219 (Wang *et al.* 2003), to match the z_r determined from optical observations. The very high-redshift 6.8 assigned to the galaxy STIS 123627+621755 was withdrawn and its z_r is undetermined (Stern *et al.* 2000).

Observed lines in host galaxies of SNe Ia identified with Hα are often too weak for Hα, *e.g.* in 95ao, 96J, 96E (Riess *et al.* 1999), 95K (Schmidt *et al.* (1998), making these identifications doubtful.

The z_r of the host galaxy of GRB 971214 has been determined using a single line (Kulkarni *et al.* 1998), and the host galaxy of GRB990123 from absorption lines only (Kulkarni *et al.* 1999). Also, a large number of absorption lines exhibited by the host galaxies of GRBs 970508 (Metzger et al. 1997), 971214, 980703 (Djorgovsky *et al.* 1998), and 990123 (Kulkarni *et al.* 1999) have been interpreted to yield a single z_r system in each case, although 2 to 20 absorbing materials are expected for extragalactic objects at such high-redshifts (Basu 1982). The spread (difference between the maximum and the minimum values of the shift in a system) for individual emission lines in the X-ray spectrum of the host galaxy of GRB 011211 is unacceptably large, and an unprecedented outflow velocity had to be invoked to match the redshift values between X-ray emission and optical absorption features (Reeves *et al.* 2003), the latter being assumed all to originate in the host galaxy.

For z_r systems in absorption lines, the same search line has been identified with more than one observed line for the same system, a single observed line has been used without any consideration of the physical characteristics of the feature, uncertainties due to large spreads have been ignored, and a weaker observed line is identified with the lower order line of a series that is of larger strength (Jannuzi *et al.* 1998). In addition, many lines remain unidentified.

Spectra of QSO pairs across active galaxies, explained as ejected from the galaxy, have both been interpreted as redshifted, although, logically, one of the pair is expected to be ejected towards us and to exhibit a blueshift.

The triplet QSO 1009-0502 with components A,B and C has been explained by gravitational lensing of the A,B pair (z_r = 2.739) and the superposition of the closer C component (z_r = 1.627) (Hewett *et al.* 1994). However, the gravitational lensing has been found inadequate to explain the triplet and the determination of the z_r of A, is inconsistent.

BL Lac objects are thought to be a class of Active Galactic Nuclei (AGN) showing almost no emission lines though absorption lines are sometimes seen. Several models have been proposed to explain these spectra, but none appears satisfactory.

4. Blueshifts in Spectra of Extragalactic Objects

Spectra of 199 extragalactic objects comprising QSOs, AGN, very high-redshift galaxies (VHRG), high-redshift galaxies (HRGs), BL Lac Objects, host galaxies of SNe Ia, and GRBs were examined, leading to the determination of 163 emission and 140 absorption blueshift systems.

The spiral galaxy NGC1097 is surrounded by a cloud of QSOs and two pairs of radial optical jets and one non-radial optical jet (Figure 5) (Arp *et al.* 1984; Wolstencroft and Zealey 1975). Conflicting ideas were put forward to explain the configuration without success (Wolstencroft *et al.* 1984; Carter *et al.* 1984). However, the merger of two black holes resulting in the ejection of the QSO cluster seen at the end of the ejection trails can explain the configuration, where half of the ejected objects should approach the Earth. Spectra of 19 of the 32 ejected QSOs are actually found to exhibit blueshifts, the rest exhibiting redshifts (Haque-Copilah *et al.* 1997).

Of 72 QSOs lying within 120″ of galaxies, and hence "closely associated" (Burbidge *et al.* 1990), 54 exhibit blueshifted spectra (Basu *et al.* 2000). The QSOs may have been produced by the ejection process, whereby many are expected to move towards the observer.

Again, emission spectra (no absorption lines seen) of 15 QSOs

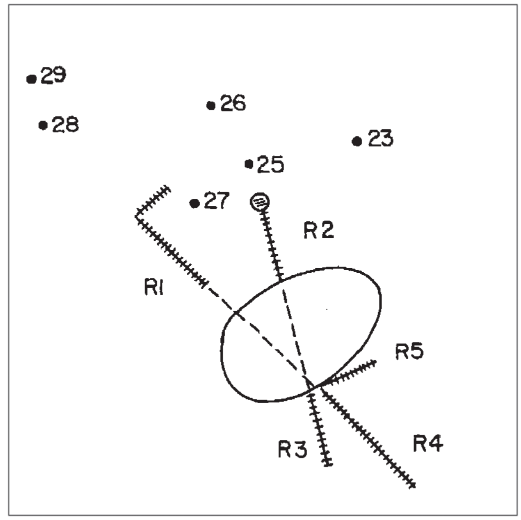


Figure 5 — Optical jets R1, R2, R3, R4 (radial), and R5 (non-radial), together with QSOs (marked 23, 25, 26, 27, 28, and 29, the numbers correspond to those in Arp *et al.* 1984) around NGC 1097 (after Haque-Colplah *et al.* 1997, with kind permissions of the authors and the Indian Academy of Sciences).

(Basu and Haque-Copilah 2001) and absorption spectra of 10 QSOs (Basu 2001a) available in the literature, were re-analyzed and found to be better interpreted as blueshifted, the latter yielding 58 absorption blueshift systems along with emission spectra that also exhibited blueshifts. Several QSOs in the sample, *e.g.* 0000-2619 and 0836+113, yield absorption z_b almost equal to the emission z_b of objects lying along the sightlines. The QSOs and the absorbers might have originated by the same mechanism as predicted earlier (Basu1982).

Furthermore, as noted in Section 3, z_r interpretation of the following objects are inconsistent, and z_b interpretation has successfully explained the observed spectra: four QSOs, *viz.* PG1407+265 (including 21 absorption systems), SDSS 1533-00 (including 4 absorption systems), PKS 0637-752 (Basu 2004), PKS 2149-306 (Figure 6), and a Type I AGN CXO CDFS J033225.3-2744219 (Figure 7) (Basu 2006a), VHRG STIS 123627+621755 (including 1 absorption system) (Basu 2001b), 15 HRGs (11 others in addition to 4 mentioned in Section 3) (Basu 1998), host galaxies of 4 SNe Ia (Basu 2000), host galaxies of 5 GRBs (including 4 emission and 10 absorption systems) (Basu 2001c, 2009a), 1 QSO in each of 4 pairs (including 2 absorption systems) across active galaxies (Basu 2006b), component A of the QSO triplet 1009-0502 (including 3 absorption systems) leading to the conclusion that A,B actually form a close pair and C an unrelated object in the field (Basu 2009b), spectra of 56 BL Lac objects (including 21 emission and 45 absorption systems), where emission lines are blueshifted out of the observed region. Absorption lines are also blueshifted (Basu 2009c).

5. Redshift or Blueshift?

The above discussion may lead to the likely question of how to choose between the two interpretations, *viz.* z_r or z_b, if and when the same spectrum can be interpreted in both ways. The equivalent

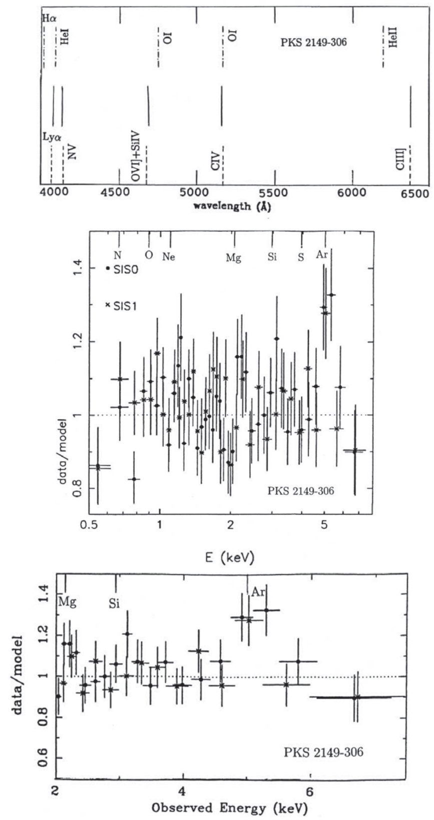


Figure 6 — (Top) Observed optical spectrum of PKS 2149-306 with the observed lines (solid) reported by Wilkes1986, (MNRAS218, 331), and lines identified as redshifted (dashed) and blueshifted (dot-dashed). identified lines are shown. (Middle and bottom) Observed X-ray spectrum of PKS2149-306. Tick marks denote positions of observed Kα energies for the elements indicated at the blueshift of the identified Ar Kα line (after Basu 2006a, with kind permission of the American Astronomical Society).

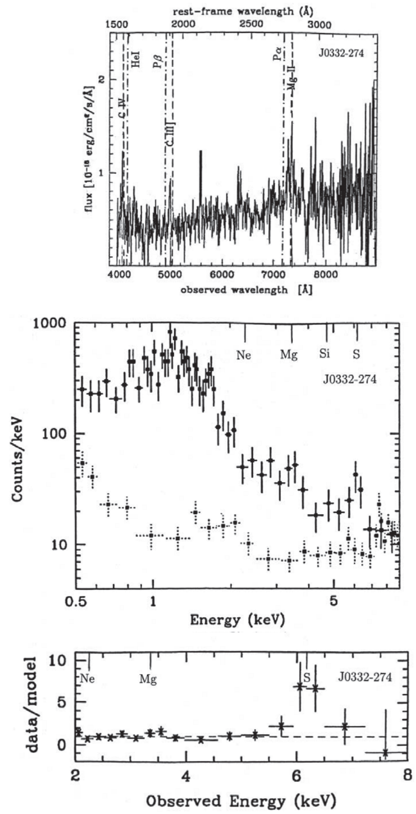


Figure 7 — (Top) Observed optical spectrum of J0332-274 with redshifted (dashed) and blueshifted (dot-dashed) identified lines shown. (Middle and bottom) Observed X-ray spectrum of J0332-274. Tick marks denote the positions of observed Kα energies of the elements indicated at the blueshift of the identified S Kα line (after Basu 2006a, with kind permission of the American Astronomical Society).

width (W) of a spectral line increases with z_r, and decreases with z_b. The effect of z_r and z_b on W can determine whether a spectrum is redshifted or blueshifted.

W_e (emitted W) were computed from W_o (observed W) in 10 QSOs for the four major UV lines (Lyα, CIV, CIII], MgII) in the z_r interpretation and also for the corresponding IR lines in the z_b interpretation, *viz.* Hα, OI 8449, [OII] 7324, [SIII] 9069, Pβ, and Pα, depending on the object (Basu and Haque-Copilah 2001). W_e in the z_r identification are much smaller than expected, whereas those in z_b interpretation are close to the expected values.

6. Proposed Explanation of Blueshifts: A Generic View

Two possible scenarios are proposed to explain observed blueshifts.

The Ejection Process

Centres of galaxies are known to contain supermassive black holes (BH), and one or more massive objects can be ejected by strong interactions between them, by the so-called "slingshot" mechanism (Valtonen 1976). The BH at the centre of a galaxy is also surrounded by an accretion disk and the latter can survive the tidal disruption resulting from the ejection process (Lin and Saslaw 1977). An AGN can be created by the interaction of the surrounding with the disk (Valtonen and Basu 1991).

Supermassive BH (primaries) at the centres of galaxies are accompanied by satellite BH of intermediate masses (Carr 1978). The merger process also ejects the satellite BH (Figure 8), and the latter can assume eccentric orbits around the primaries (Valtonen and Basu 1991). Gaseous disks are expected to surround satellite BH which interact with the surroundings, albeit, being of much smaller masses, at a reduced scale. This process would lead to the creation of smaller faint or nascent galaxies that are often seen in association with AGN (*e.g.* Giavalisco *et al.* 1994). The merger of two galaxies by the slingshot mechanism would therefore lead to the creation of an extragalactic object and several associated galaxy-like objects, the latter being in orbits around the former, would act as absorbing clouds when in proper alignment. An ejection, of course, can occur in any direction. The whole system approaches us, resulting in blueshifted emission and absorption features.

It should be noted that the ejection process does not violate cosmological laws. The observed redshift or blueshift arising from the ejection is the result of superposition of the cosmological shift and the Doppler shift.

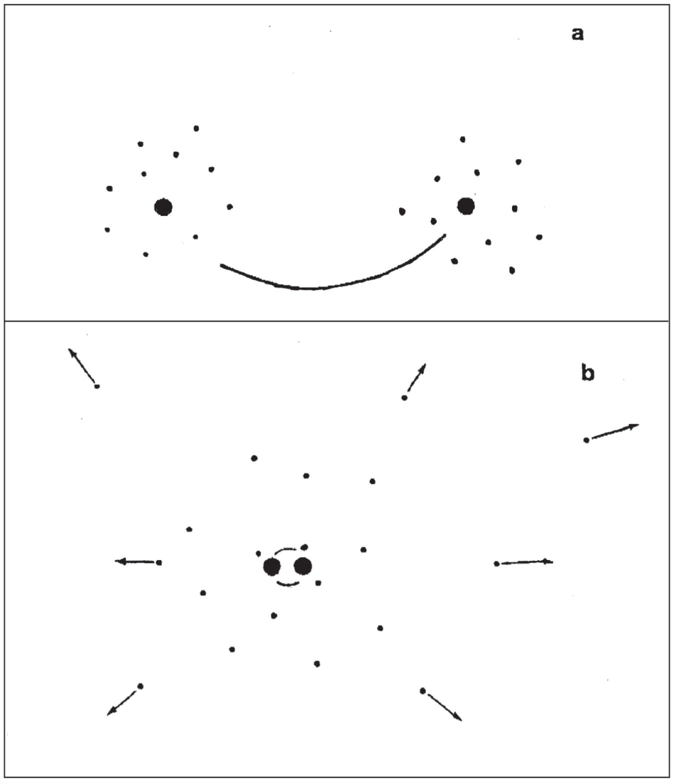


Figure 8 — Diagram representing the scenario of black holes ejected at relativistic speeds. (a) Two primary black holes with their satellite black holes, approach each other. (b) Merging of the primary black holes resulting in the ejection of satellite black holes, some of them at relativistic speeds (after Valtonen and Basu 1991, with kind permissions of the authors and the Indian Academy of Sciences).

The Multiverse

The Multiverse is defined as the ensemble of many universes and is widely accepted in the literature, although opinions vary about its characteristics. Thus, "mini-universes" generated by "creation events" and each obeying Hubble's Law (Arp *et al.* 1990), chaotic inflation leading to the process of self-reproduction resulting in "inflationary mini-universes" (Linde 1986), a spontaneously created-out-of-nothing "metauniverse" with mutually disconnected many-inflated universes predicted by quantum cosmology (Vilenkin 1995), and a parallel or disjoint collection of universes (Tegemark 1998), have been proposed. No observational evidence has been suggested so far.

Observed blueshifted spectra of HRGs (Basu 1998), host galaxies of GRBs (Basu 2001c), host galaxies of SNe Ia (Basu 2000), and QSOs (Basu 2001a) have been explained by mini-universes produced by "creation events."

Thus, our Universe comprised of clusters of galaxies, QSOs, *etc.*, expands obeying Hubble's Law. Neighbouring universes expand towards us, each obeying Hubble's Law, some of them possibly with velocities larger than the velocity with which our own Universe expands, and which may cross the "horizon" of our Universe. This makes objects in some neighbouring universes effectively approach us and we see the spectra of these objects blueshifted, although the objects are exhibiting redshifts to observers located in the reference frames of their respective universes, similar to redshifts observed by us for objects in our expanding Universe. An impartial observer therefore witnesses spectra, some of which are redshifted and others blueshifted, unaware of the host universes to which the objects actually belong.

7. Summary and Conclusion

The present article deals with some 200 objects, a rather small fraction of the very large number of extragalactic objects with known z_r. However, there has not been any search to find blueshifted spectra due to the "redshift only" mindset of astronomers. Also, there is no reason to believe that the ejection process would create objects moving only away from us and none moving toward us. Even if a small fraction of the vast number of extragalactic objects now known exhibit blueshifts, it would constitute an appreciable number (Popowski and Weinzierl 2004). If blueshifts are confirmed, the enormous impact it will have on cosmology can hardly be underestimated, as it would open up an entirely new window of research.

Recent advances in observational technology, including those obtained by spacecraft, are providing spectra that cannot be explained in terms of the conventional redshift hypothesis, but for which the blueshift hypothesis can be used to provide an interpretation. It is expected that ongoing space-based observations will bring in more data to confirm blueshifts in extragalactic objects. The on-coming *GAIA* mission will measure proper motions of more than 7000 nearby QSOs and determine whether local redshifts are due to ejections. It will certainly be interesting to see if some of these QSOs actually exhibit blueshifted spectra.

Finally, redshifts and blueshifts should be considered with equal probability when analyzing a spectrum, as one complements and not contradicts the other. Both scenarios presented above support this view.

The author thanks the Editor-in-Chief for the invitation to write this article and two editors for helpful suggestions.

References

Arp. H. *et al.* (1984). Complete Quasar Search in the NGC 1097 Field. *ApJ,* 285, 44

Arp, H. *et al.* (1990). The extragalactic Universe: an alternative view. *Nature,* 346, 807

Basu, D. (1973a). Effect of availability of search lines in determining QSO redshifts on emission line redshift distribution. *NPhS,* 241, 159

Basu, D. (1973b). Effect of the availability of search lines on the distribution of absorption-line redshifts of QSOs. *Observatory,* 93, 229

Basu, D. (1982). Distribution of identified absorption features of QSOs at different emission redshifts. *ApLet,* 22, 139

Basu, D. (1998). Are some high redshift galaxies actually blueshifting? *Ap&SS,* 259, 415

Basu, D. (2000). Are some host galaxies of SNe Ia actually blueshifting? *MPLA,* 15 (40), 2357

Basu, D. (2001a). Blueshifts in absorption lines of quasi-stellar objects? *IJMPD,* 10, 443

Basu, D. (2001b). Unusual spectra of the galaxy STIS123627+621755: evidence of blueshifts? *ApL&C,* 40, 157

