C41/ICHA SCIENCE MEETINGS

IAU XXVIII GENERAL ASSEMBLY
in Beijing, August 2012

BOOK OF ABSTRACTS

The Abstracts in this booklet have been compiled by Chris Sterken, with a minimal amount of copy editing. Some references have been omitted in order to avoid additional pages.

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EXPEDITIONS AND FIELD OBSERVATIONS

Organised by Rajesh Kochhar
Sara Schechner
Jay Pasachoff

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When the Chinese met the West: A Review of the Dissemination and Influence of Indian, Arabic and European Astronomy and Astrology in the Imperial China

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Abstract

In traditional Chinese ideology, the *tianwen* (Celestial Patterns) and *lifa* (Calendar) are important matters in the legitimization and maintenance of a regime. From very early times, astrology and astronomy became a crucial element in statecraft and establishments were always installed in the government to take care of these matters, which formed a tradition very scrupulously observed and documented by every Chinese dynasty without substantial interruption in thousands of years. A special system consisting of astrology and astronomy was developed and kept on developing on its own track. Such a long and well established tradition did not prevent China from receiving, though sometimes with reluctance and selection, arts and knowledge in astronomy and astrology from outside that might supplement and enhance the indigenous ones. This talk will give a survey on the history of the Chinese reception of astronomical and astrological knowledge from "the West", namely, India in the 7th to 10th centuries, Arabic area in the 13th to 15th centuries and Europe in the 16th to 18th centuries. Except tracing down the cultural impacts of the new knowledge from outside, I will concentrate on how the new knowledge was appropriated by Chinese governments, as well as by Chinese astronomers and astrologers.

tianwen: 天文 *lifa:* 曆法

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The mid 19th and early 20th Century Pull of a Nearby Eclipse Shadow Path

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Abstract

The unique observing conditions allowed by total solar eclipses made them a highly desirable target of 19th and early 20th century astronomical expeditions, particularly after 1842. Due to the narrowness of the lunar shadow at the Earth's surface this usually implied traveling to faraway locations with all the subsequent inconveniences, in particular, high costs and complex logistics. A situation that improved as travel became faster, cheaper and more reliable. The possibility to observe an eclipse in one's own country implied no customs, no language barriers, usually shorter travelling distances and the likely support of local and central authorities. The eclipse proximity also provided a strong argument to pressure the government to support the eclipse observation. Sometimes the scientific elite would use such high profile events to rhetorically promote broader goals. In this paper we will analyse the motivation, goals, negotiating strategies and outcomes of the Portuguese eclipse expeditions made between 1860 and 1914. We will focus, in particular, on the observation of the solar eclipses of 22 December 1870 and 17 April 1912. The former allowed the start-up of astrophysical studies in the country while the movie obtained at the latter led Francisco da Costa Lobo to unexpectedly propose a polar flattening of the Moon.

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Observatories in South America: from Astronomical Expeditions to the Foundation of National Observatories

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Abstract

One of the consequences of the 19th century development of institutional astronomy in the northern hemisphere (Europe and North America) was the rising number of expeditions sent from these countries to the southern hemisphere. We shall describe how the observation of oppositions of Mars in Chile (1849–1852), that of a solar eclipse in Brazil (1858), and that of a transit of Venus in Argentina (1882) led directly and indirectly to the foundation of permanent observatories in Santiago (1852) and Córdoba (1871), to the organisation of an imperial observatory in Rio de Janeiro (1871) and to the development of one in La Plata (1883). We shall examine the influence exerted by the first directors of these observatories – all coming from the northern hemisphere – and in each case we shall study the processes that later led to the development of a national astronomy.

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La Caille's Expedition to the Cape of Good Hope 1751–3

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Abstract

Nicolas-Louis de La Caille (1713–1762) of the Collège Mazarin in Paris was one of the greatest observational astronomers of the eighteenth century. In 1751 he persuaded the Royal Academy of Sciences to send him to the Cape of Good Hope to make a survey of the southern sky, the first systematic sky survey ever undertaken. At the Cape he worked every night for a year, observing swathes of the sky 3° wide in declination, timing the transits and interpolating the declinations of about 10 000 stars. He measured the distances of Mars and Venus (at their times of closest approach) by observing them simultaneously with European observers. He also determined the orbit of the Earth by observing the apparent orbit of the Sun, found the latitude and longitude of the Cape and generated new tables of atmospheric refraction. Additionally, he made a note of every extended object that he saw, more than doubling the number known. The existing constellations of the southern sky he found to be poorly defined. He named fourteen new ones after the scientific instruments of the time. An exceptional new name was Mons Mensa, or Table Mountain.