Basu, D. (2001c). Are some gamma ray bursts actually associated

with blueshifting galaxies? *ApL&C,* 40, 225
Basu, D. (2004). Unusual Spectra Observed in Three QSOs: Alternative Interpretation in Terms of Blueshifts. *Phys. Scr.*, 69 (5), 427
Basu, D. (2006a). PKS 2149-306 and CXOCDFS J033225.3-274219: Two AGNs with unusual spectra possibly blueshifted? *AJ,* 131, 1231
Basu, D. (2006b). QSO Pairs across Active Galaxies: Evidence of Blueshifts? *JAA,* 27 (4), 381
Basu, D. (2009a). GRB 011211: An alternative interpretation of the optical and X-ray spectra in terms of blueshifts. *Can, J. Phys.,* 87 (6), 721
Basu, D. (2009b). Close Separation Triple System QSO 1009-0252 with Discordant Redshifts: Is the Spectrum of One Component Blueshifted? *JAA,* 30 (3&4), 133
Basu, D. (2009c). Can blueshifted AGN spectra explain BL Lac objects? *Nuovo Cemento B,* 124, 591
Basu, D. & Haque-Copilah, S. (2001). Blueshifts in Emission Line Spectra of Quasi Stellar Objects. *Phys. Scr.,* 63 (5), 425
Basu, D., Haque-Colpilah, S., & Valtonen, M. (2000). Blueshifted Quasars Associated with Nearby Galaxies? *IJMPA,* 15 1057
Burbidge, G. & Burbidge, E. (1967). *Quasi-stellar Objects.* New York, NY: Freeman & Co.
Burbidge, G. *et al.* (1990). Associations Between Quasi-Stellar Objects and Galaxies. *ApJS,* 74, 675
Carr, B. (1978). On the cosmological density of black holes. *ComAp,* 7, 161
Carter, D., Allen, D.A., & Malin, D.F. (1984). The jets in NGC 1097. *MNRAS,* 211, 707
Djorgovski, S. *et al.* (1998). Spectroscopy of the Host Galaxy of the Gamma-Ray Burst 980703. *ApJ,* 508, L17
Fan, X. *et al.* (1999). The Discovery of a High-Redshift Quasar without Emission Lines from Sloan Digital Sky Survey Commissioning Data. *ApJ,* 526, L57
Giavalisco, M. *et al.* (1994). Possible identification of a cluster of galaxies at redshift z = 3.4. *ApJ,* 425, L5
Gordon, K. (1980). The Doppler effect: A consideration of quasar redshifts. *Amer. J. Phys.,* 48, 524
Haque-Colpilah, S., Basu, D., & Valtonen, M. (1997). Ejections of Population III Objects Seen as Blueshifted QSOs? *JAA,* 18, 73
Hewett. P. *et al.* (1994). The close-separation gravitational lens candidate Q1009-0252. *AJ,* 108, 1534
Jannuzi, B. *et al.* (1998). The *Hubble Space Telescope* Quasar Absorption Line Key Project. XIII. A Census of Absorption-Line Systems at Low Redshift. *ApJS,* 118, 1
Kulkarni, S. *et al.* (1998). Identification of a host galaxy at redshift $z = 3.42$ for the γ-ray burst of 14 December 1997. *Nature,* 393, 35
Kulkarni, S. *et al.* (1999). The afterglow, redshift and extreme energetics of the γ-ray burst of 23 January 1999. *Nature,* 398, 389
Le Fevre, O. *et al.* (1996). Clustering around the Radio Galaxy MRC 0316-257 at z = 3.14. *ApJ,* 471, L11
Lin, D. & Saslaw, W. (1977). The dressed slingshot and the symmetry of double radio galaxies. *ApJ,* 217, 958
Linde, A. (1986). Eternally existing self-reproducing chaotic inflationary universe. *Phys. Letts.* B, 175, 395
McDowell, J. *et al.* (1995). The unusual quasar PG 1407+265. *ApJ,* 450, 585
Metzger, M. *et al.* (1997). Spectral constraints on the redshift of the optical counterpart to the γ-ray burst of 8 May 1997. *Nature* 387, 878
Narlikar, J. & Subramania, K. (1983). A single exhaust model for backward emission in Doppler quasars. *ApJ,* 273, 44
Pascarelle, S. *et al.* (1996). Sub-galactic clumps at a redshift of 2.39 and implications for galaxy formation. *Nature,* 383, 45
Popowski, P & Weinzierl, W. (2004). A test for the origin of quasar redshifts. *MNRAS,* 348, 235
Putsil'nik, S. (1979). Do They Observe Objects with Large Violet Shifts? *A&A,* 78, 248
Reeves, J. *et al.* (2003). Soft X-ray emission lines in the afterglow spectrum of GRB 011211: A detailed XMM-Newton analysis. *A&A,* 403, 463
Riess, A. *et al.* (1998). Observational Evidence from Supernovae for an Accelerating Universe and a Cosmological Constant. *AJ,* 116, 1009
Schmidt, B. *et al.* (1998). The High-z Supernova Search: Measuring Cosmic Deceleration and Global Curvature of the Universe Using Type Ia Supernovae. *ApJ,* 507, 46
Stern, H., *et al.* (2000). Evidence against a redshift $z > 6$ for the galaxy STIS123627+621755. *Nature,* 408, 560
Stocke, J. & Arp, H. (1978). Two quasars near a peculiar pair of galaxies. *ApJ,* 219, 367
Tegmark, M. (1998). Is "the Theory of Everything" Merely the Ultimate Ensemble Theory? *Ann. Phys.,* 270, 1
Valtonen, M. (1976). Ejection Speed in the Slingshot Theory of Radio Sources. II. General Relativistic Approximation. *A&A,* 46, 435
Valtonen, M. & Basu, D. (1991). Ejections of quasars at relativistic speeds from nearby galaxies - Ejection mechanism and selection effects. *JAA,* 12, 91
Vilenkin, A. (1995). Predictions from Quantum Cosmology. *PRL,* 74, 846
Wang, J. *et al.* (2003). A Puzzling X-Ray Source Found in the Chandra Deep Field-South. *ApJ,* 590, L87
Weymann, R. *et al.* (1980). The triple QSO PG1115 + 08: another probable gravitational lens. *Nature,* 285, 641
Wolstencroft, R. & Zealey, W. (1975). The peculiar galaxy NGC 1097. *MNRAS,* 173, 51P
Wolstencroft, R., Tulley, R.B. & Perley, R.A. (1984). VLA observations of the optical jets and nucleus of NGC 1097. *MNRAS,* 207, 889
Yaqoob, T. *et al.* (1998). A Peculiar Emission-Line Feature in the X-Ray Spectrum of the Quasar PKS 0637-752. *ApJ,* 505, L87
Yaqoob, T. *et al.* (1999). A Highly Doppler Blueshifted Fe-K Emission Line in the High-Redshift QSO PKS 2149-306. *ApJ,* 525, L9

Glimpsing Jupiter's Moons with the Naked Eye

by Clark Muir, Kitchener-Waterloo Centre (cmuir10@rogers.com)

For several centuries now, there have been remarkable and perhaps doubtful claims of observers spotting one of Jupiter's moons using nothing more than their naked eye. One claim is that the Chinese astronomer Gan De, more than 2000 years ago, observed one of the moons of Jupiter. A few other anecdotal references can be found prior to the modern era.

The first and possibly most obvious explanation of such a claim can come from an unsuspecting person not seeing a moon but rather a fairly bright star that happens to be in the background and in the precise direction of Jupiter. Without optical aid, only very careful and continued observations for several days would prove this to be the situation.

In any case, the discovery of the moons still rests very securely with the early telescope users of the 1600s. There is a profound difference between glimpsing something close to Jupiter and discovering that that object is orbiting the planet. Galileo is safe.

Yet despite this pessimism, there is still enough suspicion that, under ideal conditions, it can be done. Many modern observers, a few with excellent credentials, have claimed at least to glimpse them.

Simon Newcomb (1835-1909), just over a hundred years ago, suggested that there were clear examples of deception in this claim but also supposed that if the two outer moons appeared close enough to each other, their combined light could be spotted. Garrett P. Serviss (1851-1929) also suggested that it could be done but only by those with extraordinary vision.

The biggest obstacle in seeing the moons is their perpetual closeness to Jupiter itself. The planet's glare interferes with their direct observation. All of the moons would be fairly easy naked-eye targets if they were alone in their own orbits about the Sun. Ganymede for example can get as bright as magnitude 4.3. This is bright enough to be seen from the city!

Several times over the years, I have tried to do it; I have never succeeded. Granted, my leisurely approach of random attempts is not the best way to go about it. It is clear that for any chance of success there must be near-perfect circumstances present for even a positive spotting.

These circumstances may exist in the fall of this year. Every 13 months or so, Jupiter reaches opposition; it will occur this year on September 21. It should be noted that this is the most favourable opposition since 1951. Jupiter will be only 3.95 AU distant as the Earth passes the giant planet in our orbit around the Sun. An unfavourable opposition would only bring Jupiter as close as 4.4 AU. The dissimilarity is certainly nowhere near as dramatic as the highly publicized disparity in the oppositions of Mars, but it is perceptible.

The brightness of Jupiter will be near its peak at this time at magnitude -2.9. The brilliance can be considered detrimental if the idea is to spot one of its moons within its glare. However, this problem I believe is more than compensated, for two reasons.

The first is that the moons themselves will be brighter, since obviously they, along with the planet, are closer to us.

The other factor is that during this time there will be a slightly greater apparent separation of the moons from the planet at opportune times during their orbit. Callisto will approach a separation of 10.5 minutes of arc during this period. For comparison, the separation of Alcor and Mizar (the famous pair in the handle of the Big Dipper) is just under 12 arcminutes.

Since glare is the enemy in trying to see the moons, we should make every effort to look for them when they appear as far away from Jupiter as possible. Planetarium software can assist in determining when those conditions arise, but there are a few other things that must be considered.

It is clear that only two of the four Galilean moons present possibilities for spotting. Io and Europa are probably always too close to Jupiter. Their maximum separation is barely greater than what a keen eye could observe. When you add glare to the mix, their separation from the planet is never great enough. That leaves Ganymede and Callisto.

Ganymede is the brightest of Jupiter's moons (not just because of its size but also due to its high surface brightness). It is also the second farthest of the four Galilean satellites from the planet. This circumstance perhaps makes it the best shot to glimpse under ideal conditions.

Callisto, even though it is the dimmest of the four moons (very low surface brightness), is much further from the planet than the other three, and therefore has a distinct advantage in countering Jupiter's glare.

There is an alternative that can be tried, which involves finding a moment where there is a close grouping of two or more moons, just as Newcomb (1902) and others suggested. Jupiter watchers will know that this is by no means an unusual occurrence. The ideal condition would have to involve Ganymede while it is very close to its maximum apparent separation with another moon close by. If Callisto were, say, within 2 arcminutes or less of Ganymede, then the light from the two moons to the naked eye would appear as a brighter single source, not unlike a close double star.

Again, planetarium software can quickly tell us which nights either of the moons are at their most advantageous points in their orbits to try to spot them (Table 1). Even then, we must consider the position of our own Moon. The Moon in any phase, if it is above the horizon, will wipe out any chance at success. Jupiter also must be fairly high in the sky. If it is too low, then the Earth's atmosphere will hinder any attempt at an observation.

When all of these conditions are applied there are still a few excellent opportunities remaining to try this challenge.

The circumstances will change for different locations on Earth, since the time of moonrise and the swift movement of the Jovian satellites will modify the window of opportunity. The biggest advantage will be found in the tropics (as is often the case with anything in astronomical observing), as they will enjoy a much higher transit than we will get in Canada.

For what it's worth, the October 2011 and December 2012 oppositions of Jupiter should be just as advantageous as this upcoming one, for northern observers. Although Jupiter will not be quite as close in the next two years as it is this year, it will be higher in the northern sky, and will give viewers in Canada a better window through which to try to observe the moons.

Another strategy that can be employed to assist the search, aside from observing at a dark site, is to find a way to keep the planet's blinding light from hitting your eyes. You can use a distant antenna, radio tower, or even a car radio antenna to mask Jupiter while keeping the area immediately east or west of it in clear view.

I suspect that the predictions for success will vary from the doubtful to the outright impossible. There is also a danger of a false positive, as an observer may genuinely think they are seeing something that is not there.

Most of the chances will occur during times that many of us will be out observing anyway, if it is clear. As an added bonus, Uranus will be about a degree or so to the north of Jupiter near opposition day (they reach opposition only a few hours apart). Why not take the time and see if you can spot one of them? Include time during your session to get comfortable in an observing chair and spend a few minutes trying this unique challenge.

Date 2010	Time†	Jupiter Altitude (S. ONT)	Galilean Moon(s)	Minutes E/W of Limb‡	Notes
Sep. 5	1:00 a.m.-3:00 a.m.	45°	Ganymede Callisto	5.25 W 6.50 W	Ganymede near maximum separation with Callisto nearby. View before moonrise.*
Sep. 9	1:00 a.m.-3:00 a.m.	45°	Ganymede Callisto	5.75 E 7.5 E	Excellent! Ganymede near maximum separation with Callisto nearby. No Moon interference**
Sep. 16	12:30 a.m.-2:30 a.m.	45°	Ganymede	5.75 E	Look after moonset, just after midnight
Oct. 5-6	11:00 p.m.-1:00 a.m.	43°	Callisto	10.5 W	Huge separation. No Moon interference.

Magnitudes of Jupiter's moons at opposition

Io 4.7	Europa 5.0	Ganymede 4.3	Callisto 5.4

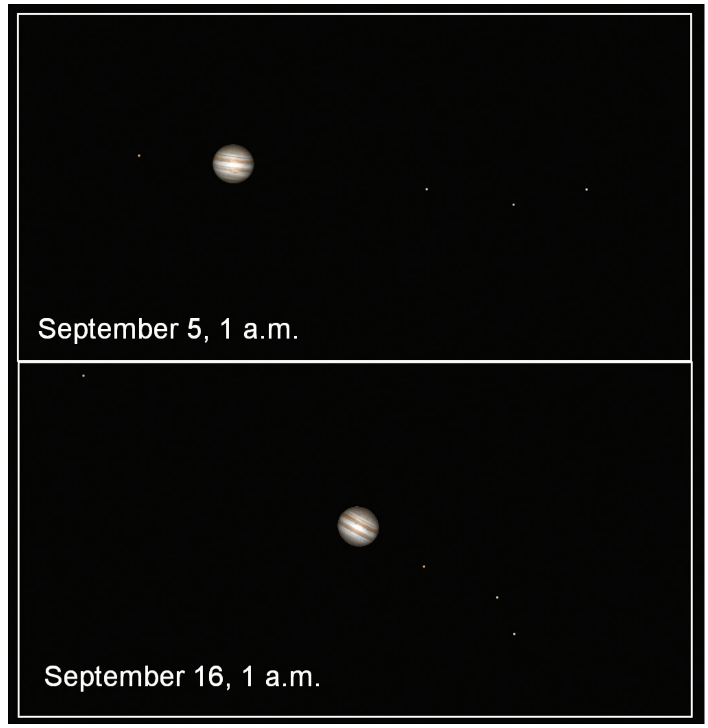
Table 1 — Optimum times for spotting Jupiter's moons

†All times are observers' local Daylight Saving Time. They are generally centred on Jupiter transit times in your region.

‡Separation is given in arcminutes, are approximate, and will vary slightly from one region to another.

*September 5 is the first of two excellent opportunities listed, with two or more moons grouped together. On this night, three moons including Europa could be close enough that the eye cannot resolve them. Their combined light may be spotted.

**On September 9, Ganymede will be close to maximum separation, while Callisto stands only about 1.5 arcminutes away.



Other opportunities exist, but only the very best chances for all regions of Canada were included in this table. It is important to observe near Jupiter transit times because of unfavourable altitudes in northern latitudes.

References

Newcomb, S. (1902). *Astronomy For Everybody,* Garden City, NY: Garden City Publishing Co.

Serviss, G.P. (1910). *Round the Year With The Stars,* New York: Harper & Brothers

Kelly, P. (2009). *Observer's Handbook.* Toronto: RASC (Thistle Printing Ltd.)

Sienna Software: *Starry Night Deluxe 2.1*

The Signs and Constellations of the Zodiac

by Jeremy B. Tatum, University of Victoria

Today, I looked at my horoscope in the local newspaper, and I found that, because I was born in late May, and the Sun is supposed to be in Gemini in late May, apparently I am a Gemini. I didn't get as far as actually reading my horoscope. I found myself more interested in the dates that were given for the 12 zodiacal signs, and I wondered if the Sun really is in these constellations on the dates given. It was while puzzling this out that I realized that the Signs of the Zodiac as known to the astrologers are really not quite the same thing at all as the zodiacal constellations that we, as astronomers, know.

Apparently, the astrologers recognize 12 "signs" of equal width, and, according to my daily newspaper, these signs, and the dates when the Sun is supposed to be in them, are as follows:

Aries	Mar. 21 - Apr. 20	31 days
Taurus	Apr. 21 - May 21	31 days
Gemini	May 22 - Jun. 21	31 days
Cancer	Jun. 22 - Jul. 23	32 days
Leo	Jul. 24 - Aug. 23	31 days
Virgo	Aug. 24 - Sep. 23	31 days
Libra	Sep. 24 - Oct. 23	30 days
Scorpio	Oct. 24 - Nov. 22	30 days
Sagittarius	Nov. 23 - Dec. 21	29 days
Capricorn	Dec. 22 - Jan. 20	30 days
Aquarius	Jan. 21 - Feb. 19	30 days
Pisces	Feb. 20 - Mar. 20	29 days

I was taught to remember them by means of the doggerel:

The Ram, the Bull, the Heavenly Twins,
And next the Crab, the Lion Shines,
The Virgin and the Scales,
Scorpion, Archer, and He-Goat;
The Man who carries the Watering Pot,
The Fish with glittering Tails.

I don't know whether this is good poetry ("shines" rhymes with "twins" and "pot" with "goat"?) but it at least has the redeeming feature that I do remember the signs.

To astronomers, the zodiacal constellations are not the same thing as the astrologers' signs of the zodiac. The zodiacal constellations, as recognized by astronomers, are the constellations through which the Sun passes in its annual journey through the stars. The path of the Sun through the stars is the *ecliptic,* which is just the plane of Earth's orbit. Many readers may be aware that the ecliptic actually passes through thirteen constellations, not just twelve, these being: Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Ophiuchus, Sagittarius, Capricornus, Aquarius, and Pisces. The "extra" constellation is Ophiuchus. And, the ecliptic misses Cetus by just a hairs-breadth.

There are several points of interest about Aries. One is that we measure Right Ascension from the point on the ecliptic where it intersects the equator at the ascending node, this point being known, for historical reasons, as the First Point of Aries. This point was indeed in the constellation Aries in the time of Ptolemy and Hipparchus, but the precession of Earth's axis has long carried it out of Aries into the next constellation, Pisces. In fact, it is close to the western boundary of Pisces, and is rapidly approaching the next constellation, Aquarius, which it will reach in about the year 2600. I wonder if we shall then still be calling it the First Point of Aries.

A second point of interest about Aries is that, although we pretend and purport to have nothing to do with astrology, we usually, when we draw the celestial sphere prior to explaining some point in spherical astronomy, still denote the First Point of Aries by the astrological symbol ♈ — or at least I do. I wonder if the printers of this *Journal* can still find such a symbol, and, if so, whether they will deign, in a scientific publication, to use it. (Hint, I found it in Bookshelf Symbol 3 — capital L.)

Yet another point (besides the First Point) about Aries is that a disconcertingly large number of Canadians pronounce it as though it rhymes with "fairies" — a pronunciation that would have made my old Latin teacher very cross indeed. I have a young Mexican student whom I had occasion to teach about the significance of the First Point of Aries, and I did not prompt her as to how it ought to be pronounced. It was a sheer delight to hear her say, on first go and without any hesitation, "Arry-ess."

The astrologers seem to use the spelling Capricorn, while we prefer the Latin Capricornus. The astrologers use the spelling Scorpio, Scorpionis, while we use the spelling Scorpius, Scorpii. Which is correct? Well, the astrologers could justly claim that Scorpio is the correct Latin spelling for a scorpion. We, one the other hand, could counter that our spelling enables us to distinguish between the arachnid *Scorpio* and the constellation Scorpius. It is interesting that my computer recognizes the astrological spellings of Capricorn and Scorpio, but it flags the astronomical spellings as mistakes. And, of course it has never heard of Ophiuchus.

How is it that the ecliptic manages to include that 13th constellation, Ophiuchus? I have heard the explanation (yes, even from astronomers, who should know better) that this is because of the precession since the time of Hipparchus. This is not right at all. The ecliptic, remember, is the plane of Earth's orbit, and the plane of Earth's orbit is certainly not affected in any way by the precession of its rotation axis. It was indeed precession that made the First Point of Arry-ess slip from Aries to Pisces, but it had nothing to do with Ophiuchus. Until 1930, the boundaries of the ancient northern constellations were very vague indeed. Precise boundaries of the newer-fangled southern constellations were established not long after they were named, but the old traditional northern constellations lagged behind. The boundaries were finally set by the International Astronomical Union in 1930, and it was how the IAU chose to draw the boundaries that resulted in Ophiuchus being straddled by the ecliptic.

The boundaries were drawn parallel to the colures of Right Ascension and the parallels of Declination for the equator of 1875.

These boundaries remain fixed relative to the stars, but, because of precession, the boundaries are no longer parallel to the RA colures and Dec parallels today. The setting of the boundaries by the IAU resulted in a few anomalies with the Flamsteed numbers. For example, the stars 37 Lyncis and 14 Leonis Minoris are now within the IAU boundaries of the constellation Ursa Major, while10 Ursae Majoris is in Lynx. It would be interesting if some reader might one day do a bit of research and give us a list of all of these Flamsteed numbers that are now in the "wrong" constellation. The problem isn't confined to Flamsteed numbers, either. At least one of the bright Bayer Greek letters was affected. The bright star in the top left of the Great Square of Pegasus, which was once known as δ Pegasi, is now not in Pegasus at all. Its current designation is α Andromedae.

To return to the zodiacal constellations, here are the dates in which the Sun is in each of the 13 zodiacal constellations. The dates may vary from year to year or according to your time zone, by one or at most two days. You may note that the Sun spends very little time in Scorpius — indeed less than in Ophiuchus — and quite a long time in Virgo. And, it is of interest to compare these dates with the dates of the astrological "signs" of the zodiac, all of which are of equal width, and do not appear to have taken the effect of precession into account. Indeed, the failure to account for precession over the last 2000 or so years means that, in a month corresponding to a given "sign," the Sun is, for most of the year, not in the corresponding constellation, but in the adjacent one. Put another way, the dates when the Sun is in a particular constellation are, for the most part, about one month from the dates when it is supposed to be in the corresponding astrological "sign." When I was born in late May (making me, according to the astrologers, a Gemini), the Sun was actually in the constellation Taurus.

Aries	Apr. 20	-	May 14	25 days
Taurus	May 15	-	Jun. 22	39 days
Gemini	Jun. 23	-	Jul. 21	29 days
Cancer	Jul. 22	-	Aug. 11	21 days
Leo	Aug. 12	-	Sep. 17	37 days
Virgo	Sep. 18	-	Nov. 01	45 days
Libra	Nov. 02	-	Nov. 24	23 days
Scorpius	Nov. 25	-	Nov. 30	6 days
Ophiuchus	Dec. 01	-	Dec. 18	18 days
Sagittarius	Dec. 19	-	Jan. 20	32 days
Capricornus	Jan. 21	-	Feb. 16	27 days
Aquarius	Feb. 17	-	Mar. 12	25 days
Pisces	Mar. 13	-	Apr. 19	38 days

Do the positions of the planets (whether in their astrological signs or in their astronomical constellations) affect our daily lives? For most people, no they don't — not at all. But they do very strongly affect the daily, and the nightly, lives of the very people who believe least in astrology, namely the astronomers. If a dark spot should appear on Jupiter, or a white one on Saturn, or if the Moon were to pass in front of a planet, or a planet in front of a star, or if a new planet were to swim into our ken, this very much affects our lives. Whatever happens to the planet causes us to get out our telescopes and stay up at night staring at it, and perhaps spend the next day doing complicated orbital calculations. The consequences of a particularly interesting planetary phenomenon might conceivably even result in a divorce. So, it just isn't true that the planets do not affect our lives. It's just not, perhaps, in quite the same way as the predictions of our horoscopes.

Dr. Jeremy Tatum is a retired Professor of Physics and Astronomy at the University of Victoria, where for 31 years he taught and conducted research on atomic and molecular spectroscopy, the composition of comets, and the orbits of asteroids — particularly near-Earth asteroids. Asteroid 3748 bears the name "Tatum" in honour of his work.

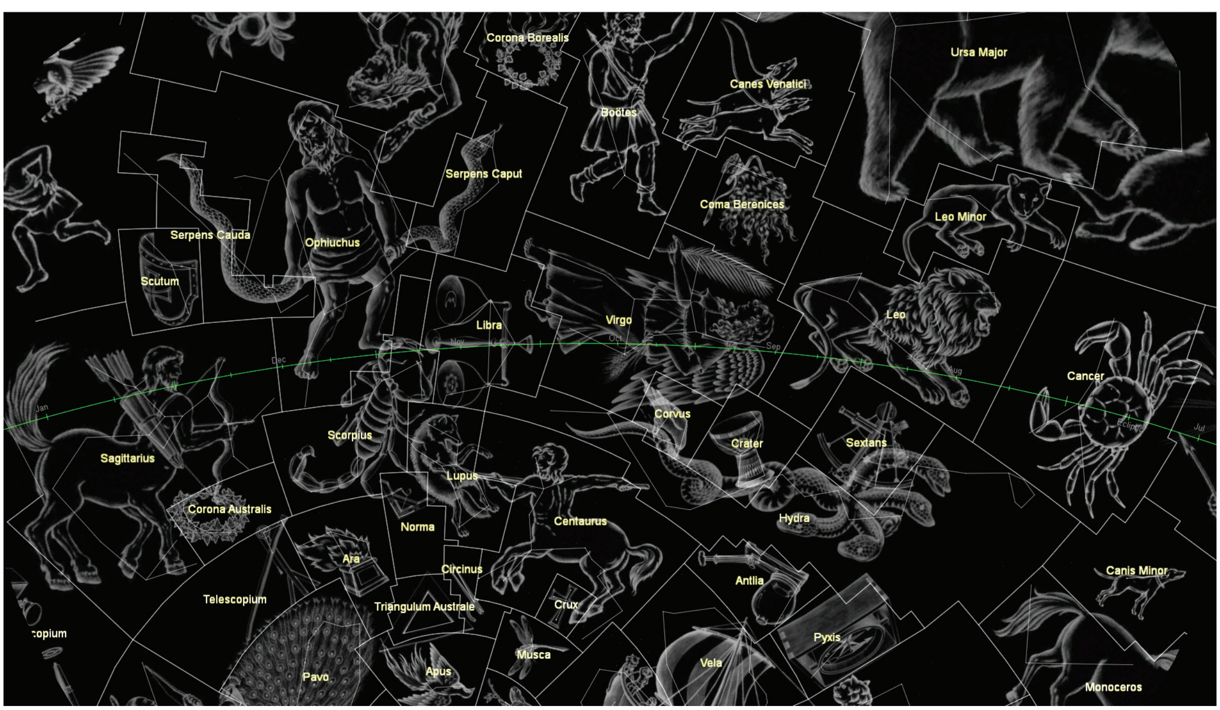


Figure 1 — The path of the ecliptic from Cancer to Sagittarius.

Solar Observing Results 1999-2009 from Starlight Cascade Observatory

by Kim Hay (RASC[1], AAVSO[2], ALPO[3]) (cdnspooky@persona.ca)

Objective

The objective of this paper is to present the solar sunspot observing results between 1999 and 2009 from Starlight Cascade Observatory (SCO) and show how they compare to results from NOAA (National Oceanic Atmosphere Association) located in Boulder, Colorado, and to results from the SDIC (Solar Dispatch Indices Centre) located in Germany.

General Information About the Solar Cycle

The solar cycle follows approximately an 11.1-year period. Solar Cycle 23 ended in December 2008 and we are now in the early stages of Cycle 24; the current cycle is expected to peak in June 2013 with a sunspot number of 70 (Figure 1) (`http://solarscience.msfc.nasa.gov/predict.shtml`). There is generally a transition period between sunspot cycles, with spots from the older cycle persisting at low solar latitudes, while those associated with the new cycle form at high latitudes. Magnetic polarity reverses from one cycle to another, making members of the new cycle easy to identify.

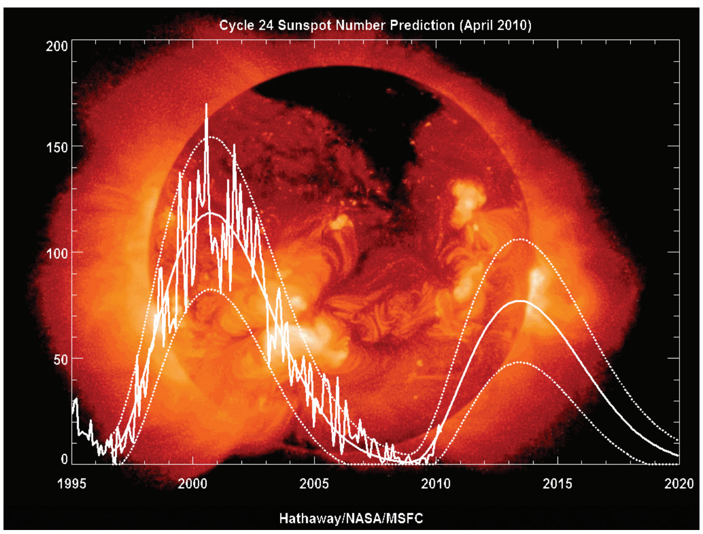


Figure 1 — Cycle 23 and predicted Cycle 24. See `http://solarscience.msfc.nasa.gov/predict.shtml` for details. Image: NASA.

Most of the data collected here is for Cycle 23; it shows the peak between 2000 and 2002, its trailing off into December 2008, and a minimal amount of growth in the first six months of 2009. Winter weather in Canada is plagued with cloudy days, rain, and snow, so the dataset has gaps. In December 2001, for instance, the count for the month was zero due to the complete absence of favourable observing conditions.

Within each cycle are Carrington rotation periods, consisting of successive intervals of 27 days, plus or minus 2 days, which correspond to the period of solar rotation. From 1999 January 1 to 2009 July 31, there were 142 Carrington cycles, denoted CR1944 to CR2086. The ALPO Solar Section uses Carrington rotation periods and the heliographic location of spots on the Sun as part of their normal solar data collection procedures; instructions can be found at `www.alpo-astronomy.org/solarblog`. The author sketches and charts each solar observation. An example of data collected by ALPO for CR2086, from 2009 July 24 to 2009 August 20, is shown in Table 1.

			Heliographic					
Calendar Date	Julian Date	Rotation Number	Lo	Bo	Po	Diameter (arcmin)	RA (HH:MM)	Dec
7/24/2009	2455036.5	2086	357.28	5.15	7.56	31.489	08:14.3	19.89
7/25/2009	2455037.5	2086	344.05	5.23	7.98	31.492	08:18.2	19.68
7/26/2009	2455038.5	2086	330.82	5.32	8.4	31.495	08:22.2	19.46
7/27/2009	2455039.5	2086	317.59	5.4	8.81	31.498	08:26.1	19.24
7/28/2009	2455040.5	2086	304.36	5.48	9.23	31.502	08:30.0	19.01
7/29/2009	2455041.5	2086	291.13	5.56	9.63	31.505	08:34.0	18.77
7/30/2009	2455042.5	2086	277.89	5.63	10.04	31.509	08:37.9	18.54
7/31/2009	2455043.5	2086	264.67	5.71	10.44	31.513	08:41.8	18.29
8/01/2009	2455044.5	2086	251.44	5.78	10.84	31.516	08:45.7	18.04
8/02/2009	2455045.5	2086	238.21	5.85	11.24	31.52	08:49.5	17.79
8/03/2009	2455046.5	2086	224.98	5.93	11.63	31.525	08:53.4	17.53

Table 1 — Carrington rotation for several days in 2009. Lo is the heliographic longitude of the centre of the disk; Po, the position angle of the north end of the axis of rotation, measured +ve if east of the north point of the disk; Bo, the heliographic latitude of the centre of the disk; diameter, the apparent diameter of the Sun; RA, Dec, position of the Sun. Ephemeris produced by Brad Timerson, ALPO

Example of Relative Sunspot Number Report

In order to compensate for variations in observing small sunspots, ALPO uses the relative sunspot number devised by Johann Rudolf Wolf (1816-1893), calculated according to the following relationship:

Relative Sunspot Number = number of Groups × 10 + Total Number of Spots

The data are assembled monthly and an average is created to produce a final smoothed Relative Sunspot Number. Tables of recent relative sunspot numbers can be found at `www.aavso.org/observing/programs/solar/means.shtml`. The author collects and submits data monthly as a part of this program. A sample of relative sunspot numbers is shown in Table 2 (permission for use granted by Paul Mortfield, AAVSO).

The AAVSO Solar Committee also works with a group of electronic observers who monitor very-low-frequency radio stations for sudden enhancements of their signals. These Sudden Ionospheric

Continued on Page 108

Pen & Pixel

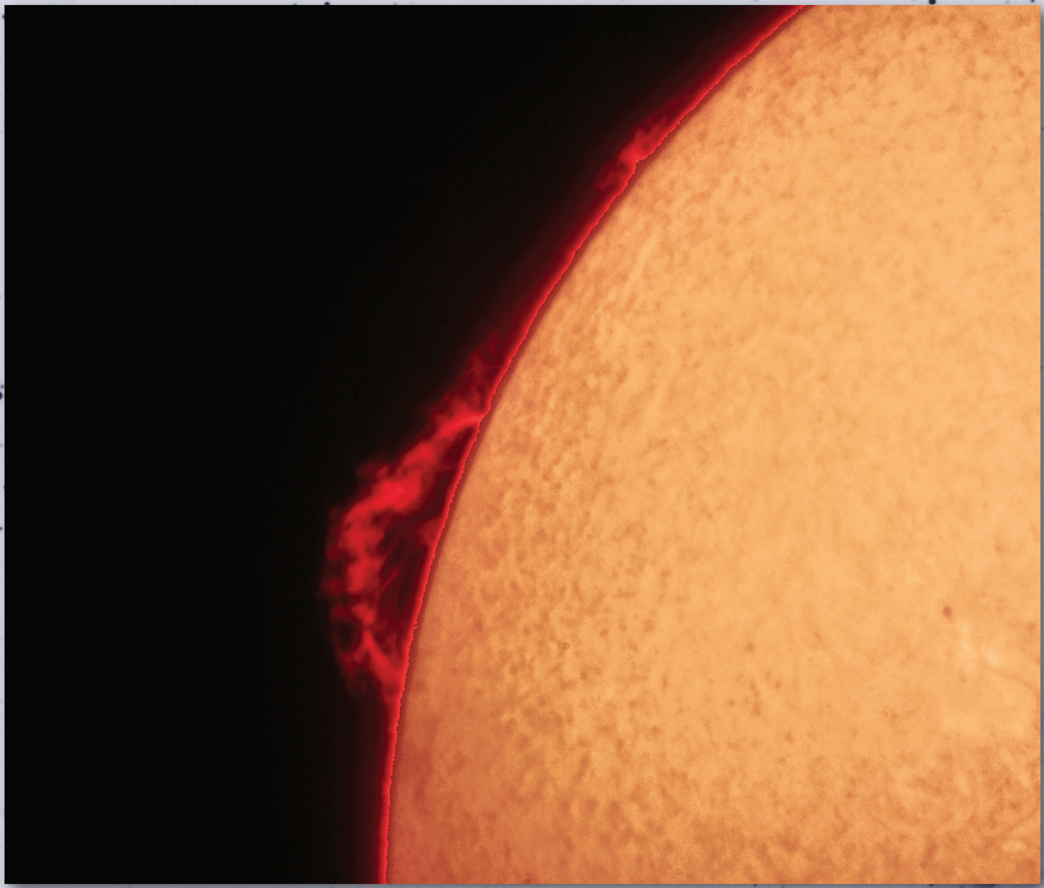


Figure 1 — Steve Irvine captured this magnificent solar prominence using eyepiece projection through a Coronado Personal Solar Telescope (PST). He replaced the lens on his Canon 50D with a 5-mm Baader Planetarium Hyperion eyepiece using a T-adapter. Exposure was 1/4 second with ISO 250 at 2:58 p.m. EDT March 16. Focussing was accomplished using the camera's live-view function.

Figure 2 — Rick Stankiewicz writes "On April 4, the skies were finally clear after sunset for the close 3-degree conjunction of our Solar System's two innermost planets. Venus was shining brightest (magnitude -4.0), but Mercury was no wilting lily at magnitude -0.7, as the attached image attests. The White Pine tree (*Pinus strobus*) appears to be reaching with outstretched arms to present the two planets in all their glory in the twilight sky." Rick used a Canon 400D camera and Sigma 70- to 300-mm lens at 119 mm, ISO 400, and a 3.5-s exposure at f/4.

Figure 3 — Winnipeg Centre's Kevin Black said goodbye to Orion as it sank toward the horizon on April 3 this year. Kevin used a 24-104-mm lens at 46 mm on a tripod-mounted Canon 5D. Exposure was 20 seconds at f/5.6.

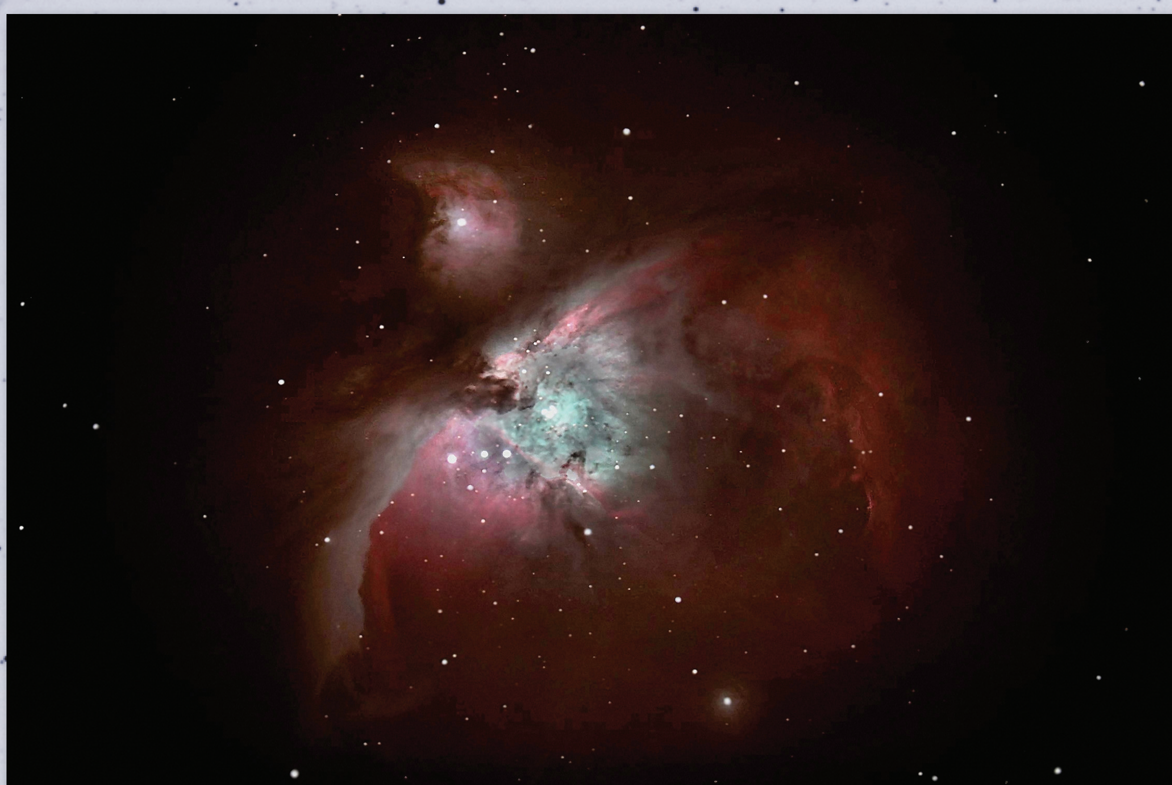


Figure 4 — Gary Boyle also paid homage to Orion in this three-filter image of M42, the Orion Nebula. More to come.

Continued from Page 105

Disturbances (SIDs) provide an indirect detection of solar flares. Familiarity with the Zurich (`www.cv-helios.net/zmci_cls.html`) and McIntosh (`http://sidc.oma.be/educational/classification.php`) sunspot classification systems are imperative for studying and learning about the dynamics of the Sun.

The Starlight Cascade Observatory Program

Equipment used at Starlight Cascade Observatory for solar observing:

Main viewing equipment:

100-mm (4-inch) SCT f/12, 1200-mm focal length
26-mm Plössl eyepiece
Thousand Oaks Type II solar filter

Other equipment:

250-mm (10-inch) Dobsonian (f/5.5 1405-mm f.l.), 26-mm Plössl, Baader solar filter
200-mm (8-inch) Dobsonian (f/6 1200-mm f.l.), 26-mm Plössl, Baader solar filter
Solar Max 60 for H-alpha observing added in 2009

All data are charted on a monthly sheet, with heliographic coordinates. Solar groups and spots are sketched on a template of a solar sphere marked with 10-degree increments from the central point.