After finishing his celestial observations he made an expedition to the north of Cape Town to determine the local radius of the earth by means of latitude observations taken in conjunction with a precise geodetic survey. To his surprise, he found the planet to be somewhat pear-shaped. This incorrect result was afterwards attributed to deflection of his plumb lines by nearby mountains.

La Caille returned to France via Mauritius and Réunion in 1754. The eight months of his life that he spent at sea led to an interest in navigational matters. He was largely responsible for showing

the potential and limitations of "Lunars" for the determination of longitudes. This method was of practical use to navigators for many decades, until chronometers became cheap and reliable.

La Caille died relatively young, at the age of 49, in 1762, the same year as two other great observers, James Bradley and Tobias Mayer.

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Social Impact of Solar Eclipse in Indonesia: A Comparative Study

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Abstract

The social impact and public comprehension of the natural phenomenon varies depending on how a particular cultural background perceives the phenomenon and how the interaction between general public and the authoritative bodies has persisted.

While astronomers and scientists have taken for granted that solar eclipse is a natural phenomenon and subjected it to various scientific studies, large percentages of the population have been left uninformed scientifically and have responded to the phenomena quite differently. The technical and scientific aspects of the earliest expedition, to Padang (Sumatra) in 1901, have recently been discussed at length.Two major solar eclipses, namely the 1926 and 1929, offered many scientific outputs as well as results on observations of societies: anthropology, demography, and culinary habits of the local inhabitants.

Those days, science was the preserve of a few selected. To a certain degree, many old perceptions of on natural phenomena, with their ruling deities still lingered on.

The purpose of this paper is to show the changing views of the endogenous population in particular after the government's massive efforts to enlighten the people and to empower the younger generations in comprehending natural phenomena. The great efforts of the Government of Indonesia's Institute of Sciences (LIPI) related to the June 1983 solar eclipse produced a dramatic change in the sense of appreciation of solar eclipse as a natural phenomenon in consequence of relative motions of the Sun, Moon

and the Earth. It took however another five years, till the time of the great eclipse in 1988, to a full fruition in which younger generations as well as older ones abandoned almost completely the old views and embarked on the understanding the value of solar eclipse for science.

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Did Ibn Sina Observe the Transit of Venus of 1032 CE?

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Abstract

The Persian polymath Abu Ali ibn Sina (980–1037 CE), known to early Western sources as Avicenna, records that "I say that I saw Venus as a spot on the surface of the sun". This statement has been quoted, for example, by Nasir al Din al Tusi (1201–1274 CE). A Transit of Venus indeed took place during ibn Sina's life time, that is on 24 May 1032 CE. Did ibn Sina see this Transit or did he merely see a sunspot? The question was addressed by Bernard R. Goldstein in 1969 who concluded that "this Transit may not have been visible where he lived". Goldstein based his conclusion on the input provided by Brian G Marsden who in turn used mathematical tables prepared by J. Meeus in 1958.

I have begun re-examination of the question by employing Fred Espenak's Transit predictions. Preliminary work shows that ibn Sina could indeed have obtained a glimpse of the Transit of Venus just before sunset from places like Isfahan or Hamadan. In other words, when ibn Sina said he saw Venus on the surface of the Sun, he probably meant it.

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Transits of Venus and Colonial India

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Abstract

Astronomical expeditions during the colonial period had a political and national significance also. Measuring the earth and mapping the sky were activities worthy of powerful and power-seeking nations. Such was the sanctity of global astronomical activity that many other agendas could be hidden under it. An early astronomy-related expedition turned out to be extremely beneficial, to botany. The expedition sent by the French Government in 1735 to South America under the leadership of Charles Marie de la Condamine (1701–1774) ostensibly for the measurement of an arc of the meridian at Quito in Ecuador surreptitiously collected data that enabled Linnaeus to describe the genus cinchona in 1742.

When the pair of transits of Venus occurred in 1761 and 1769, France and England were engaged in a bitter rivalry for control of India. The observation of the transits became a part of the rivalry. A telescope presented by the British to a South Indian King as a decorative toy was borrowed back for actual use. Scientifically the transit observations were a wash out, but the exercise introduced Europe to details of living Indian tradition of eclipse calculations. More significantly, it led to the institutionalization of modern astronomy in India under the auspices of the English East India Company (1787).

The transits of Venus of 1874 and 1882 were important not so much for the study of the events as for initiating systematic photography of the Sun. By this, Britain owned most of the world's sunshine, and was expected to help European solar physicists get data from its vast Empire on a regular basis. This and the then genuinely held belief that a study of the sun would help predict failure of monsoons led to the institutionalization of solar

physics studies in India (1899). Of course, when the solar physicists learnt that solar activity did not quite determine rainfall in India, they forgot to inform the Government.