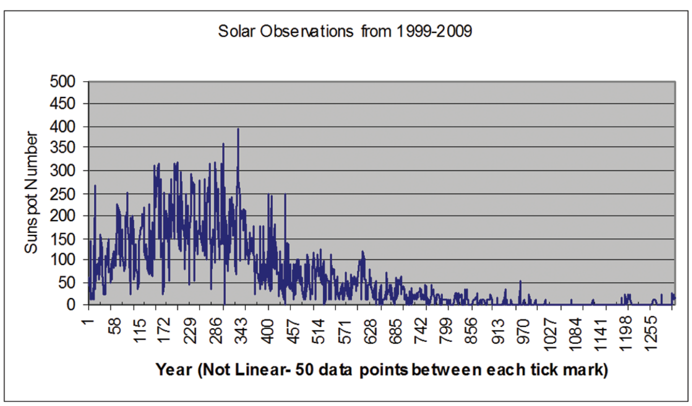


Figure 2 — Solar observations from Starlight Cascade from 1999 January 1 to 2009 July 31.

Cycle 23 had two activity peaks, of which April 2000 was the highest, with a smoothed sunspot number of 120.8; data from Starlight Cascade Observatory also showed this pattern (Figure 2). In December 2009, the Sun produced several spots numbered AR11034-AR11039, as well as several flares. The SCO data show a spike in December 2009, which fits well with the NASA statistics.

Conclusion:

Plots of sunspot data from the Starlight Cascade Observatory

Day	Number of observations	Raw Mean	Ra
1	32	0	0
2	37	0	0
3	34	0	0
4	28	1	1
5	26	0	0
6	27	0	0
7	29	0	0
8	34	0	0
9	44	0	0
10	39	1	0
11	41	1	0
12	35	1	1
13	36	6	4
14	37	11	7
15	37	9	7
16	27	8	6
17	36	7	5
18	38	8	5
19	35	1	1
20	39	1	0
21	32	0	0
22	36	4	2
23	38	7	5
24	39	0	0
25	38	0	0
26	34	0	0
27	34	0	0
28	29	0	0
29	33	0	0
30	33	1	0
31	42	12	7
Means	34.8	2.5	1.6

Table 2 — AAVSO calculation of monthly relative sunspot numbers for May 2009 (AAVSO Solar Bulletin, Vol. 65, No. 5, *ISSN 0271-8480*). Ra = relative sunspot number.

compare very well with those from NOAA and NASA. SCO is limited by weather, so data collection is not available for every day. Solar observing was done on clear days, whether observing transparency was poor, fair, or excellent. The cloud cover, wind, and temperatures are also recorded during data collection, but are not a part of the analysis.

In 2010, solar observing has been enhanced by the deployment of NASA's *Solar Dynamics Observatory*, or SDO. SDO is designed

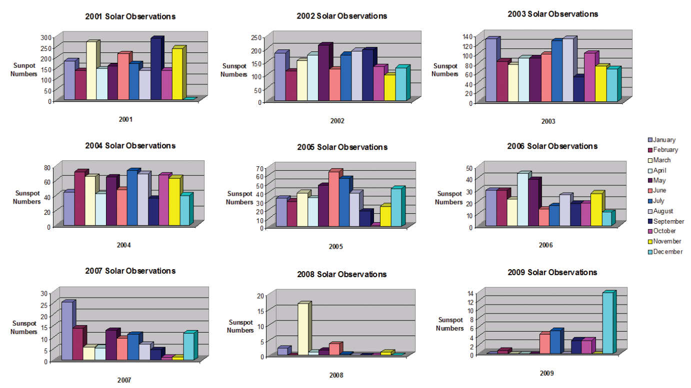


Figure 3 — Recent yearly solar observation data from Starlight Cascade Observatory.

to help us understand the Sun's influence on Earth and near-Earth space by studying the solar atmosphere on small scales and in many wavelengths. For more information on SDO see http://sdo.gsfc.nasa.gov. Starlight Cascade Observatory will continue observing the sun and collecting data, in order to have several solar cycles to compare to the prediction of Cycle 24 from NASA.

Web Links:

Solar Cycle 24 Predictions: http://science.nasa.gov/headlines/y2009/29may_noaaprediction.htm

Wolf Relative Sunspot Number: www.ngdc.noaa.gov/stp/SOLAR/SSN/ssn.html

NASA Solar Physics: http://solarscience.msfc.nasa.gov/predict.shtml; http://solarscience.msfc.nasa.gov/images/ssn_predict_l.gif

SIDC: http://sidc.oma.be/html/wolfjmms.html

Official Space Weather Advisory issued by NOAA Space Weather Prediction Center Boulder, Colorado, USA: http://swpc.noaa.gov

Space Today Online: www.spacetoday.org/SolSys/Sun/SunspotsTwinPeaks.html

Kim Hay is a member of the Kingston Centre and author of a new solar section in the Observer's Handbook*. She lives in the outskirts of Yarker, Ontario. Kim is currently the ALPO Solar coordinator, and a member of the AAVSO. Her other interests, in addition to astronomy, include heirloom seed saving, the local-food movement, and gardening.*

[1] The Royal Astronomical Society of Canada
[2] American Association of Variable Star Observers. Solar Division: HAYK; Variable Stars: HKY
[3] Association of Lunar and Planetary Observers

On Another Wavelength

by David Garner, Kitchener-Waterloo Centre (jusloe1@wightman.ca)

The Cygnus Loop and Witch's Broom

Supernova explosions blast the surrounding interstellar medium (ISM) with heavy elements. A typical supernova releases huge amounts of energy, sending a supersonic shock wave outward to the surrounding ISM at speeds of up to 30,000 km per second.

The Cygnus Loop is believed to have originated around 8000 years ago from a hot B0 massive star (perhaps 15 solar-masses) that fused heavier elements from hydrogen, including helium, oxygen, sulphur, and eventually iron. When the star finally collapsed, the resulting supernova explosion left behind a stellar remnant that was either a neutron star or a black hole, depending on its mass. If the final stellar remnant was greater than three solar masses, then it became a black hole, but it has not yet been determined which type it is.

The Cygnus Loop is a typical shell-like supernova remnant that is almost circular in shape, except that it has a large break ("blowout") region in its southern part. One explanation for this blowout is that it resulted from a lower density in the ISM in that region, whereas another explanation suggests a second supernova may have occurred in that area, leaving behind a recently discovered neutron star at the centre of the blowout.

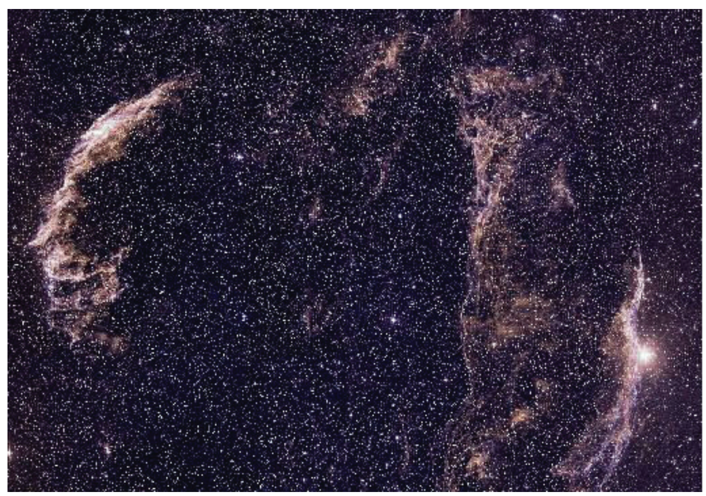


Figure 1 — This image shows the entire complex of filaments known as the Cygnus Loop.
Copyright: ESA & Digitized Sky Survey (Caltech)

The remnant of the Cygnus Loop is shaped by an expanding shockwave as it slams into the surrounding dust. The hydrogen, oxygen, and sulphur gases observed in the surrounding ISM are ionized by this shockwave, and therefore emit characteristic wavelengths associated with these elements (Hα at 656.3 nm, OIII

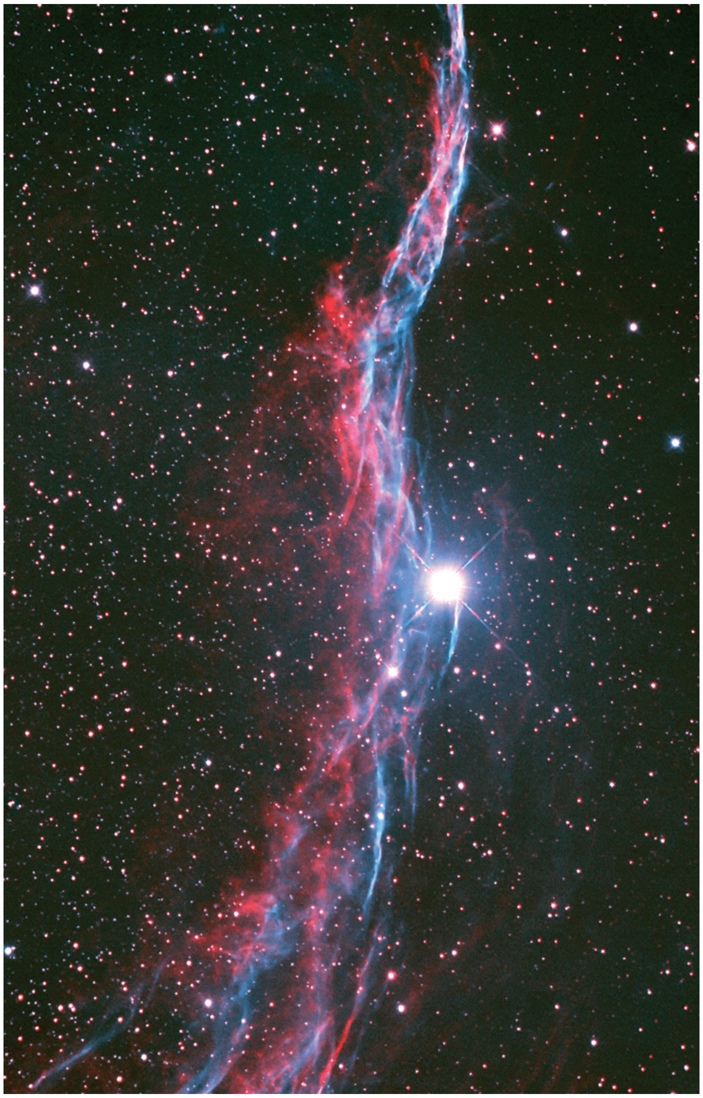


Figure 2 — The Witch's Broom, courtesy of Stephen Holmes, K-W Centre. The image is narrowband, based on 180 minutes of OIII and 310 minutes of Hα. Stephen used a QHY9 camera with Baader filters, through an 8-inch f/6.4 GSO-Ritchey-Chrétien on an EQ6 mount and autoguided with *KWIQGuide*.

at 500.7 nm, and Sulphur II at 673.4 nm). Over thousands of years, the central part of the nebula has been cleared of the dust, making background stars in this area more visible.

As we are viewing the thin shock-wave front edge on, the surrounding gas and dust of the remnant appears as a beautiful, filamentous structure that has been studied by astronomers since its original discovery in 1784 by Sir William Herschel. The Cygnus Loop is actually composed of three parts: the Eastern Veil Nebula (NGC 6992), shown on the left side of Figure 1, the Western Veil (NGC 6990) also known as the Witch's Broom, shown near the bottom right side of Figure 1, and Fleming's Triangular Wisp (or Pickering's Triangle), just above and east of the Witch's Broom. The Witch's Broom (Figure 2) is the portion of the supernova remnant that appears close to the bright star 52 Cygni, and is often photographed by amateur astronomers.

Although difficult to see at a distance of 1470 ly, the Cygnus Loop with its Witch's Broom is approximately 3 degrees across. It is

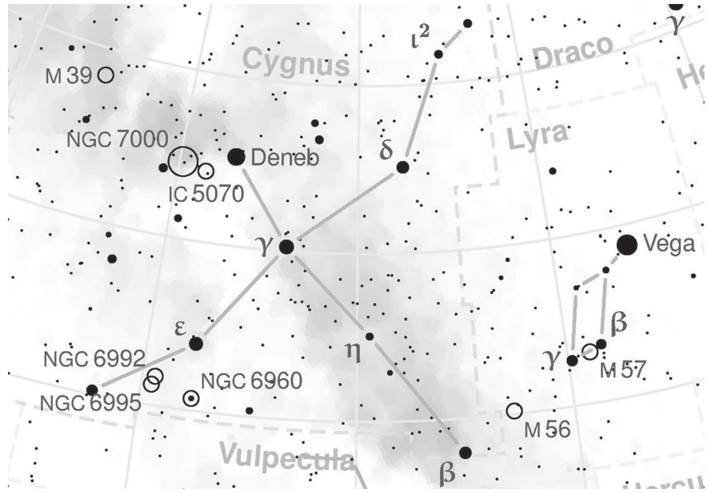


Figure 3 — A map of the constellation Cygnus.

interesting to compare this to the Moon, which is only a half-degree across. Look for it at Right Ascension $20^h\ 45^m\ 38^s$; Declination +30° 42′ 30″; it has an apparent magnitude of +7.0. The map in Figure 3 will help you to get started.

Dave Garner teaches astronomy at Conestoga College in Kitchener, Ontario, and is a Past President of the K-W Centre of the RASC. He enjoys observing both deep-sky and Solar System objects, and especially trying to understand their inner workings.

Second Light

by Leslie J. Sage (l.sage@us.nature.com)

Imaging the Eclipse of ε Aurigae

Epsilon Aurigae has been a perplexing eclipsing binary system for nearly 190 years. The main puzzle is that the eclipse lasted so long: anywhere between 640 and 730 days, and the eclipsing body was unseen. It had the further unusual feature of a brightening in the middle of the eclipse. Proposed explanations included hyper-inflated stars and even a black hole with an accretion disk, but opinion gradually coalesced around another star surrounded by a relatively opaque disk. Brian Kloppenborg, of the University of Denver, and his collaborators have now seen the disk encroaching on the surface of the star, at the beginning of an eclipse (see the April 8 issue of *Nature*).

The star was first suspected of being a variable back in 1821, and since then it has been documented to dim from an apparent visual magnitude of ~2.9 to ~3.8 every 27.1 years. The orbital elements indicated that the visible star (type F) and the invisible companion were about the same mass. For much of the 20th century, the F star was believed to be a giant with a mass of ~15 solar masses. Only recently has it been determined that it is a more normal F star with a mass of 2-3 $M_\odot$, and that the companion star inside the opaque disk is a B star.

Let's take a moment to reflect on the oddness of the eclipse. The orbital dynamics imply a motion of the eclipsing body of ~25 km/s with respect to the F star. Stars of a few solar masses have a radius of ~150 million km, and therefore, if the eclipsing body was a star, it should pass over the F star in 300 million/25 km/s, or 12 million seconds, which is about 138 days. Instead, the eclipses last about five times as long. Interested readers are encouraged to consult `www.citizensky.org/forum/history-and-evolution-disk-theory-epsilon-aurigae` to see in detail why the preferred explanation became that of a star inside a dense disk (the entry is a blog by Kloppenborg).

Kloppenborg and his collaborators used an optical/near-infrared interferometer named CHARA, run by Georgia State University on Mount Wilson, outside Los Angeles. The instrument has a resolution of 0.0005 arcsec in the H band (1.5-1.74 microns), which translates to ~0.3 AU at the distance of e Aur, or to put it into Solar System terms, just inside Mercury's perihelion. They obtained their data during early November 2009 and early December 2009, just after the beginning of the current eclipse. The figure shows the star before the eclipse started and the disk covering increasing amounts of the surface of the star.

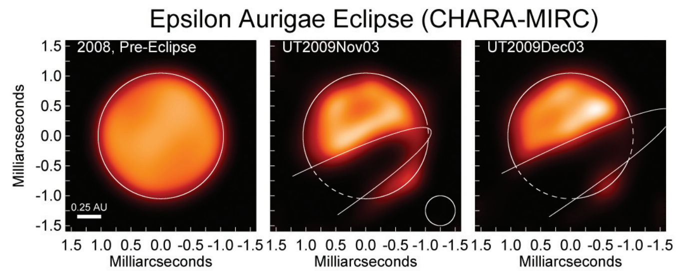


Figure 1 — The panels show the star before the eclipse started and two panels from the *Nature* paper with the disk encroaching on the star. Images courtesy of Brian Kloppenborg and *Nature*.

Based upon the observations, and fixing the semi-major axis of the disk at 6.10 milli-arcsec (from the eclipse timing), they are able to determine the properties of the disk. The semi-minor axis is 0.61 milli-arcsec, at a position angle of ~120 degrees. Between November and December, the disk moved 0.62 milli-arcsec west, and 0.34 milli-arcsec north. The maximum thickness of the disk is 0.76 AU, with a radius of ~1.75 AU, and adopting a dust density based upon the opacity of the disk leads them to conclude that the mass of dust in the disk is ~0.15 Earth masses, which is negligible compared to the stars' masses. If there is gas in the disk in the same proportion as exists in the interstellar medium, the disk could be ~100 times more massive (still dynamically negligible). But Kloppenborg concludes that the disk is more likely to be thin and tilted to the line of sight, than to be thick.

They are also able to determine that the ratio of masses of the F star to the B star is 0.62. Fixing the B star's mass to be 5.9 $M_\odot$, leads to a mass of 3.63 $M_\odot$ for the F star.

I hope you are as struck by the remarkable result as I am. To be able to image an eclipsing disk at a distance of 625 pc is amazing!

Leslie J. Sage is Senior Editor, Physical Sciences, for Nature *Magazine and a Research Associate in the Astronomy Department at the University of Maryland. He grew up in Burlington, Ontario, where even the bright lights of Toronto did not dim his enthusiasm for astronomy. Currently he studies molecular gas and star formation in galaxies, particularly interacting ones, but is not above looking at a humble planetary object.*

Through My Eyepiece

By Geoff Gaherty, Toronto Centre (geoff@foxmead.ca)

The Herschel Club

A few months ago, I was invited by the Montreal Centre to give their annual Townsend Memorial Lecture. I attended my first Townsend Lecture in 1958 when the speaker was Dr. Fred Whipple of "dirty snowball" fame, so I was in distinguished company. After the lecture, we retired to the nearest gourmet restaurant, named after an illustrious Sudbury hockey player.

I spent a bit (a Tim "bit"?) of time chatting with my old friend Constantine Papacosmas who, oddly enough, doesn't seem to have changed much in the 50-plus years we've been friends. He was bemoaning the fact that nobody in the wider world of astronomy seems to be aware that the Herschel Club is a Canadian invention, specifically another product of the fertile mind of Isabel Williamson. Constantine urged me to write about the original Herschel Club, so here goes.

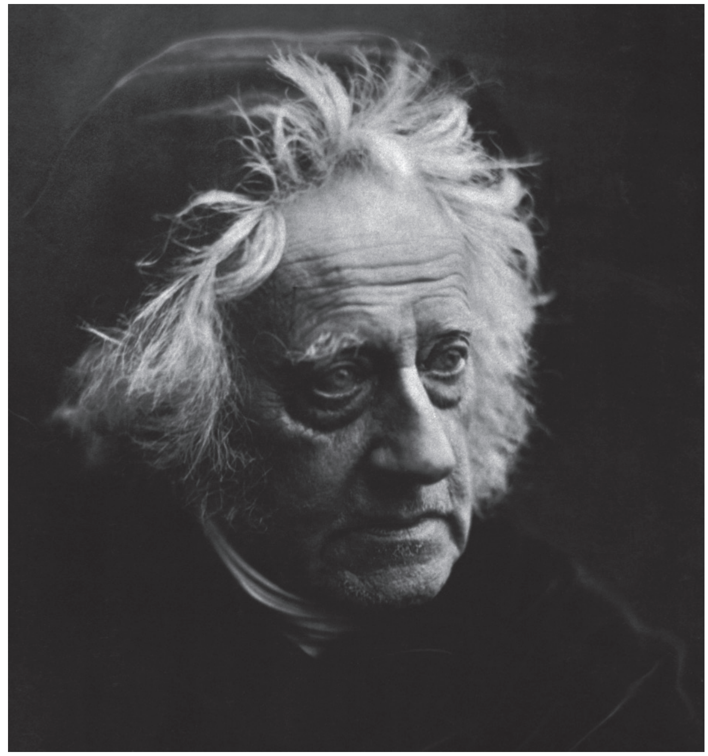
In an earlier column (*JRASC* August 2006: `www.gaherty.ca/tme/TME0608_Cosmic_Birdwatching.pdf`), I recounted the history of Isabel's most famous invention, the Messier Club. When Tom Noseworthy was on the verge of becoming the Messier Club's first graduate, he asked Isabel "What should I observe next?" to which she replied, "Well, there are always the Herschels!"