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Science News or Astrological Debating: Chinese Records of the Transit of Venus of 1874

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Abstract

The Venus transit is very important in the measuring of the distance between the sun and the earth. It ever occurred in 1874, but this time it was visible only in China and some other places in eastern sphere. So many astronomers of the western countries had to come to China to observe it. In traditional Chinese astrological explanation, the sun represented the emperor. If the sun were invaded by other stars, it means that the emperor and the country would have some ominous disasters. In late 19th century, western astronomical knowledge was widely translated into Chinese and understood by Chinese intellectuals. The Venus transit should easily be understood by Chinese intellectuals as one kind of astronomical phenomena. But early before the Venus transit taking place in 1874, many Chinese publications had to introduce this kind of celestial phenomena as science news because at same time, some influential news papers and journals also had some discussion on what astrological connection between the Venus transit of this time and the fortune of the country. This article collects these interesting Chinese records and discusses what different attitude to the Venus transit by Chinese intellectuals and officials during that period in which western learning was widely disseminated in China.

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The Eclipse Expeditions of the Lick Observatory and the Beginnings of Astrophysics in the United States

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Abstract

During the years 1898 to 1932, Lick Observatory organized a remarkable series of 17 solar eclipse expeditions, all the more remarkable because Lick astronomers evidenced no enduring interest in solar physics. The science of these expeditions involved three issues of major significance during the development of astrophysics during the first three decades of the twentieth century: (1) testing of General Relativity; (2) non-LTE in extended atmospheres and gaseous nebulae; (3) role of magnetic fields in the sun. The expeditions made major contributions to the first two topics. Even though W.W. Campbell, the director of Lick, had extensive contact with George Ellery Hale, who had measured the magnetic fields of sunspots at Mt. Wilson, Lick astronomers missed the clues concerning the importance of magnetic fields in the corona.

Campbell's measurement of the deflection of starlight at the eclipse of 1922 was his major achievement of the many eclipse expeditions. He had approached that test of General Relativity with considerable distrust of Einstein's theory and considered Eddington's 1919 results to be suspect. It is to Campbell's great credit that the results published jointly with Trumpler confirmed the predictions of Einstein with higher precision than Eddington had achieved.

Donald Menzel joined the staff of Lick Observatory in 1926 as their first astrophysicist. Osterbrock describes him as a "stranger

in a strange land." He was given the analysis of the eclipse flash spectra. This work, published in 1931, represents the beginning of the astrophysical study of chromospheres and laid the foundation for the quantitative analysis of extended atmospheres and gaseous nebula.

When Menzel left Lick for Harvard he began a series of papers on the analysis of the physical conditions in nebulae, which demonstrated major departures from thermodynamic equilibrium. The need to consider the effects of non-LTE in analyzing stellar chromospheres was thoroughly established by the 1961 monograph of Richard Thomas, a student of Menzel, and R. Grant Athay a student of Thomas. By the late 1950s, it became clear that non-LTE was so dominant in chromospheres and interstellar gasses that extensive laboratory measurements of atomic parameters were needed, for which the Joint Institute for Laboratory Astrophysics was founded in Boulder.

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Expeditions to Death and Disaster: Chappe d'Auteroche and Charles Green at the 1769 Transit of Venus

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Abstract

Scientific expeditions usually bring back information or specimens that forward human knowledge. We also prefer them to bring back the humans in good shape, but that does not always occur. I discuss the expeditions to Siberia in 1761 and to Baja California in 1769 by the French abb Jean Chappe d'Auteroche and to Tahiti in 1769 by the English astronomer Charles Green, accompanying Captain James Cook, to observe the transits of Venus. Neither Chappe d'Auteroche nor Green survived their expeditions. Chappe managed to hang on after the transit to see an eclipse of the Moon about two weeks later, and it is said that since "the intent of his voyage was fulfilled, and the fruit of his observations secured," he "died content," since "he saw nothing more to wish for." Green died of dysentery caught in Batavia (now in Indonesia) on the continuation of his expedition with Capt. Cook on the ship Endeavour after the transit.

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Value of the Astronomical Expedition to the West Spitsbergen after 40 Years

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Abstract

An astronomical expedition to the West Spitsbergen, which took place 40 years ago, was the polar Arctic observatory, in which the first astronomical observations of stars were made on the program of positional astronomy. The program of observations and determinations of right ascensions of stars at transit instrument APM-10 (D = 100 mm, F = 1000 mm) with photoelectric recording was planned for three polar nights (1974–77), and included 552 stars of the fundamental catalog FK4 in the zone of declination from $+10°$ to $+80°$. Continuous (twenty-four hours) observations with change of observers and engineers for each polar night were planned. Nikolaev observatory (at that time, Nikolaev Department of Main (Pulkovo) Astronomical Observatory, ND MAO) was the initiator and principal organizer of the expedition. The site for the expedition was chosen Barentsburg (latitude $78°05'36''$ N, longitude $14°12'36''$ E, height 44 m), the transit instrument and auxiliary equipment were prepared two years before. In total, 15 employees of Nikolaev Department (ND MAO), Pulkovo Observatory (MAO) and Astronomical Observatory of Leningrad State University (AO LSU) took part in three polar nights and ensured successful execution of the program. The work took place under special polar night conditions, such as, great remoteness and isolation from the mainland, difficult weather conditions. A great tragedy was happend with the polar explorers in the first polar night. On March 9, 1975 two astronomers fall down from steep coast fjord during the trip on the snowmobile with fatal outcome.

Results of the polar astronomical expedition to the West Spitsbergen in 1974–77 were follows:

1. The unique observations with duration of 18 or more hours were obtained during three polar nights in the environment of stable weather conditions;

2. For the first time in history, more than 15 000 stars observations were carried out during three polar nights. Most of them were included in 25 series, which were lasting from 18 to 155 hours. Almost a quarter of all observations of stars were made in two culminations under similar conditions of observation. In addition, the number of observations of each star was 25 times in average;

3. The absolute catalog of right ascension of stars Nik75 (Spz) with high accuracy was compiled by processing 13.5 thousands of most accurate observations. That catalog was used for creation of the new international fundamental catalog of the star positions FK5;

4. In 1977, the Council on Astronomy of the USSR Academy of Sciences accepted the work of the expedition to Spitsbergen as the best astronomical research in the USSR.

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Astronomy behind Enemy Lines: Colonial American Field Expeditions, 1761–1780

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Abstract

In May 1761, John Winthrop packed up two students, two telescopes, a clock, and an octant, and embarked for Newfoundland, to observe the Transit of Venus. Winthrop's departure was hasty. Only days before had the President and Fellows of Harvard College approve Professor Winthrop's request to take the college apparatus behind enemy lines during the French and Indian War, to serve the cause of science. Winthrop knew he had no time to waste if he were to reach St. Johns and properly calibrate his equipment before the Transit.

In 1761 Winthrop was the sole North American astronomer in a global network helping to determine the distance from the Earth to the Sun. The expedition was a major achievement for colonial astronomy, especially in time of war. Winthrop, however, looked forward to a second chance to observe a transit in 1769. Benjamin Franklin urged him to go to Lake Superior, but preparations for the transit were thwarted by two events: the loss of Harvard's apparatus in a 1764 fire; and pre-Revolutionary War politics in the American colonies. In the end, Winthrop was forced to content himself with observations in Cambridge.

In 1780 Winthrop's successor at Harvard, Samuel Williams, risked the college apparatus once again. During the American War of Independence, he received permission to go behind British enemy lines in order to observe a total solar eclipse in Penobscot Bay, Maine. Limitations placed on his encampment led him to be slightly outside totality, but able to observe what would later be known as Baily's beads.

This paper will examine the challenges of observational science in provincial America, especially when one had to negotiate with enemies to have access to the best apparatus and field sites.

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Solar Eclipse Expeditions of Hamburg Observatory

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Abstract

Total solar eclipses had – and still have, in spite of the maximum duration of eight minutes – an important meaning for astronomical research. For a long time in the 19th century astronomers were searching for a planet inside the orbit of Mercury. But especially, the solar atmosphere was studied: during an eclipse the bright photosphere is covered by the moon and enables the observation of the chromosphere with the prominences and the flash spectrum.

George Rümker (1832–1900), the third director of Hamburg Observatory, made a solar eclipse expedition to Spain in 1860. He used only small instruments like a 4-foot Fraunhofer telescope and a comet seeker. Richard Schorr (1867–1951), the director of the new Hamburg Observatory in Bergedorf, observed in 1905 the solar eclipse in Algeria and put the emphasis on astrophysical research, investigation of the inner corona and the prominences. A horizontal telescope with 20-m focal length and an equatorial double refractor were acquired, both instruments made by Carl Zeiss of Jena. This instrumentation and many smaller instruments were used for all the expeditions in the 1920s, like in 1922 – Java, in 1923 – Mexico, in 1925 – Atlantic Ocean, in 1927 – Jokkmokk, Sweden, and in 1929 – Philippines. These Hamburg solar expeditions of the 1920s put the emphasis on two topics: to solve the so-called riddle of coronium, or mystery of coronium – the nature of the green emission line – and to measure the deviation of light for verifying Einstein's general theory of relativity.