Most people took this as a joke, but a few of us, including Constantine and myself, actually made a start on observing the Herschels. Our main source of information in those days was *Norton's Star Atlas,* which plotted a number of the brighter Herschels with their original designations. We also were beginning to use the *Skalnate Pleso Atlas* that used those new-fangled NGC numbers. Both were pretty unreliable sources compared to the beautiful atlases available today.

John's father, Sir William Herschel compiled an impressive catalogue of some 2600 deep-sky objects over his lifetime. Unlike Messier, who threw everything together in one list, Herschel was more organized and divided his objects into eight categories based on their telescopic appearance:

I. Bright Nebulae
II. Faint Nebulae
III. Very faint Nebulae
IV. Planetary Nebulae
V. Very large Nebulae
VI. Very compressed and rich star clusters
VII. Compressed clusters of small and large stars
VIII. Coarsely scattered clusters of stars

At the time, Herschel was using the largest apertures that had ever been pointed at the sky, so he was able to detect much fainter objects than anyone previously, plus see detail in brighter objects that had escaped earlier observers. His categories were strictly based on observable differences, since he had no idea (at least in theory) exactly what any of these objects were in reality. I personally have a strong suspicion, from Herschel's remarks, that he was really forming some quite accurate notions about the true nature and distance of the objects he studied.



Sir John Herschel

My own observations of the Herschels were sporadic and unsystematic. In June 1959, when I was only seven objects shy of completing my Messiers, I started sneaking a few Herschels into my observing. On October 21, I completed my Messiers by observing M77 with the Montreal Centre's 165-mm refractor up behind Molson Stadium. On October 29/30, I had my first official Herschel observing session, logging six open clusters in the northern Milky Way and the famous Sculptor Galaxy, NGC 253. On my 21st birthday, 1962 March 7, I logged seven more Herschels, again mostly open clusters. That was it until I completed my second run through the Messiers in 1999, when I finally resumed my Herschel hunting after a 37-year lapse. To date, I have observed 427 of Herschel's 2600 objects.

Geoff Gaherty recently received the Toronto Centre's Ostrander-Ramsay Award for excellence in writing, specifically for his JRASC *column,* Through My Eyepiece. *Despite cold in the winter and mosquitoes in the summer, he still manages to pursue a variety of observations, particularly of Jupiter and variable stars. Besides this column, he writes regularly for the* Starry Night Times *and the* Orion Sky Times. *He recently started writing a weekly column on the* `Space.com` *Web site.*

Carpe Umbram

by Guy Nason, Toronto Centre (asteroids@toronto.rasc.ca)

Why I Sing the Blues

Everybody wanna know
Why I sing the Blues.
Yeah, everybody wanna know
Why I sing the Blues.
Well, I've been around a long time
I really have paid my dues.

From "Why I Sing the Blues," written by B.B. King, Dave Clark
(c) Pamco Music Inc, BMI 1969

I am writing this on an impossibly bright, sunny, warm early April day in southern Ontario. Snow is only a distant memory. Ice has released its grip on our lakes. The robins are back. Buds are bursting out all over. All is full of optimism for an enjoyable spring. Best of all, today is Major League Baseball's Opening Day. So why do I sing the Blues?

The winter of 2009-2010 in the Lower Great Lakes, while unusually light of snow, was heavily laden with clouds, and that's not good for astronomy. My mood is further justified by those rare clear occasions when, in attempting to observe and record asteroidal occultations, I had the target stars in view or on screen, but observed no change in brightness because, despite the best predictions, I was outside the actual occultation paths. Here are some entries in my log and messages I wrote to the Yahoo! Group of the International Occultation Timing Association (IOTA) during the last six months, which I'm sure will help you understand my mood.

2009 October 2: (302) Clarissa: Clouded out. One cloud drifted over the target star two minutes prior to the predicted time and cleared the target two minutes afterward. [Maximum duration was expected to be 6.8 seconds.] Arrgh!

2009 October 4: For me, it [the (412) Elizabetha event] was one of those "it's friggin 2:30 in the morning and the shadow is hundreds of km from here, and oh good it's cloudy and I'm staying in bed" events.

2009 November 8: Three in one night? Video-recorded low-probability event by asteroid (97461) 2000 CZ19. No occultation. [13 minutes later]: No observation of another low-probability event involving the asteroid (25469) Ransohoff. Failed to locate target star in time. [136 minutes later]: Video-recorded a possible blink by (27124) 1998 WA20, but I lost my data when I inadvertently over-recorded that part of the tape during my next occultation.

2009 November 9: (79) Eurynome: For once, the clouds held off just enough for me to observe the target star at the right time. With 100-percent confidence, I can report an observed miss. I was 6 km inside the right (south) limit so this confirms a northward shift in the path.

2009 November 14: Last night I observed ... two occultations whose predicted times were separated by only 7 minutes.

I had originally planned to travel up the east coast of Georgian Bay to get near the centreline of the (278) Paulina occultation. While there, I would also try for the (263) Dresda occultation, even though I would be [outside its path and] its predicted time was only 6 minutes prior to Paulina's.

However, the afternoon Clear Sky Chart update showed increasing cloud along the lee shores of Lake Huron and Georgian Bay, so I had to do a quick re-think. Farther inland, I found a spot I have used before, which should remain clear long enough to do the jobs, and would be reachable in time to set up for the occ'ns at 21:28 and 21: 35 EST. However, now I would be 20 km outside Dresda's left limit and [far outside] Paulina['s]. Not great, but the best I could do given the topography and the cloud situation.

Despite frightful rush-hour traffic getting out of Toronto, I made it in time and set up my station. This would be the first time I would use the user-defined object catalogue in my Sky Watcher EQ-6 GoTo mount. I preloaded the coordinates for both target stars and shuttled back and forth between them. Both landed inside the 0.3 × 0.22 degree field of my video camera [at prime focus of my 200-mm f/4 Newtonian telescope]. Great!

The first event came and went with not so much as a flicker. I waited almost 2 minutes more, then, while keeping the tape rolling, I sent the telescope to "defined object #2," Paulina's target star. It landed right on the edge of frame, but being the brightest star within a degree or so, I knew it was the one, so I centred it and went back to watching the TV screen. Three minutes to go. Two minutes. One minute. Any second now. Hmmm. Time plus one minute. Two. Three and still no change. Stopped tape and replayed. Then went back to the telescope and drifted around the area to confirm I was indeed on the correct star, which I was.

Although I failed to record either occultation, at least I got the mount to finally work right; I proved that I could do two events in quick succession.

2009 November 18: Four in one night? Not this time. From the shores of Lake Erie I was clouded out of all four occultations by asteroids (17426) 1989 CS1; (694) Ekard; (30134) 2000 FR49; and (28838) 2000 JA41.

2009 December 9: Weather forecast for the (134) Sophrosyne occultation [tomorrow] night is hopeless. [And in another email posting two days later]: ... it's a good thing I stayed home last night. Fifty cm of snow fell in the Muskoka region of Ontario that I would have had to drive through and it's still falling. Another 20 cm are expected before it ends today. If I had gone to my planned station, I'd still be there and would be *very* late for work today.

2009 December 14: No (163) Erigone for me tonight. It's raining.

2010 January 8: I was clouded out of the (11) Parthenope occultation Friday morning. Curses! Two high-probability occultations foiled in one night — the other being (139) Juewa, 4 hours 20 minutes earlier.

2010 January 10: My skies were clear but my calendar wasn't. My wife and I were just returning from an absolutely perfect afternoon of cross-country skiing about two hours' drive north of Toronto. Gorgeous conditions! Lots of dry, powdery snow; no wind; just cold enough to keep the snow perfect (~ -4 °C); pristine snow-laden trees against an impossibly blue sky. Gawd, it was soooo goooood! But exhausting. By the time I got home I was totally, but euphorically, bagged. Sometimes great weather can cause failure, too! One occultation-related side effect, though: I found a ploughed-out parking lot in the middle of the woods that's ideal for Friday's (71)

Niobe occultation.

2010 January 15: Because of poor weather prospects Friday evening, I have withdrawn my announced station for the (71) Niobe occultation.

And on and on it went until, last week, when the Clear Sky Chart predicted zero percent clouds and good transparency for southern Ontario (but overcast skies farther along the path in New England) in time for an occultation by (324) Bamberga. Several hours before the event, IOTA president David Dunham wrote to the IOTA Yahoo! Group: "It's clearly payback time for Ontario! The ... forecast shows total overcast across New England, mostly cloudy in northern New York, and clear across most of southern Ontario." After the event, I replied: "Well, of course that was the Kiss of Death! I was clouded out."

That's why I sing the Blues. However, head bloodied but unbowed, I'll persevere because "I've been around a long time and I really have paid my dues." When the successes come they make everything all right and I put away the blues for awhile!

* * * * * * * * * * * * * *

In the February 2010 issue of *JRASC,* I promised I would provide an update concerning the possible duplicity of the asteroid (234) Barbara. Since writing that article, there were two occultation opportunities in North America involving Barbara: on 2009 December 14 and 2010 January 10. Both events were observed and measured by only one person, Dr. David Dunham. All others were clouded out or otherwise unable to participate. For the former event, two of Dunham's stations — one autonomous and one staffed by himself — recorded occultations. Only one occultation was recorded during the latter opportunity. Because of the scarcity of chords, the subsequently generated profiles showed no evidence for or against duplicity. Future occultation opportunities will be flagged by IOTA for observation.

* * * * * * * * * * * * * *

Both experienced and new occultationists are encouraged to visit IOTA's Web site at `www.asteroidoccultation.com` to search for asteroidal occultations in their area. More information about IOTA and its recommended methods of recording occultations can be found at `www.lunar-occultations.com/iota/iotandx.htm`. Happy hunting!

A Moment With…

by Phil Mozel,
Toronto and Mississauga Centres (dunnfore@gmail.com)

Dr. Sabine Stanley

If you like science, you are a nerd. Such is the opinion in some quarters. Some resent the term while others seem to embrace it. Dr. Sabine Stanley, besides being a researcher, teacher, and role model, is unabashed about her status and has actually served on "Team Nerd"...in public...and conversed with Klingons!

I suppose that brings everything full circle since Dr. Sabine Stanley was, in part, motivated by the television show *Star Trek: The Next Generation.* She had, at one point, wanted to be a doctor, but high school fanned her interest in math and physics. At university, she originally looked to cosmology but soon decided that something closer, more tangible, almost "hands on" would be more suitable. The planets fit the bill. After all, one can imagine actually going there. Her first physics course at the University of Toronto happened to be taught by a geophysicist, Jerry Mitrovica, and his mentorship piqued her interest in that particular field. After completing her degree, she headed to Harvard to earn her Masters and Ph.D. degrees.

Magnetic fields have long provided an attraction for Dr. Stanley, particularly those harboured by other planets. Such fields are generated by a dynamo in the planet's core. Earth, of course, has a field today but Mars no longer does. Instead, magnetic fields frozen into its crustal rocks are the only vestiges of an ancient dynamo that was active in the planet's early history. Oddly, Mars' crustal magnetic field is much stronger in the southern hemisphere. This hemispheric dichotomy is reflected in the surface features of the planet too: thin, low-lying crust, with infill burying many of the craters in the north, and thick, elevated, crater-covered crust in the south.

Previous workers had suggested mechanisms for the creation of the crustal dichotomy, for example, a Pluto-sized object could have struck Mars with a glancing blow in the northern hemisphere, blasting away a large amount of crustal material (hemispheric dichotomy explained). Dr. Stanley and her colleagues proposed that this same mechanism could explain the odd magnetic field. The heating produced by the impact in the northern hemisphere resulted in the northern core-mantle boundary being hotter than that of the south and this affected the liquid metallic core of the planet where the magnetic field was created. The conveyor-belt motions of molten iron (think lava lamp) forming a dynamo would work properly only in the southern hemisphere (magnetic dichotomy explained). There is further fallout from these ideas. Since the poles of Mars' unusual magnetic field would not have lined up with the planet's rotational poles, studies of Mars' past rotational behaviour based on magnetic data would no longer be valid. In addition, with little or no field in the north to protect the atmosphere from the solar wind, the air would tend to bleed out of this leaky "valve." The dynamo theory has so far been modelled on a super computer, and further study with planetary spacecraft will be sought to verify its essentials.

Dr. Sabine Stanley

Mercury also has a magnetic field. Discovered by *Mariner 10* in the 1970s, this field could be the result of a currently active dynamo or merely a remnant crustal field like that of Mars. At one time, the expectation was that a planet this small would have cooled off and the core would have become solid long ago, shutting down the dynamo. That this might not be the case could be the result of "antifreeze." Elements like sulphur, mixed in with the iron in

Mercury's core, have lowered the freezing temperature, keeping the core molten.

Mercury is in the news again due to the three recent flybys of the *MESSENGER* spacecraft. Dr. Stanley is excited about *MESSENGER* since she has published dynamo models to explain Mercury's magnetic field that can be tested with upcoming data from the mission. In fact, Dr. Stanley did post-doctoral work with Dr. Maria Zuber, chair of MIT's Department of Earth, Atmospheric and Planetary Science, who is leading the analysis of *MESSENGER*'s Mercury Laser Altimeter data.

Dr. Stanley has also provided guidance to the Canadian Space Exploration Working Group, Planetary Geology and Geophysics section, helping decide what to focus in on studies of the terrestrial planets, *e.g.* searching for water, impacts, the Martian magnetic field (of course!), the development of the Tharsis bulge, and the size of the core of the Red Planet. To accomplish the latter goal, she (and others) has suggested the placement of several seismometers on the surface. This was actually to have been done by the European Space Agency's *NetLander* mission now, unfortunately, cancelled. Similar future missions will hopefully fly and provide a vast array of new data on the Red Planet's interior.

I asked about the magnetic fields of the gas giants, supposing that they are produced by mechanisms different from those of the terrestrial planets. Apparently not; a dynamo is still responsible. Surprisingly, in some ways it is easier to study such fields on these planets than it is on Earth. The reason is that, on worlds like Earth, there are many sources of magnetic fields (*e.g.* remnant crustal fields), and these can mask, and make difficult to study, the main field produced by the dynamo. On Jupiter, there are no rocks, so the field is simply from the dynamo. In this case, atmospheric hydrogen changes from an insulator to a conductor not all that far down, so the dynamo there is easier to study than it might otherwise be. On Earth, one must "dig" very deep to find the details of the field.

Moving from the very large to the very small, Dr. Stanley is also interested in certain types of meteorites, *i.e.* angrites, and their parent bodies. Angrites are a rare type of achondrite and are thought to be the oldest igneous rocks, having crystallized over 4.5 billion years ago, and thereby preserving information about the Solar System's earliest history. Part of that information involves these meteorites' magnetism, most likely a remnant of their parent body. Even a small object could have a magnetic field generated by a dynamo for a short time, although other sources of magnetism are possible. Dr. Stanley would like to decode the message of these meteorites to see what was happening as Earth and the other planets were being born. Muddying the picture is the possibility that Mercury is the source of the meteorites, although its current field does not seem strong enough to have played a role.

Sending a spacecraft to study asteroids and their magnetic fields would be very helpful and, as it turns out, the *DAWN* spacecraft is already on its way to Ceres (now categorized as a dwarf planet) and Vesta, due to arrive at the latter in August 2011. Unfortunately, the magnetometer was cut from the mission, so this avenue of research seems closed. But, Dr. Stanley says this problem might be worked around by looking at the asteroids' regolith. The colour will depend on how much it has been exposed to the solar wind, which, in turn, depends on whether a magnetic field was present at some point. Stay tuned!

Like other women scientists profiled in these pages, Dr. Stanley is very concerned by the under-representation of women in science and takes seriously being a role model. She is involved in Girls Rock Science, monthly workshops in the physical and mathematical sciences for high-school-age girls held at the University of Toronto. In this series, she gives a computer workshop on chaos, and has students generate fantastic images of strange attractors and fractals. Once, when discussing the physics of figure skating to a group of young ladies, a "chalk talk" simply wouldn't do; demonstrations took place on the ice with the help of a figure skater. Her excellence in teaching has been recognized both at Harvard and the University of Toronto.

As for being a nerd, the cat is definitely out of the bag. She had "tons of fun" serving on the "Nerds" team on CBC Television's Test the Nation, and admits that great embarrassment would have ensued had her team lost (luckily, the Nerds finished first ahead of five other teams). Dr. Stanley was easy to spot, seated beside a Klingon (who, at one point, leaned over and admitted that some of his friends found his fashion choices "strange").

As can be seen from magazines, books, podcasts, documentaries, discussions with scientists such as Dr. Stanley, and so on, we are in a golden age of science. It would seem that the same might be said for nerds!

Phil Mozel is a past librarian of the Society, and he was the Producer/Educator at the former McLaughlin Planetarium. He is currently an educator at the Ontario Science Centre.

Gizmos

by Don van Akker, Victoria Centre (dvanakker@gmail.com)

Don't Wait Until Dark

It's June and the star-party season is upon us. Once again, all over the continent, like-minded people will gather in dark places to look up and look out. Look up in wonder at the splendour of the Universe and look out in horror of the person who opens a car door and ruins two hours of dark adaptation with a blinding flash from klieg-like dome lights or even headlights.

Sure they turn them off when the yelling starts, but that doesn't get rid of the afterimage that's burned into your retina, and it will be a full half hour before you can even hope to see that faint fuzzy again, and by then it's gone behind a tree.

It's even worse if you are the one making the light. The instant disapproval of all those people you were trying to impress with your camp and your cool makes you want to crawl into a hole somewhere — a dark hole.

But, what can you do when you can't stay the night and you must start the car, or what you need is in it and you must open the door?

Actually, you can do something but it needs to be done before you go, or at least before it gets dark.

Dome lights are usually the easiest. Every vehicle is different but most will allow you to decide if the dome lights come on when you open the door. Look for a switch on the light itself. It will likely have three positions: on all the time, on when the door is open, or off all the time. Open the door to make sure you have it right. Also

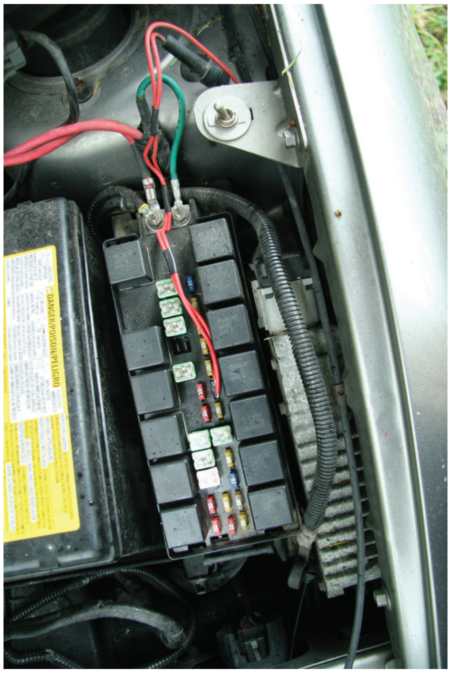


Figure 1 — The fuse box in a 1999 Dodge minivan. The large black squares are relays. Leave them alone. The smaller rectangles are high-capacity fuses. Leave them alone too. The much smaller coloured rectangles with numbers on them are the fuses. Find out which circuits they protect from the diagram on the lid or from the owner's manual. The daytime headlight fuse in this car was replaced by a switch with wires soldered to the tangs of a fuse and inserted into the socket. Such a circuit must be equipped with an in-line fuse.

common is the thumbwheel on the dash that dims the instrument lights. All the way up turns the dome lights on, anywhere in the middle and they come on when the door is opened, all the way down and they are off.

A last resort for dome lights is simply to pull the bulb(s). Remove the translucent cover, usually by squeezing the sides or ends, and remove the bulb. Push it in, turn counter clockwise about a quarter turn and pull straight out. On newer vehicles just pull on the bulb. It should come straight out.

The headlights are more difficult. All vehicles now have full-time daytime headlights that generally come on with the ignition. If the ignition is on, the lights are on and you can't turn them off, at least not with a switch. But try the emergency brake. In many vehicles the daytime headlights are off when the emergency brake is on, so engage the brake only part way, just far enough to activate the switch but not far enough for the brake to grab.

If the emergency brake trick doesn't work, it's time to look at the fuses. Every circuit in a vehicle is protected by a fuse; if you pull the right fuse, the lights stay off.

Your owner's manual is a good place to start. It will tell you where the fuse box is and what the fuses are for. But, what if you don't have the owner's manual? What if you bought a new telescope instead of a new car?

The fuse box is made of plastic and it is generally black or gray. It will be located in plain sight under the dashboard or to one side under the hood. It will have a cover secured with a snap or clip, and

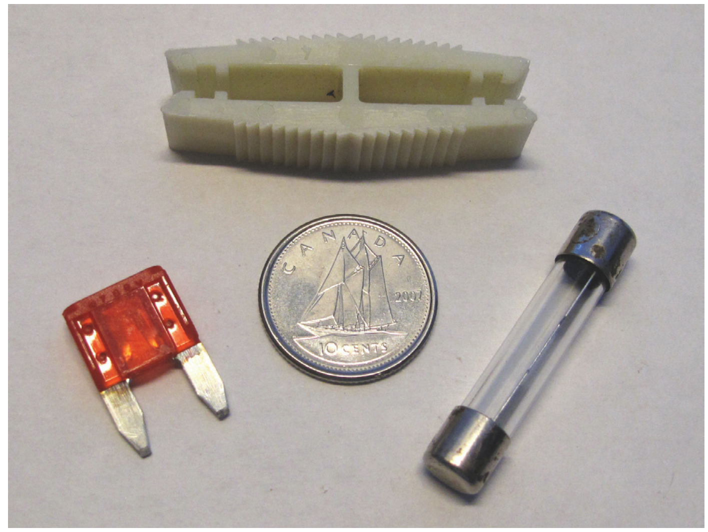


Figure 2 — On the left is the bayonet fuse, now standard in most vehicles. Above is the plastic fuse puller that is clipped inside the panel cover of a Ford pickup truck. On the right is the glass tubular fuse common in older vehicles. It can be removed with a similar puller, or a hook made of wire, or, often, just with your fingers.

often a diagram showing the fuse layout will be glued or embossed on the inside of the lid. The descriptions will probably be a little cryptic, but should be understandable.

Fuses come in a number of different styles but almost all modern vehicles use the bayonet type, consisting of a plastic body with two metal prongs (like a miniature appliance plug without the cord), that pushes into a socket in the box. They can be pulled with a pair of needle-nose pliers or with the little puller that is clipped to the fuse panel of many vehicles.

The number on the face of the fuse (10, 15, 20, or the like) represents the capacity of the fuse in amperes. It must be replaced only with a fuse of the same value. If the value is too low, the fuse will blow when you turn on the circuit that it protects. If the value is too high, the circuit will not be protected adequately and could, in the worst case, cause a fire under the hood of your car.

Another word of warning here: 12-volt power systems are not dangerous to work around. You can touch an exposed contact without feeling a shock, but if you cross those contacts with a metal tool, like pliers or a screwdriver, there will be a blue flash that might not be so harmless, so be careful!

If that scares you, there is a low-tech solution - just cover the lights. Hang a coat over them and duct tape it to the hood. Don't ignore the tail lights. They may be red, but they are also bright, much too bright for the exquisite sensitivity of dark-adapted eyes, so hang something over them as well.

The message here? Don't wait until dark. Think this through, and decide what you are going to do about your lights before you are forced to turn them on. It will help your friends keep their night vision and it will help you keep your friends.

Don van Akker is a member of the Victoria chapter. He observes with his wife Elizabeth from their home on Salt Spring Island. He learned about this stuff the hard way. Don can be contacted at dvanakker@gmail.com.

Society News

by James Edgar, Regina Centre (jamesedgar@sasktel.net)

National Council gathered for the first meeting of 2010 (NC101) in Toronto on Saturday, March 27. Some noteworthy items stemming from that meeting are:

- The Public Speaker Programme, resurrected from the now defunct Speaker's Travel Assistance Programme (STAP) and the Centre Project Fund, has been declared active and we await applications from Centres to host speakers for public talks at their locations.
- The following names are put forward for the respective positions, to begin July 4:
  - Mary Lou Whitehorne — President
  - Glenn Hawley — 1st Vice-President
  - Colin Haig — 2nd Vice-President
  - Mayer Tchelebon — Treasurer
- Jay Anderson has been appoint *Journal* Editor for an additional two-year term
- Dave Lane has been appointed as *Observer's Calendar* Editor for an additional one-year term
- The new chair of the Observing Committee is Chris Beckett; Paul Gray has stepped down from that position, but remains on the committee
- National Council approved the plan to hire an Executive Director, which will proceed forthwith
- Council approved a $3 increase for regular members, and held Youth memberships to no increase
- Winnipeg Centre will host the 2011 General Assembly to mark their centenary in the RASC
- Edmonton Centre will host the 2012 General Assembly to mark their 80th anniversary

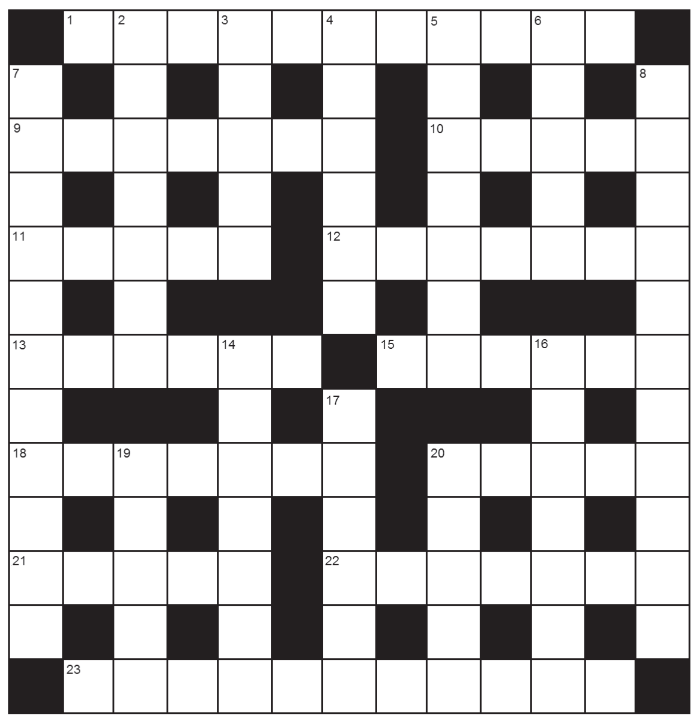
On a sad note, I was advised of the passing of long-time Edmonton Centre member Ed Newcombe, who died on March 30. Our condolences go out to his family and friends.

And, further, we express our sincere condolences to National President, Dave Lane, whose father passed away on April 8, after a lengthy struggle against cancer.

Astrocryptic

by Curt Nason

Cryptic Advertising for GA 2010



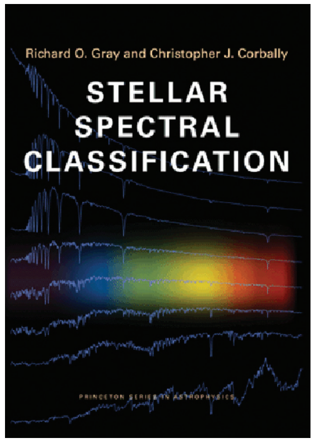
ACROSS

1. Whipple and Idle not returning to the host city (11)
9. Quality eyepieces with a 57º field of view? (7)
10. Temperature turning poor at this sphere in the air (5)
11. Binocular perception studied at the Department of Health (5)
12. Rocketeer Willy returns in evenings to look through it (3,4)
13. Saturn turns with a south-east shift in all of the Universe (6)
15. Curse about everything first done by Perseus for Andromeda (6)
18. Giant is a midnight riser for GA2010 (7)
20. Not a giant battle in dynamic friction setting (5)
21. Constellation to watch from a sailboat off St. Andrews (5)
22. Ring in spiral movement around unmoving star (7)
24. Confused, he adds field ferns at the banquet (11)

DOWN

2. Jupiter oddly sported this feature (3,4)
3. Extinction measured across or inside a thinned chip (5)
4. Pattern of lines in images of the outer asteroid belt (6)
5. Nebula yeast turns up in Canadian Encyclopedia (4,3)
6. Solar UV absorbed by it when one follows Baum's land (5)
7. Jockey brand in a twist at the old observatory (7,4)
8. Tosses rich field eyepiece into quiz at the Maritime bash (11)
14. Stared wildly around the edge of Eridanus when stunned again by police (7)
16. Ran the AGM like Cassiopeia (7)
17. Upset the French star like Polaris (6)
19. Lab dish comes across telescope tripod (5)
20. Seaweed slued around in the hospitality suite (5)

Reviews/Critiques



Stellar Spectral Classification, by Richard O. Gray and Christopher J. Corbally, pages 592+xvi, 16 cm × 24 cm, Princeton University Press, 2009. Price $65 US, paperback (ISBN-13: 978-0-691-12511-4).

For the past 55 years, the art of two-dimensional spectral classification has been knowledge gained through years of practical experience as well as information passed along verbally by those fortunate enough to have learned the trade from W.W. Morgan or his students. Up until 20 years ago, it was also something learned from peering closely at widened photographic spectrograms through microscopes or spectrocomparators, carefully matching features of the spectrum of a program star with those observed in the spectra of comparison stars of known spectral type. As an art form, spectral classification also bore no relationship to one's abilities in other areas; some of my best students academically failed miserably when it came to spectral classification, while "lesser lights" excelled at it wondrously with minimal instruction. Knowledge of which spectral lines and line ratios to use as sensitive temperature or luminosity indicators is spelled out on the charts of several spectral atlases, including the MK Atlas itself, but rarely in much detail. Most spectral atlases are also difficult (or impossible) to obtain these days, and it is often a challenge to compare the relative intensities of lines in CCD spectra with those observed visually on atlas prints. So how do you pass on such knowledge without recourse to individual instruction? My own solution was to produce copious notes for student use over the years, complete with whatever reference spectra were available, but it was never a good option.

Richard Gray and Chris Corbally have managed to solve that long-standing problem elegantly with their textbook on *Stellar Spectral Classification*. Finally there is a reference manual that contains all of the information of the MK Atlas along with the physical rationale behind the choice of spectral line ratios to use for accurate temperature and luminosity classification, illustrated with copious examples of CCD spectra demonstrating the features discussed in the text, along with the extra dimensions — stellar rotation, anomalous chemical abundances, emission, *etc.* — that make spectral classification a true art. *Stellar Spectral Classification* is more than just a new entry into the literature on spectroscopy; it is a reference work that is likely to stand for many years to come as the definite "must have" for any astronomer for whom work with stellar spectra forms a frequent component of their research. In an era when monographs seem to be a vanishing component of the offices of university faculty, *Stellar Spectral Classification* ranks with the various published works — dictionaries, course textbooks, calendars, *etc.* — that no office should be without. My review copy will soon take its rightful place in my own office library.

As implied by the number of pages of text, *Stellar Spectral Classification* is a complete study of the characteristics of stars of every temperature class in the well known spectral sequence: O, B, A, F, G, K, M, L, T. The main chapters are written by the two lead authors, while specialty areas are discussed in separate chapters by contributing authors who are known experts in the field. Thus, for example, the chapter on OB stars is by Nolan Walborn, M and L dwarfs are discussed by Davy Kirkpatrick, and T dwarfs are discussed by Adam Burgasser. The result is some unevenness in the writing style, although that is probably justified by the uninterrupted high quality of the final product. The individual authorship for the remaining chapters appears to be dominated by the writing of Richard Gray, if my previous experience at reading the papers of the authors is any indication, but both clearly contributed to the end product. The appendices also contain handy lists of standard stars, as well as effective temperature and absolute magnitude calibrations that may well become earmarked through frequent use. The authors clearly put considerable thought into what the book should contain to maximize its usefulness for readers.

As expected for a textbook on spectroscopy, the introductory chapters also include a discussion of the physical basis for the information gleaned from stellar spectra, as tied to basic concepts about the sources of continuous and discrete absorption (and emission) of light in stellar atmospheres. It is important to gain a working familiarity with the Saha and Boltzmann equations, if one is to understand the physical basis for the temperature and luminosity sensitivity of certain spectral line features or line ratios. All of that is covered in the early chapters, and in most cases the descriptions are quite eloquent. The one exception may be the description of the temperature and luminosity sensitivity of the hydrogen Balmer lines, which, although complete, tends to be overly long. There is also a noticeable change in writing style as one encounters chapters written by the contributing authors, which I found detracts from the book's pedagogical usefulness.

The text has other weaknesses. Chapter One, for example, contains lovely reproductions of photographic spectra from several of the older spectral atlases, including the detailed 1977 Yamashita atlas, one of my personal favourites, yet the figure from the atlas is never actually referred to in the text. The useful combination of spectral classification with photometric data is also referred to briefly in a section on complementarity, but without further elucidation. Perhaps another contributing author should have been added? The method of citing journal references in the bibliographies at the end of each chapter is also a curious mixture of standard usage with something concocted by the authors. Abbreviations such as ApJ and AJ for the *Astrophysical Journal* and *Astronomical Journal* are standard these days, but the journal *Astronomy and Astrophysics* is abbreviated as A&A not AA (much too close to AcA used for *Acta Astronomica*). Likewise, DAO publications are referred to using the old IAU designation of *Publ. Dominion Astrophys. Observ. Victoria,* compared with PDAO in current usage. The same is true for *Bull. Astr. Inst. Netherlands* instead of BAN and *Baltic Astronomy* instead of BaltA. For that matter, proper IAU shorthand is *Astron.* not *Astr.*, which accentuates the confusion.

The written text also leans closely towards the style often promulgated in scientific journals, which contains standard grammatical errors (dangling gerunds, in particular) that detract from readability (do I sound like a former *JRASC* editor frustrated by how the English language is abused by scientists?). A wonderful feature of English is its rich vocabulary, which is why I find it tiresome to have explanations for various spectral features characterized by a dozen or more "due to" this or "due to" that on a given page, even if the term is used correctly? Such pitfalls only provide fuel for people like Robert Hartwell Fiske (The Grumbling Grammarian), author of *The Dictionary of Disagreeable English,* but they also describe interesting (dare I say, exciting?) atomic phenomena in extremely passive and repetitive fashion, which tends to detract from the pedagogical intent. More often than not, simple replacement of the repetitive term with "from" or "of," anything to make the presentation more engaging, would help. The scientific literature does not have to devolve into the boring style seen in any recent issue of *ApJ*. Pick up a research paper from 50 to 90 years ago and you will find writing styles from the last century that were much more interesting and educational (and literate) than they are today.

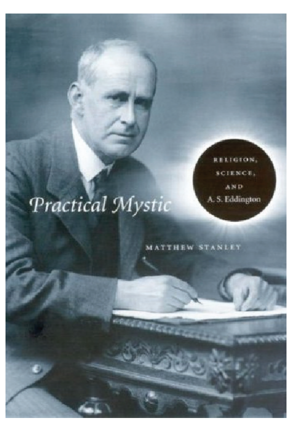
The coverage of most areas of spectral classification is extremely thorough, despite my misgivings about writing style (a portion of which can be blamed on the contributing authors), and the authors are commended for bringing a much-needed reference manual to a field that has long tended to survive through oral tradition. I was somewhat disappointed by the lack of complete coverage for M supergiants, but such stars are notoriously variable in brightness and spectral characteristics, and the definitive study of their spectra and characteristics has yet to be made. There is also no discussion of the instrumental requirements needed to obtain high-quality stellar spectra, which may be a drawback for those wishing to enter the field from the ground floor.

I recommend the book highly for bringing something unique to the field of spectroscopy: a reference guide and manual containing lots of information, figures, and tables that are of use to the practitioner. In recent years, observational spectroscopy has become popular with a number of keen amateur astronomers who have been making solid astronomical observations of considerable use to professionals in their work. *Stellar Spectral Classification* should be of interest to them as well, since it makes a wonderful reference guide for observers of all types, and is priced reasonably enough to make it affordable by everyone who wants a copy.

David G. Turner

David Turner is an aging stellar astronomer who still has photographic spectra and a viewing microscope available for use in his office, although that was not always the case. His experience in galactic astronomy includes stellar spectroscopy, photometry, and the study of different types of variable stars, in addition to the discovery of previously unnoticed star clusters associated with Cepheids, a list that continues to grow on a yearly basis.

Practical Mystic: Religion, Science, and A. S. Eddington, by Matthew Stanley, pages 313 + xii, 16 cm × 24 cm, The University of Chicago Press, 2007. Price $37.50 US, clothbound (ISBN-13: 0-226-77097-4).



Sir Arthur Stanley Eddington (1882-1944), Plumian Professor of Astronomy at the University of Cambridge, was a key figure in the shaping of 20th-century astrophysics. In the inter-war years, his name was nearly as well known as Einstein's to readers of respectable broadsheets and insalubrious tabloids on either side of the pond. The rise of both scientists to celebrity through well-publicized, spectacular, and mind-bending science was mutually interconnected. In the photographic record of the Principe solar-eclipse expedition (1919 May 29), Eddington and colleagues were widely perceived to have captured decisive observational proof for Einstein's theory of relativity. The Plumian Professor also wrote the first reliable popular and mathematical treatments of relativity in English. Eddington was, however, much more than Einstein's prophet. His stellar models were foundational to latter developments, and he was a pioneer in the pursuit of a unified field theory, a long, difficult, and reputation-imperiling excursion into unsure territory. Eddington's life and science were not devoid of controversy — contemporaneous and posthumous — but his lasting contributions ensured his good name, anchored his reputation, and reserved his place in the pantheon of astronomical gods and heroes. With *Einstein and Eddington* (BBC/HBO 2008) he has even had the honour — or endured the slight — of making it to the small screen. That maladroit dramatization at least offered viewers the rare opportunity to see a bespectacled David Tennant portraying a Dr. *Somebody,* rather than a *Dr. Who*.

Eddington had nebulous but actual connections to the RASC. Death alone forestalled his election to an honorary membership, his books were reviewed favourably in this *Journal,* and he was a guiding influence on the first female president of the RASC, Alice Vibert Douglas (1894-1988).

In 1956, Prof. Douglas honoured the memory of her mentor with a serviceable and still viable nuts-and-bolts biography (Douglas, A.V. (1956). *The Life of Arthur Stanley Eddington,* London: Thomas Nelson), yet the history of science, like its object, shifts with time, kicking sand in the face of ancient verities, crumbling old characterizations and categorizations, and disintegrating taboos. One ancient verity eating sand is the eternal "war" between religion and science; one crumbled characterization is that scientists ought to categorize their lives into mutually exclusive boxes labelled "science" and everything else; and one taboo thankfully transgressed is that such matters are not subject to a variety of experience. Matthew Stanley's study is an examination of the relationship of Eddington's Quaker beliefs to his science, and his principal argument is that Eddington's Quakerism provided vital conceptual tools for his innovative astrophysics; without religiously derived conceptual tools *The Internal Constitution of the Stars* (Eddington, A. S. (1926). Cambridge: Cambridge University Press) would not have been the startlingly original and influential work that it was. Stanley's book is welcome, and can sit worthily alongside recent work by Michael Crowe, Helge Kragh, Owen Gingerich, and Guy Consolmagno, who explore the relationship between modern astronomy and religion in productive but very different ways.