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Jean-Charles Houzeau's Visual Magnitude Estimates from Jamaica in 1868

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Abstract

Jean-Charles Houzeau de Lehaie (1820-1888) was a Belgian astronomer who, as an observer, covered astronomy, geography, cartography, geodesy and natural sciences. He is known for designing the "heliometer with unequal focal lengths" for the 1882 transit of Venus, for which he organised two expeditions: one to San Antonio (Texas), and one to Santiago (Chile).

Less known, but historically important from the point of view of his consistent approach to observational science, was his "Uranométrie générale", in which he systematically recorded visual magnitudes of 5719 northern and southern stars up to mag 6.4. He carried out the visual estimates from Jamaica in less than 400 nights in 1875–76.

This presentation discusses the observational approach of his project, and weighs the merit of a dataset that was produced in one throw, by one single person from one single observing site of excellent atmospheric quality, without any recourse to data produced by other observers. A proving example of the virtue of Houzeau's Uranométrie is that it has been used in the construction of the charts of the first edition of "Norton's Star Atlas".

DISCOVERY AND CLASSIFICATION IN ASTRONOMY

Organised by Steven Dick
Ken Kellerman

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The Reclassification of Pluto as a Dwarf Planet

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Abstract

At the IAU General assembly in Prague in August 2006 a resolution was passed to define a class of Dwarf Planets and to reclassify Pluto as the prototype of this new class of objects. This event received a high level of attention, in the public, and in the astronomy and the planetary communities. The issue was primarily one of classification in astronomy and in this case a new classification received an unusually high level of attention. I will describe the background to this event and some of the IAU reasoning for handling it the way we did. It is certainly interesting that a debate on astronomical classification received so much visibility and had ramifications well beyond the astronomy community. Since 2006 we have had spirited discussions on the www and in other fora and some rumblings still continue. However we do now have an orderly naming process for our solar system objects, which already includes at least 5 classified dwarf planets.

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A General Framework for Discovery and Classification in Astronomy

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Abstract

An analysis of the discovery of 82 classes of astronomical objects reveals an extended structure of discovery, consisting of detection, interpretation and understanding, each with its own nuances and a microstructure including conceptual, technological and social roles. This is true with a remarkable degree of consistency over the last 400 years of telescopic astronomy, ranging from Galileo's discovery of satellites, planetary rings and star clusters, to the discovery of quasars and pulsars. Telescopes have served as "engines of discovery" in several ways, ranging from telescope size and sensitivity (planetary nebulae and spiral nebulae), to specialized detectors (TNOs) and the opening of the electromagnetic spectrum for astronomy (pulsars, pulsar planets, and most active galaxies). A few classes (radiation belts, the solar wind and cosmic rays) were initially discovered without the telescope. Classification also plays an important role in discovery. While it might seem that classification marks the end of discovery, or a post-discovery phase, in fact it often marks the beginning, even a pre-discovery phase. Nowhere is this more clearly seen than in the classification of stellar spectra, long before dwarfs, giants and supergiants were known, or their evolutionary sequence recognized. Classification may also be part of a post-discovery phase, as in the MK system of stellar classification, constructed after the discovery of stellar luminosity classes. Some classes are declared rather than detected, as in the case of gas and ice giant planets, and, infamously, Pluto as a dwarf planet. Others are inferred rather than detected, including most classes of stars.

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Discovery and the Search for the Design of the Universe

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Abstract

Astronomers tend to think of their discoveries as part of a larger set of astronomical endeavors engaging their community at a particular time. That the complexion of discoveries is dependent on societal or economic factors, if recognized at all, is often considered a regrettable distraction from a logical path forward. Actually, the opposite is true: In the second half of the 20th century, astronomical discoveries were dominated by societal priorities. As World War II was ending, the United States embarked on a national program of post-war research that would seamlessly coordinate basic research in academic institutions with efforts to strengthen the nation's economy and military security. As part of this thrust, astronomy became driven by radio, infrared, X-ray, and gamma-ray discoveries, many initially made as part of military programs, before academic astronomers and astrophysicists adopted the new tools. Similarly coordinated national research programs also began to shape research in other nations. I will describe these arrangements before turning to two questions: 1) Can such coordinated national research programs survive into the 21st century, when most military institutions are loath to release classified information on sophisticated detection systems to the large international consortia required to share progressively mounting costs? 2) Has our vision of the Cosmos, today, been selectively shaped by the instrumentation made available to astronomy, through society's military and economic priorities?

We need only think of how our concepts of the Universe have changed since the days when ground-based optical techniques were the sole means for probing the Universe.