Practical Mystic: Religion, Science, and A. S. Eddington begins with a brief biography of Eddington, presenting the development of his religious beliefs and scientific practices, their interrelation, and their narrower and wider contexts. There are *inter alia* chapters on Eddington's pacifism, the famous eclipse expedition viewed in the tradition of the Quaker "adventure," the practice of science, thinking about science, and liberal theology. Not surprisingly, Stanley is at particular pains to outline the precise nature of Eddington's religious beliefs prior to establishing their importance for Eddington's practice of science. It is that influence, at core a contextual argument, that is at the heart of his study.

Eddington was a cradle Quaker, but unlike the majority of his older co-religionists, who practiced either an inherited insular quietism or a stridently reactionary evangelicalism, he chose to follow the "third way" of the relatively new and emergent Quaker "renaissance" (1890s-). While sharing in the trademark pacifism — real or nominal — of all Friends, proponents of the Quaker renaissance were distinguished by their willingness to engage actively with the world, embrace modernism, align themselves with brands of liberal theology, and harbour a loosely socialist political view. Eddington's Quaker undergraduate experience at Owens College (founding college of the University of Manchester) instilled in him the approach that "science was an organic part of society and held responsibilities toward it.... The expertise of the scientist was a resource for making society a better place" (29). One way or the other, at the back of all Quaker endeavours, including a Quaker doing science, was the practice of Quaker "mysticism." It is the crucial concept for Stanley's study. And, it is the cross on which his ultimately successful work nearly flounders. The problem is not entirely of Stanley's making, and I return to it below.

In general, Stanley's work is well-written and bears few traces of its origin as a Ph.D. thesis (the original Harvard thesis was also agreeably written). His exoneration of Eddington from charges of bias in the interpretation and presentation of the 1919 eclipse results is fully convincing (ch. 3), as are his accounts of Eddington's conflicts with Sir James Jeans and Subrahmanyan Chandrasekhar (both ch. 2). The accusation of asperity or racism in Eddington's treatment of his one-time pupil is seen to be totally without foundation, and Stanley acquits himself well here. His account of the playing out of his subject's difficult pacifist stance in wartime, and his principled belief in internationalism, and the effect of both on a man trying to do science, are good.

The religious themes in the lives of Eddington and his contemporaries are not as deftly handled. A recurrent problem is that the reader is not provided with enough contextual or comparative material to effectively place Eddington's practice of science and belief in a meaningful context. From the second half of the 19th century to the end of Eddington's career, clergymen of various stripes played significant roles in astronomy (*e.g.* Charles Pritchard, Angelo Secchi, Georges Lemâitre), yet no attempt is made to contrast the relationship of faith and science in their lives to Eddington's. Stanley states that when Eddington was arraigned before the Cambridge County Conscription Tribunal, "the conflict was between two different understandings of science clashing with two different understandings of religion" (152). We are told something of Eddington's views of religions and science, but nothing of those of the Tribunal; without that evidence, the reader can hardly decide on the quality of Stanley's argument. Stanley's most serious shortcut is his propensity to manufacture straw men to oppose Eddington. Stanley's one-dimensional caricature of Anglican scientists contemporary with Eddington as hard-line conservatives to a man and all resistant to change, as if their views had not shifted since the publication of the third Bridgewater Treatise (1833), is hardly the stuff of true history. There were a variety of views current among scientifically informed Anglicans. E.W. Barnes (1875-1953), Bishop of Birmingham and fellow of the Royal Society, was an important theoretical mathematician and theological liberal possibly to the "left" of Eddington. Their younger contemporary, the famous King's College professor of historical theology, Fr. E.L. Mascall, OGS (1905-1993), was a Cambridge wrangler, and no unreflective evangelical conservative. It is perhaps revealing that Stanley's caricature of Anglican science never appears with citations.

Some important sources are not treated as scientifically as one might wish. The version of the *General Advice to the Society of Friends* (1656) to which Stanley refers is never specified (orthography would suggest a late edition), nor are biblical references either traced, or identified.

Why, one wonders, is a definition of science never given in Eddington's own words? And what of mysticism?

"Mysticism" is both the heading of a section (11), near the beginning where Stanley lays out the basic terms of reference for the book, as well as a chapter title (ch. 2). At neither location is Quaker "mysticism" defined for the reader. It is only at a structurally unimportant place that one finds anything approaching a definition (37-38), and it is not even taken from Eddington, but from an influential American Quaker (R.M. Jones): "Mysticism was 'the type of religion which puts the emphasis on immediate awareness of relation with God, on direct and immediate consciousness of the Divine Presence'." It is a fair definition of the concept, and an excellent illustration of its vague elusiveness. The bare words could also describe any believer, Christian, Muslim, Buddhist, Neo-Pagan, what-have-you, and their relationship to the divine when partaking in any of their rites. Its main difficulty is that it can hardly be said to define the nature of that relationship. It could, for instance, perfectly well define Richard Dawkins' relationship to "God"; his "immediate awareness" is of a non-existent relationship, his "direct and immediate consciousness of the Divine Presence" is that one does not exist. Out of frustration with such a difficult-to-define concept, the reader might even be tempted to quote the wag who uncharitably said that "Quaker mysticism is to orthodox mysticism as pipe smoke is to incense." The problem lies in Stanley's sources. It is, nevertheless, more than a little hard on the reader that Stanley did not explore the "what" of Quaker mysticism head-on; a more *definite* definition, or one drawn from Eddington's own words, or a discussion of the difficulties of the concept and the relationship of Quaker mysticism to that of orthodox mysticisms might have helped.

Does Stanley's main contention hold water? Can Eddington's Quaker beliefs be said to have greatly influenced his practice of science? The simples answer is yes:

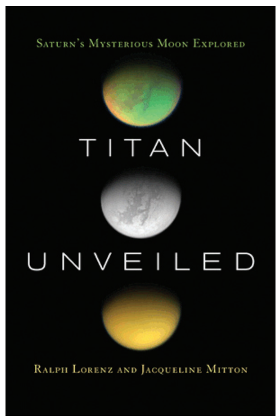
> *His [*i.e. *Eddington's] success in addressing those problems [regarding stellar interiors] was based on his willingness to forgo scientific certainty in favor of opportunities for further progress. Developing his theory of stellar structure was an exercise in contesting the local boundaries of scientific validity... Just as the Quakers argued that the import of the spiritual life was not in dogma or final truth, Eddington was comfortable with a scientific method that functioned without certainty (47).*

Practical Mystic: Religion, Science, and A. S. Eddington is a worthwhile study of an important figure who had a hand in molding astrophysics as we know it. It is of value to astronomers curious about a seminal figure and period for their science, and is particularly to be recommended to amateurs who mistakenly believe the relationship between faith and science is a simple story line enacted by people wearing either black caps (institutional thought police) or white hats (free thinkers). Eddington (1928, *Nature of the Physical World,* Cambridge: Cambridge University Press, p. 333) was a religious believer who had no time for the arguments now known as intelligent design: "I repudiate the idea of proving the distinctive beliefs of religion either from the data of physical science or by the methods of physical science." Eddington was intellectually brave in his time. The readers of astronomical history should be likewise.

Randall A. Rosenfeld

Randall Rosenfeld was formally trained in ancient writing systems and the technologies of communication before 1500. He was an invited participant to The International Workshop on one Century of Mars Observations in Paris under the aegis of the Société Astronomique de France and the International Astronomical Union for the International Year of Astronomy 2009, and some of his astronomical art will be published by Springer this spring. He is currently serving as RASC Archivist, with no hope of parole till 2050. His latest project involves the hunt for J.S. Plaskett's monocle among the historic debris of the National Office.

Titan Unveiled: Saturn's Mysterious Moon Explored, by Ralph Lorenz and Jacqueline Mitton, pages 243 + xiv, 17 cm × 24 cm, Princeton University Press, 2008. Price $29.95 US, hardcover (ISBN 978-0-691-12587-9).



In *Titan Unveiled,* Ralph Lorenz and co-writer Jacqueline Mitton have produced an excellent account of the *Huygens* lander-probe that was launched from *Cassini,* the mother robotic spacecraft, to sample Titan's atmosphere and observe its intriguing surface. The book also reviews some preliminary results gathered by the *Cassini* orbiter during early flybys of Titan. *Titan Unveiled* consists of seven chapters beginning with the "lure" of Titan, the waiting and arrival of the *Cassini* spacecraft, *Cassini*'s first "taste" of Titan, the jettisoning of *Huygens* and its landing on the Saturnian moon, the continuation of the *Cassini* mission beyond its original objectives, and a look at the future. An appendix contains a brief summary of dynamical and physical data, while a separate section contains a list of further reading.

The value of the book rests with the insight presented and science described, all coupled with a recounting of the collective human endeavour that led to the project's success. Page after page, the reader is walked through the scientific thinking, rationale, planning, and excitement of this unique mission of Solar System exploration. Through concise analysis, the reader gains insight into how the different scientific specialists in their respective fields — planetary and atmospheric science, chemistry, geological structures, weather dynamics, fluids, vulcanology, and others — interpreted electronic data beamed back to Earth.

Six experiments were chosen for the Huygens probe: gas chromatography/mass spectrometry, descent imagery/spectral radiometry, Doppler wind measurement, aerosol collection/pyrolysis, *Huygens* atmospheric structure study, and surface science. The co-authors discuss the preliminary analysis of incoming data in a way that is understandable to the amateur astronomer or reader new to the topic.

The *Cassini-Huygens* exploratory mission, as it was officially called, launched from Cape Canaveral on 1997 October 15. *Huygens* landed on 2005 January 14. *Cassini*'s four-year primary mission ended on 2008 June 30, at which time a two-year extension, called the *Cassini Equinox Mission,* was initiated and is currently in progress. *Titan Unveiled* went to press with two years remaining in the original four-year *Cassini-Huygens* mission. New scientific data that have continued to accumulate are not discussed.

At the end of this well-crafted account of the mission to Saturn and its moon, Titan, the reader walks away with insights into the following areas:

(i) how late-20th- and early 21st-century interplanetary science is done,
(ii) how multi-disciplinary scientists and engineers think and work together,
(iii) the ingenious, information-generating electronic-based scientific tools at scientists' disposal,
(iv) the flexibility necessary to reprogram either an orbiter's or probe's activities when obstacles arise or equipment fails,
(v) the magic of electronic communication over the vastness of Solar System space to issue commands and manoeuvres for spacecraft located vast distances from the home planet,
(vi) the depth of mathematical knowledge and computer programming that goes into managing such long-distance missions,
(vii) the teamwork required to keep an interplanetary project alive and performing well at peak capacity once on site, despite unexpected glitches and undiscovered human errors committed years before launch,
(viii) the necessary luck to avoid the hazards of space travel over immense distances,
(ix) the complex mathematical calculations developed by scientists that ease a hurtling spacecraft safely into final orbit at the right speed and the correct angle of approach,
(x) the finely orchestrated release of a sophisticated lander-probe at the right place in the mothership's journey of exploration, and
(xi) the triumph of *Homo sapiens sapiens* in conquering the challenges of interplanetary robotic travel.

Titan Unveiled is worthy of a reader's time. The co-authors succeed in unveiling Titan from the scientific perspective, and lay bare the wondrous spirit of humanity's continuous search for new knowledge and experience of what's just over the next and unexplored horizon. It is a welcomed addition to anyone's personal library on matters related to Solar System astronomy and robotic exploration.

Andrew I. Oakes

Andrew I. Oakes is a long-time member of RASC who enjoys being an armchair amateur astronomer. He lives in Courtice, Ontario, and focuses his reading on Solar System developments and the formation of stars and galaxies.

Be...in New Brunswick

... for something new in some place old, something old in some place new. The New Brunswick Centre invites you to attend the 2010 General Assembly at the University of New Brunswick campus in Fredericton. RASC NB proudly celebrates its tenth anniversary by hosting this venerable event in Canada's Picture Province for the first time, at an institution that is celebrating its 225th anniversary. We promise great food and great fun, served up with Down East hospitality at a cost that will make you smile.

Fun 'n Food

Fredericton is inland but is situated along the scenic Saint John River, "The Rhine of North America." We will bus you to two historic Maritime locations for photo-op scenery, education, a chance to escape the inland summer heat by Nature's air conditioner, and have you back in time for dinner. Seats are limited for each tour, so register early to book yours.

- St. Andrews by the Sea sailing and Kingsbrae Gardens — Sail Passamaquoddy Bay aboard the 72-foot *Jolly Breeze,* where you are likely to see seals basking, whales busking, and eagles daring. Shop and sightsee in the quaint seaside mecca of St. Andrews, and then experience Kingsbrae Garden with its variety of gardening styles and Jurassic-era Wollemi tree.

- Bay of Fundy Tides Tour — See the awesome power of the highest tides in the world. Walk among the Hopewell Rocks "flowerpots" at low tide and return after lunch in nearby Alma to view the incoming tide. (We are negotiating to have the New Moon moved ahead a week to enhance your experience, but no luck so far.)

Meanwhile, back in Fredericton:

- **William Brydone Jack Observatory/Museum** — This diminutive building, where the first true longitude coordinates in Canada were determined, is located on the UNB campus and will be open for guided tours. It still has the mahogany and brass Merz refractor, as well as antique astronomical and engineering instruments.
- **Wine and Cheese Official Opening** — Meet and greet your RASCally friends and browse the poster displays in the Wu Centre foyer.
- **Get your kicks on the pitch** — Work up an appetite by participating in, or cheering on, the West *vs* East soccer match. We apologize if you were expecting traditional mooseback polo. The moose have weekends off, by contract.
- **RASC BBQ & Lobster Boil** — Of course there will be lobster, and you won't have to bob for them. If you prefer breasts to tails and claws, we also have chicken burgers. After dinner, join us for awards and game entertainment.
- **Non-denominational Sunday church service** — A first, perhaps, at the campus chapel. Expect some stellar hymns, and it wouldn't hurt to pray for a calm AGM.
- **Closing Banquet** — Traditional New Brunswick fare; and featuring a presentation by the Prince of Tides, Dr. Roy Bishop. If you took the trip to Hopewell Rocks you will appreciate the experience even more.
- **Hospitality Suite** — Thursday through Sunday evenings at the residence. Where the real astronomy happens.

Tentative Schedule of Events

Wednesday, June 30
- National Council BBQ & Kitchen Party (National Council Representatives, Executive, and their co-delegates only)

Thursday, July 1
- St. Andrews Sailing & Kingsbrae Garden Tour
- National Council Meeting #1
- William Brydone Jack Observatory / Museum Tours (2)

Friday, July 2
- Bay of Fundy Tides Tour
- William Brydone Jack Observatory / Museum Tours (3)
- Posters Available for Viewing
- Wine and Cheese Reception / Official Opening
- Awards Presentation

Saturday, July 3
- Paper Sessions #1 and #2
- Helen Sawyer Hogg Lecture
- West-East Soccer Match
- RASC National BBQ & Lobster Boil
- Awards Presentation

Sunday, July 4

- Non-denominational Church Service
- RASC Annual General Meeting
- National Council Meeting #2
- Paper Session #3
- Closing Banquet
  - Keynote by Dr. Roy Bishop
  - Awards Presentation
  - 2011 General Assembly Presentation

Registration and Accommodations

Visit our Web site `www.rasc.ca/ga2010/index.shtml` for information on registration and accommodations rates, cancellation fees, and deadlines. You may register on-line or by mailing the form. If you plan to extend your visit to New Brunswick and make day trips from Fredericton, you may book your GA room for a number of days before or after the GA. Simply inform the UNB Accommodations staff when you book your room.

Transportation

UNB is about 12 km from Fredericton International Airport. We will be pleased to pick you up and return you for your departure between Wednesday, June 30, and Monday, July 5. Just send us your travel arrangements with your registration. If you plan to rent a vehicle, see our Web site for directions to UNB.

Contacts

If you have questions that cannot be answered through our Web site you may contact:

Paul Gray	snpgray@nb.sympatico.ca	(506) 472-6978
June MacDonald	junie@nbnet.nb.ca	(506) 634-0931

Correction: Sunrise and Sunset in the Southern Hemisphere

by Jeremy B. Tatum, University of Victoria

The table on page 236 of the December *JRASC* in the article on sunrise and sunset applies also to southern hemisphere latitudes, provided that the words "sunset" and "sunrise," and "summer" and "winter," in the column headings are interchanged. The extended version of the table is reproduced below.

	Northern Winter Date of		Northern Summer Date of	
	Latest sunrise	Earliest sunset	Earliest sunrise	Latest sunset
	Southern Summer Date of		Southern Winter Date of	
Latitude	Latest sunset	Earliest sunrise	Earliest sunset	Latest sunrise
25°	Jan. 13	Nov. 29	Jun. 8	Jul. 3
30°	Jan. 9	Dec. 3	Jun. 11	Jul. 1
35°	Jan. 7	Dec. 5	Jun. 13	Jun. 29
40°	Jan. 4	Dec. 8	Jun. 14	Jun. 28
45°	Jan. 2	Dec. 10	Jun. 15	Jun. 27
48.5°	Dec. 31	Dec. 12	Jun. 15	Jun. 26
50°	Dec. 30	Dec. 13	Jun. 16	Jun. 25
55°	Dec. 29	Dec. 14	Jun. 17	Jun. 24
60°	Dec. 27	Dec. 16	Jun. 18	Jun. 23
65°	Dec. 23	Dec. 19	Jun. 20	Jun. 21

We Celebrate our 2009 Donors

R.A. Rosenfeld and Dave Lane

Cast your eye over the lives and achievements of notable stargazers of the last two millennia, and you'll discover that some of the greatest astronomers reached to the stars through collaboration with patrons. The RASC's enlightened patrons are listed below, and the success we enjoyed in fulfilling our IYA2009 mandate, *as well as* in maintaining our regular activities promoting astronomy and allied sciences, is due to their generosity. Many of the names should be familiar; they are astronomers, amateur and professional, and RASC members. The ongoing generosity of our donors is essential to the Society's life and work as a registered charity enabling Canadians to weave astronomy into the fabric of Canadian culture, embracing everything from pure enjoyment of the night sky to pure research. Who can say what may grow from the seed of a Galileo Moment? We are most grateful to our 2009 donors, who chose to invest in astronomy through investing in us.