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Cognitive Astrophysics

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Abstract

Cognitive Astrophysics works at the cusp between Cognitive Science and Astrophysics, drawing upon lessons learned in the Philosophy of Science, Linguistics and Artificial Intelligence. We will introduce and illustrate the concept of "Downward Causation," common in philosophical discussions, but either unknown to or disdained by most physicists. A clear example operating on cosmological scales involving the origin of large-scale structure will be given. We will also make the case that on scales exceeding most laboratory experiments, self-gravitating matter can be considered to be in a "fifth state", characterized primarily by its negative specific heat, as first recognized by Lynden-Bell and Lynden-Bell (1977, MNRAS, 181, 405). Such systems increase their temperature as they lose energy. Numerous examples will be given and discussed.

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"A Desideratum in Spectrology": an Editor's Lament in the Great Correlation Era

David DeVorkin

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Abstract

Of all the known observable characteristics of the stars in the late 19th Century, classification by the appearance of their spectra was by far the most problematic. In 1904, Edwin Frost lamented that some 23 distinct classification systems had been created, yet none were universally accepted. In 1908, the applied mathematician Karl Pearson and a student evaluated correlations between spectra and other characteristics of the stars, hoping to "look upon the stellar universe as an orderly whole . . . by which we pass from chaos to an organised and locally differentiated cosmos." None of the major spectral systems, however, allowed them to draw any conclusions, other than state a high correlation with color. Yet, by 1917, astronomers were making correlations, and applying them, to make some pretty strong statements about the nature and history of the sidereal system as well as the lives of the stars. One of the strongest was the technique of spectroscopic parallaxes. But even its discoverer, Walter Sydney Adams, worried about what it all meant. Writing to Eddington in 1917, Adams wished that "we had more physical knowledge regarding the interpretations of stellar spectra." And as E. A. Milne observed some years later, in retrospect, "[t]here was a gap in the logical argument."

My talk will address some historiographical issues arising from this phase in the development of modern astrophysics that hopefully will illuminate why the gap was closed in the way it was closed, and the effect it had on the continuing process of spectral classification.

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The Overdue Discovery of Quasars and AGN

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National Radio Astronomy Observatory

Abstract

The extragalactic nature of quasars as a major new component of the Universe was not recognized until 1963 when Maarten Schmidt somewhat accidentally measured the spectrum of 3C 273 and recognized that the relatively simple hydrogen line Balmer series spectrum implied a redshift of 0.16. Curiously, 3C 48 and other very compact radio sources had been previously identified with "quasi-stellar" objects several years earlier. Even though the redshift of 3C48 was measured as early as 1960 as 0.37, it was rejected due to apparent spectroscopic technicalities and preconceived ideas about what appeared to be an unrealistically high luminosity.

The strong radio source known as 3C 273 was first catalogued in 1959 and the now recognized magnitude 13 optical counterpart was known at least as early as 1887. Although, since 1960, much fainter optical counterparts were being routinely identified using accurate radio interferometer positions, interestingly, 3C273 eluded identification until a series of lunar occultations by Hazard et al. in 1962 were used to determine the position and morphology of the radio source.

Acceptance of the cosmological nature of quasars and the implied excessive radio and optical luminosity was not universal, and claims for a more local population continued for at least several decades, confused perhaps by the recognition of the much larger class of radio quiet quasi stellar objects and active galactic nuclei (AGN), the uncertain connection with previously known Seyfert and other compact galaxies, as well as attempts to classify quasars into numerous sub-categories based on their observed optical, radio, IR and high energy properties.

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Mining the Observational Phase Space

Ray Norris

CSIRO, Australia

Abstract

Experience has shown that many great discoveries in astronomy have been made, not by testing a hypothesis, but by observing the sky in an innovative way. The necessary conditions for this to take place are (a) a telescope observing an unexplored part of the observational phase space (frequency, resolution, time-domain, area of sky, etc), (b) an intelligent observer who understands the instrument sufficiently well to distinguish between artefact and discovery, (c) a prepared and enthusiastic mind ready to accommodate and interpret a new discovery. Next generation survey telescopes will easily satisfy (a), if only in terms of the numbers of objects surveyed. However, their petabytes of data, and arms-length access, may prevent an observer from satisfying (b) and (c). We can only hope that someone will eventually stumble across any unexpected phenomena in the data. However the impenetrable size of the database implies dark corners that will never be fully explored. Discoveries may remain undiscovered, forever.

What is the alternative? Can we harness data-mining techniques to help the intelligent observer search for the unexpected? I believe we can, and indeed we must if we are to reap the full scientific benefit of next-generation survey telescopes.