General Donations to the Society

Bruce A. Aikenhead
Dr. M.E. Alexander
Frank N. Aldrich
Robert M.P. Alexander
William C. Allen
Jay Anderson
Ray Andrejowich
Gordon Anthony
Ruth Anthony
Ron Armstrong
David Asbury
John Geoffrey Ascah
Raymon d Auclair
Dirk Auger
Claude R.J. Bastien
Robert B. Bates
William Bell
Marquerite F. Blades
Kevin Blomme
Richard Bramm
Eric Briggs
Sher Brisebois
Michael Brooke
Robert L. Brooks
Donna E. Brown
Mary Brown
Larry B. Caine
Paul Campbell
Gerald F. Carroll
Nathaniel Chafee
Francois Chevrefils
William J. Clair
Rodney Clark
Tessa Clarke
Geoffrey Cockhill
Michael Davidson
Timothy deBortoli
Jeremy Demings
William A. Demond
David Demers
Tibor Devenyi
William C. Dillon
Gay Docherty
Randy Dodge
John Dudych
Dale Embree
Michael Evans
Denis Fell
Glen Douglas Ferguson
Al Fishler
Leon Francois
Donald N. Funston
Paul Gammon
Gary Gerelus
Gordon Grant
Peter D. Hagar
Ian Halliday
Evelyin Hamblin
Weldon Hannaford
Searle Hartman
Brad Heath
Chris Hemstock
Louis Henken
Donald H.C. Herne
Lynn Honey
Dr. Michael Hoskinson
Gary Irwin
Peter Jedicke
Norman Jeffery
Shahzad Jessani
Frank P. Johnston
Robert Johnston
Garner Keeling
John D. Kerr
Lorne V. Knibbs
Julia Knight
Laurie Kolk
Alexander W. Krieger
Karl Kropf
Robert P. Lemke
Norman Melville Lewis
Robert L. Lewis
Michael Lloyd
Kevin A. Lusty
Hugh MacLean
David Maguire
Dr. Chris Malicki
Jacek W. Malinowski
Frederick D. Marlett
Michael Mattie
Robert McAllister
Matthew McCall
Donald McDonald
Gail McNeil

John McPhee
Serge-Antoine Melanson
Al Metzger
Terry G. Miller
Peter Milligan
Ron Mills
Robert (Bob) E. Mitchell
John Molgaard
Edmund Montgomery
Duane Morse
Christopher M. Mulders
Graham C. Murphy
Andrew Murray
John Mustard
Jeremy D. Nixon
Evans Paschal
Joseph Paul
Mark Pilon
F. Lindsay Price
David C. Quinn
Rhonda L. Reich
Samuel J. Richter
David Robinson
Richard Robert
Iain Robertson
John Ross
Mijo Samija
Francis Sanowski
Patrick Saxton
Charles Schaeffer
Heinrich Schmidt
Tony Schellinck
Kinchen J. Searcy
Bruce Seifred
Donald Howard Smith
Marjie S. Solmundson
Jill Spear
Joseph & Renata Suchocki
Edward Taje
David Tanton
Alphonse Tardif
Norm Tellier
Gerald Thompson
Joseph Tiberio
Denis Tremblay
Adam Trzcinski
David & Patricia Turner
Jim Van Doren
Steve Venner
Robert C. Victor
Mark J. Walker
Dave Watson
Louise E. Whalen
Gerry Wissiak
Bruce Wright
Jim Wyse
Scott Young
Valerie Zenk
two anonymous donors
six donations in memory of Laurence Anderson
three donations in memory of Leo Enright

IYA

Astronomical Donors (Over $500)

Raymond Auclair
Nathaniel Chafee
David G. Patterson
one anonymous donor

Galactic Donors ($200 to $500)

James Hesser
Lloyd Higgs
Damien Lemay
Donald L. MacDonald
Asbjorn Olsen
one anonymous donor
one donation in memory of Ian Matthews

Nebular Donors (Over $50 to $200)

Richard Armstrong
Gary Billings
Gary Bunclark
Len A. Chester
Christine Clement
G.D. Lucian De Silva
Gay Docherty
John Campbell Fahrner
Victor Gaizauskas
Herman Genschorek
Dr. Glyn George
Denis and Nicholas Grey
Barbara A. Hall
Kimberley Hay
John Huschilt
Dr. Kimmo A. Innanen
Elizabeth Keller
Ray Khan
Alexander W. Krieger
Dr. Ulrich J. Krull
Mike E. Lalonde
David J. Lane
James Low
Sergio Mammoliti
Alan McKeown
Henry G. Neil
James L. Olsen
Dr. John Percy
Mel Rankin
Guy Ridgway
Nancy Thompson
Bill Tomlinson
Marvin Warkentin
Sherman Williams
Peter Tumilty
one anonymous donor
one donation in memory of Efthymia Balaskas
one donation in the name of Bill Hydomako

Stellar Donors (Up to $50)

Dr. M.E. Alexander
Gordon Anthony
Ron Armstrong
Miron Balych
Prasad P. Banerjee
Peter A. Beaulieu
Alicja Borowski
David Bourgeois
Shirley A. Brennick

Barry W. Bruce
Dieter Brueckner
Beverley Burns
David Cleary
Earl Clements
Douglas Cnudde
Gerry Cyr
Sebastian Czan
Jeremy Demings
Felice J. DesMarais
Patrick Devin
Phil Dubois
John Dudych
Jim Edgar
Leo Enright
John J. Evans
Roy Falconer
Kevin Foster
David Fry
Larry W. Funfer
Susan Gagnon
Sarah Gardiner
Laurent Gilbert
Wolf Graf
Alice Hyung Han
Bill Hawken
Ursula R. Hawkins
Ingrid Hutchinson-Young
Albert Isaacs
Barry Jeffrey
Alfred H. Johnson
Sharon Johnson
John Johnston
Robert Johnston
Bryan W. Kelso
John Kerr
Patrick J. Laffey
Chris P. Lamothe
Dr. Denis Laurin
Richard A. LecLerc
Alex Le Creux
James Lee
Robert L. Lewis
Andrew Love
Joseph & Kathleen Lupton
Dr. Petr Macak
Anthony J. MacKay
Paul Mahon
Dr. Roy Makepeace
Matthew Manning
Robert Marceau
Marc Mariage
Frederick D. Marlett
Mike Marsh
David McCarter
Shirley McIntyre
Murray McKenzie
Bob McLean
Igor Morin
Christiane A. Murray
Guy Nadon
Joe Nelson
George Newton
Elaine Pelletier
Jeannine Pelletier
James G. Peters
Paul Porayko
Donald Robb
Jacques Robichaud
James Ronback
Graham A. Rose
Jack Rusch
Michael Ruxton
Peter R. Ryback
Milton C. Schenk
Alan A. Sebastian
R. Glenn Shugg
Anthony Sosnkowski
Rick Stankiewicz
Murray R. Strankay
Leslie Strike
Joseph & Renata Suchocki
Richard P. Taylor
Galen Thurber
Ming Tsang
Dr. Edward Robert Walker
Mark P. Walker
David G. Watson
Maria Weisgarber
John Yoshioka
thirteen anonymous donors
one donation in the name of Camille C.
one donation in memory of Jean C. Strickland

Sustaining Members

Roger Abbott
Kevin Adam
Bruce A. Aikenhead
Gina Almeida
Thomas M. Alloway
Marlie R. Anderson
Wallace Anhorn
Douglas Bates
James Beckwith
Matthias Benfey
Paul A. Wefers Bettink
Joshua D. Bradford
William P. Bradley
Bruce Brandell
Donna E. Brown
David A. Brozovsky
Gary Bunclark
Beverley Burns
Neil Campbell
Steve Capling
Gerald F. Carroll
David Chapman
Emmanuel Charbonney
George Charpentier
Dave Clark
Donald Cruikshank
Stephen Danis
David Demers
Patrick Devin
Tibor Devenyi
Randy Dodge
James Edgar
Dale Embree
Abdulhamid Eshawesh
Gordon K. Falconer

Antoine Fils-aime
David Fry
Larry W. Funfer
Donald N. Funston
Dr. Robert Garrison
Mike Gore
Kelly Graves
Michael Hall
Peter Hall
Searle Hartman
Robin Heisey
Chris Hemstock
Dr. Alan R. Hildebrand
Stephen Hillier
Dr. Michael Hoskinson
Norm Howe
Vicki Huntsman
Malcolm Jardine
Rockney Jascobsen
Dr. Ronald Javitch
David L. Jenkins
Glenn Johanson
Tracy Jones
Robert W. King
Lorne V. Knibbs
Stanley A. Krajenke
Alexander W. Krieger
Mike E. Lalonde
David J. Lane
William M. Leahey
Robert P. Lemke
Michael S. Lloyd
James Low
Richard Lowndes
Kevin A. Lusty
David MacPherson

John I. Majpruz
Wayne Malkin
Mike Marsh
Allan McBride
Gail McDonald
W. John McDonald
Derek J. McKay
Stephen McKinney
Bob McLean
Ludjie A. Molner
Edmund Montgomery
William Moore
John Mustard
Jane Norwell
Don Ogden
Glen Paling
Jason Paquin
Joseph R. Pasek
William D. Praskey
Peter Raine
John Ross
Neil Rowlands
Pierre Sarkis
Charles Schaeffer
Murray K. Sheridan
Kevin J. Shin
William C. Simon
Eric Solomonson
Mike Stephens
Joseph & Renata Suchocki
Patrick David Sutton
John M. Taylor
Bill Townsend
Denis Tremblay
Peter Tumilty
Colin D. Ward

Peter Weber
David Weiss
Trevor Wekel
Joerg Wittenberg

Ruth Northcott Memorial Fund

Remy A. Aubin
Beverley Burns
Nathaniel Chafee
Francois Chevrefils
Dr. C.M. Clement
Tariq Francis
Kevin Kell
Fredrick D. Marlett
Roy Quigley
Amelia Wehlau
one donation in memory of Lewis K. Brooks

Peter Millman Endowment Fund

Gail Ferguson
George D. Knill
Richard J. Lacelle
Dennis Larcombe
Fredrick D. Marlett
John D. Spencer
Ron Steele

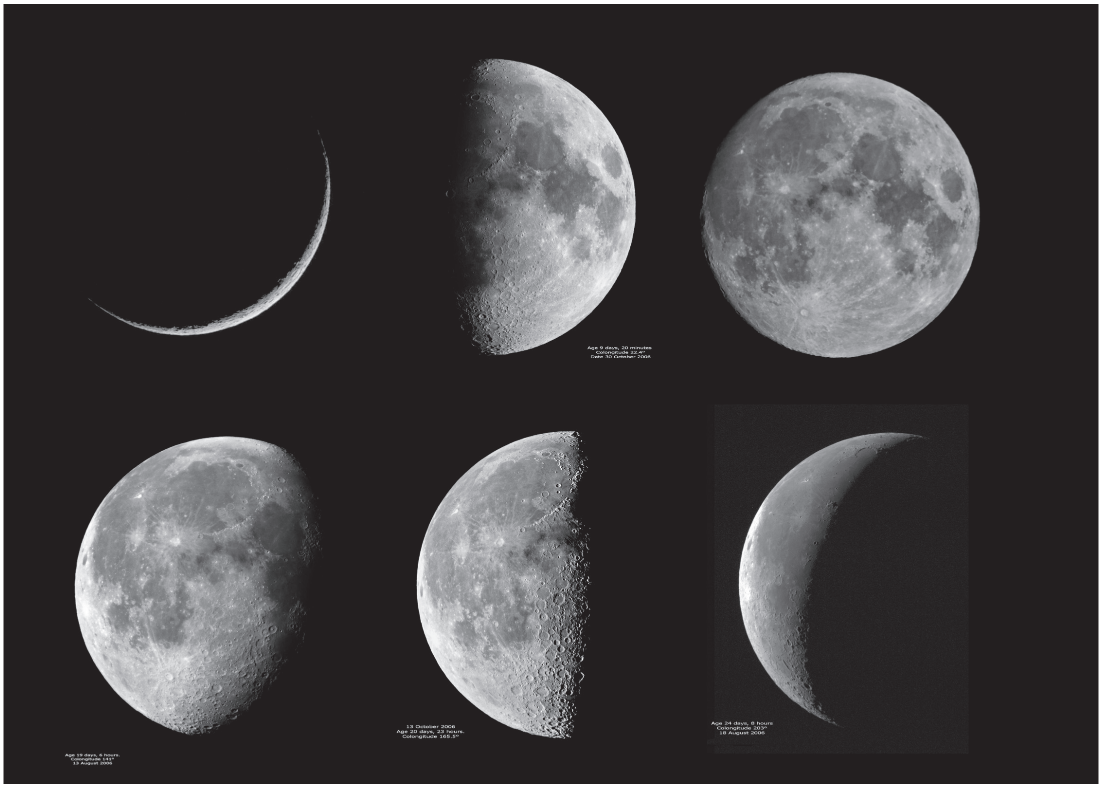
Donations to the RASC Archives
(gifts and donations in kind)

Peter Harris
Barry Matthews
one anonymous donor

Great Images

Tim Doucette from the New Brunswick Centre took this image of Messier 94 from his mid-city Deep Sky Eye observatory in Moncton. Tim used a Celestron 9.25-inch on a CGEM mounting and a 6-megapixel QHY8 camera. Exposure was 14x5 minutes at f/6.3. M94 lies in Canes Venatici, under the handle of the Dipper, at a distance of about 15 Mly, and is one of the closest galaxies that is not a member of our local group. Its 11′x9′ size and 8th-magnitude brightness make it an easy object for any telescope.

Victoria Centre member Jim Cliffe thought that a collection of lunar images for each day of its cycle would be an interesting project, and so he began collecting images in 2006. These samples are a part of that endeavour. Jim used an Olympus E-500 camera on both a Celestron C80ED and a 10-150-mm zoom lens. It's a slow project: in Jim's words, "...the observing conditions have been abysmal in recent months...."



THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

NATIONAL OFFICERS AND COUNCIL FOR 2010/CONSEIL ET ADMINISTRATEURS NATIONAUX

Honorary President	Jim Hesser, Ph.D., Victoria
President	Dave Lane, Halifax
1st Vice-President	Mary Lou Whitehorne, Halifax
2nd Vice-President	Glenn Hawley, B.Sc., B.Ed., Calgary
Secretary/Recorder	James Edgar, Regina
Treasurer	Mayer Tchelebon, MBA, CMA, Toronto
Past Presidents	Scott Young, B.Sc., Winnipeg and Peter Jedicke, M.A., London
Editor of *Journal*	Jay Anderson, B.Sc., MNRM, Winnipeg
Editor of *Observer's Handbook*	Patrick Kelly, M.Sc., Halifax
Editor of *The Beginner's Observing Guide*	Leo Enright, B.A., Kingston*
Editor of *Observer's Calendar*	Dave Lane, Halifax
National Office Manager	Jo Taylor, 203 - 4920 Dundas St W, Toronto ON M9A 1B7 Telephone: (416) 924-7973

* Deceased 2009 August 11

CENTRE ADDRESSES/ADRESSES DES CENTRES

The most current contact information and Web site addresses for all Centres are available at the Society's Web site: **www.rasc.ca**

Belleville Centre
c/o Greg Lisk, 11 Robert Dr, Trenton ON K8V 6P2

Calgary Centre
c/o Telus World of Science, PO Box 2100 Stn M Location 73, Calgary AB T2P 2M5

Charlottetown Centre
c/o Brian Gorveatt, 316 N Queen Elizabeth Dr, Charlottetown PE C1A 3B5

Edmonton Centre
c/o Telus World of Science, 11211 142 St, Edmonton AB T5M 4A1

Halifax Centre
PO Box 31011, Halifax NS B3K 5T9

Hamilton Centre
576 - Concession 7 E, PO Box 1223, Waterdown ON L0R 2H0

Kingston Centre
PO Box 1793, Kingston ON K7L 5J6

Kitchener-Waterloo Centre
305 - 20 St George St, Kitchener ON N2G 2S7

London Centre
c/o Peter Jedicke, 82 Barrydale Cres, London ON N6G 2X4

Mississauga Centre
PO Box 98011, 2126 Burnhamthorpe Rd W, Mississauga ON L5L 5V4

Centre francophone de Montréal
C P 206, Station St-Michel, Montréal QC H2A 3L9

Montréal Centre
18455 Meloche St, Pierrefonds QC H9K 1N6

New Brunswick Centre
c/o Paul Gray, 1068 Kingsley Rd, Birdton NB E3A 6G4

Niagara Centre
PO Box 4040, St. Catharines ON L2R 7S3

Okanagan Centre
PO Box 20119 TCM, Kelowna BC V1Y 9H2

Ottawa Centre
1363 Woodroffe Ave, PO Box 33012, Ottawa ON K2C 3Y9

Prince George Centre
7365 Tedford Rd, Prince George BC V2N 6S2

Québec Centre
2000 Boul Montmorency, Québec QC G1J 5E7

Regina Centre
PO Box 20014, Regina SK S4P 4J7

St. John's Centre
c/o Randy Dodge, 206 Frecker Dr, St. John's NL A1E 5H9

Sarnia Centre
c/o Marty Cogswell, 6723 Pheasant Ln, Camlachie ON N0N 1E0

Saskatoon Centre
PO Box 317 RPO University, Saskatoon SK S7N 4J8

Sunshine Coast Centre
PO Box 577, Sechelt BC V0N 3AO

Thunder Bay Centre
286 Trinity Cres, Thunder Bay ON P7C 5V6

Toronto Centre
c/o Ontario Science Centre, 770 Don Mills Rd, Toronto ON M3C 1T3

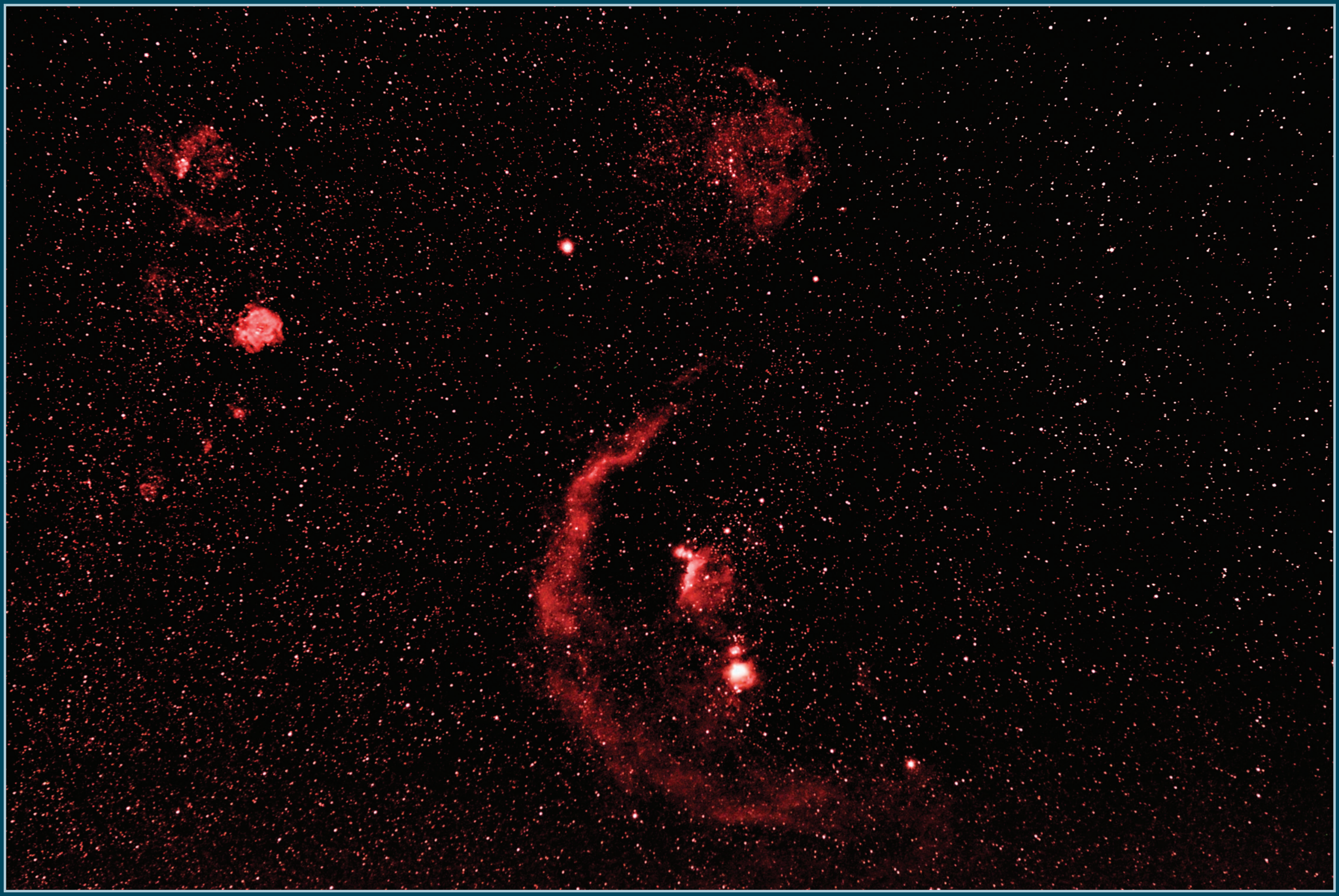
Vancouver Centre
1100 Chestnut St, Vancouver BC V6J 3J9

Victoria Centre
3046 Jackson St, Victoria BC V8T 3Z8

Windsor Centre
c/o Greg Mockler, 1508 Greenwood Rd, Kingsville ON N9V 2V7

Winnipeg Centre
PO Box 2694, Winnipeg MB R3C 4B3

Great Images



Who says you can't use an H-alpha filter with a DSLR camera? John McDonald shows how it's done with this wide-field image of the Orion region using a 28-mm lens and a 13-nm H-alpha filter on a Canon T1i. The bright object on the left is the Rosette nebula. Barnard's loop circles the belt and sword region of Orion. The star cluster Collinder 69 that forms Orion's head is surrounded by a faint glowing nebula. Exposure was 14 x 240 sec plus 31 x 120 sec, with suitable darks and flats.