EXTENDED CASE STUDIES OF KEY ASTRONOMICAL HERITAGE SITES

Organised by Clive Ruggles
on behalf of the
Astronomy and World Heritage Working Group

C41/ICHA Science Meetings
International Astronomical Union, XXVIII General Assembly
Beijing, August 2012

IAU Extended Case Studies of Key Astronomical Heritage Sites

Clive Ruggles

University of Leicester, UK

Abstract

Following a directive from the IAU in 2010, members of the WG have been developing 11 "extended case studies" in order to explore and clarify some of the key general issues that can arise in the particular case of astronomical heritage sites. Specific extended case studies might well facilitate the eventual preparation of a full nomination dossier should a State Party decide to prepare one, but this is not the aim of our work.

While dark sky areas cannot in themselves be recognized by UNESCO as specific types or categories of World Heritage cultural or natural property, the WG has a strong interest in how dark sky issues might best be represented within nomination dossiers for various types of astronomical heritage site. For this reason, more than half of the extended case studies relate in one way or another to such issues.

These case studies will be presented to the General Assembly for formal approval at the second plenary session, as part of the General Secretary's report. This session will provide a more detailed presentation of the ECSs and a discussion forum where delegates can give their reactions and feedback and raise issues.

Provisional programme

1. Background and purpose of the Extended Case Studies (Clive Ruggles, WG Chair)

2. Presentation of selected extended case studies:

   - The Royal Observatory, Cape of Good Hope, South Africa (Ian Glass, South African Astronomical Observatory)

- Bayconur Space Launch Facility, Russian Federation (Mikhail Marov, Russian Academy of Sciences)
- The Canarian observatories, Spain (Cipriano Marn, Starlight Foundation)
- Mauna Kea Observatory, Hawaii, USA (Richard Wainscoat, Institute for Astronomy, University of Hawaii)
- The Aoraki Mackenzie Starlight Reserve, New Zealand (John Hearnshaw, University of Canterbury, NZ)

3. Discussion forum

CONSERVATION AND PROTECTION OF DIFFERENT CATEGORIES OF ASTRONOMICAL HERITAGE

Organised by Clive Ruggles
Sara Schechner

C41/ICHA Science Meetings
International Astronomical Union, XXVIII General Assembly
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Different Categories of Astronomical Heritage: Issues and Challenges

Clive Ruggles

University of Leicester, UK

Abstract

Since 2008 the AWHWG has, on behalf of the IAU, been working with UNESCO and its advisory bodies to help identify, safeguard and promote cultural properties relating to astronomy and, where possible, to try to facilitate the eventual nomination of key astronomical heritage sites onto the World Heritage List.

Unfortunately, the World Heritage Convention only covers fixed sites (i.e., the tangible immovable heritage of astronomy), and a key question for the UNESCO-IAU Astronomy and World Heritage Initiative (AWHI) is the extent to which the tangible moveable and intangible heritage of astronomy (e.g. moveable instruments; ideas and theories) influence the assessment of the tangible immovable heritage. Clearly, in an ideal world we should be concerned not only with tangible immovable heritage but, to quote the AWHWG's own Terms of Reference, "to help ensure that cultural properties and artefacts significant in the development of astronomy, together with the intangible heritage of astronomy, are duly studied, protected and maintained, both for the greater benefit of humankind and to the potential benefit of future historical research".

With this in mind, the IAU/INAF symposium on "Astronomy and its Instruments before and after Galileo" held in Venice in SepOct 2009 recommended that urgent steps should be taken

1. to sensitise astronomers and the general public, and particularly observatory directors and others with direct influence and control over astronomical resources, to the importance of identifying, protecting and preserving the various material products of astronomical research and discovery that already have, or have

significant potential to acquire, universal value; (N.B. National or regional interests and concerns have no relevance in the assessment of "universal value", which, by definition, extends beyond cultural boundaries and, by reasonable expectation, down the generations into the future.

2. to identify modes of interconnectivity between different forms of astronomical heritage, including its intangible aspects, that will help in the development of more integrated approaches to identification and cataloguing, protection and preservation; and

3. to increase global awareness of regional, national and local initiatives relating to astronomical heritage in all its forms.

In pursuance of these aims, the meeting also recommended that the AWHWG, working in collaboration with the WGs on Astronomical Instruments and Archives, and other bodies as appropriate, should develop the following additional projects:

1. to establish guidelines to help in the identification and safeguarding of tangible and intangible astronomical heritage in all its forms;

2. to gather examples of existing best practice, and to make these available as case studies on their website; and

3. to develop the website of the Astronomy and World Heritage Initiative (AWHI) as a portal to existing on-line catalogues and thesauri.

It also recommended that the WGs should work together to:

1. formulate recommendations about the ways in which links and common approaches should be developed in the future; and

2. organise a meeting of international experts in the historical and heritage aspects of astronomical structures, instruments, and archives, focussed specifically upon the task of developing more integrated approaches to identification and cataloguing, protection and preservation.

This joint session will attempt to make headway on as many as possible of these issues. In this opening talk I will attempt to lay out some of the main challenges that we face, and outline what we hope to achieve in this session.

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Preservation Challenges in North America: Recent Efforts by the American Astronomical Society

Sara J. Schechner

Harvard University, Collection of Historical Scientific Instruments, Cambridge, Massachusetts, USA

Abstract

In January 2007 in Seattle, the Council of the American Astronomical Society established the Working Group for the Preservation of Astronomical Heritage (WGPAH) in response to a report from the society's Historical Astronomy Division (HAD). Twelve members of WGPAH are chosen on the basis of their professional qualifications relating to the preservation of sites, astronomical instruments, and historical documents. Two additional members represent the concerns of active research observatories.

WGPAH is charged with developing and disseminating procedures, criteria and priorities for identifying, designating, and preserving astronomical structures, instruments, and records so that they will continue to be available for astronomical and historical research, for the teaching of astronomy, and for outreach to the general public. The Working Group may interact with other academic, international, or governmental organizations, as appropriate to advance the preservation of astronomical heritage.

As a founding member of the Working Group, I will speak about both the AAS's initiatives and the leadership it has shown in affirming the value of historical astronomical data, glass plates, instruments, observatories, research papers, and editorial records. I will also describe the challenges faced in preserving these things in North America.

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The Cape Observatory: all Categories of Heritage

Ian S. Glass

South African Astronomical Observatory

Abstract

In this presentation I will give an outline of the various types of heritage related to the Royal Observatory, Cape of Good Hope, established in 1820 and now the headquarters campus of the South African Astronomical Observatory, located quite close to downtown Cape Town.

In terms of tangible, fixed heritage, the campus itself, the domes and the various other buildings are obviously relevant. This category includes the Classical Revival Main Building of 1828 and the McClean dome of 1895 by the leading colonial architect Herbert Baker as well as many other buildings and even the graves of two directors.

Tangible movable items include, in principle, the telescopes, the accessory instruments and many pieces of apparatus that have been preserved. In addition, extensive collections of antique paintings, drawings, furniture and books add to the site's cultural significance. Many of the Observatory's archives are still kept locally.

The intangible heritage of the Observatory consists for example of its history, its major discoveries, its interaction with the City, its central role in the history of science in South Africa and its appeal as a living cultural institution. Especially notable were the observations by Henderson (ca 1831) leading to the distance of a Cen and the early sky survey known as the Cape Photographic Durchmusterung.

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Pulkovo Observatory and its Former Branches in the Crimea and Nikolaev

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Abstract

The Central Astronomical Observatory at Pulkovo was founded in 1839 for "providing permanent and, as far as possible, the most perfect observations aimed at the prosperity of Astronomy and necessary for geographic undertakings of the Russian Empire and for ends of the Practical Astronomy as well". The first director of the Pulkovo was the prominent astronomer F.G.W. Struve (1793–1864). The Observatory was designed by the well-known architect Alexander Brüllow. The three-dome Pulkovo style was propagated over the world. Widely-used methods of astrometric observations along with famous fundamental star catalogs were developed in Pulkovo. The Observatory has kept the leading position in Russia up to date, conducting research in all major areas of astronomy – astrophysics, solar physics, radio astronomy, astrometry, celestial mechanics, etc.

In 1908, the south branch of Pulkovo Observatory in Simeiz (Crimea) was organized, where both systematic observations in search of new comets and minor planets, photometric and spectroscopic observations of stars and galaxies were started. These observations yielded fundamental results concerning rotation of stars, structure of galaxies, the role of magnetic field in interstellar medium. In 1945 Crimean Astrophysical Observatory of USSR Academy of Science (now Scientific Research Institute "Crimean Astrophysical Observatory", Ukraine) was founded on the base of the Simeiz department. Now it is a leading astronomical institution in Ukraine. Areas of research at CrAO are solar

physics, chemical composition and activity of stars and their surroundings, extragalactic studies, geo-dynamics, small bodies in the Solar System and in the near-Earth space, instrumentation for ground-based and space astronomy.

In 1912, Nikolaev branch of Pulkovo Observatory was organized on the basis of the oldest in Russia Naval Observatory in Nikolaev, which was founded in 1821 by Admiral A. Greig, chief commander of the Black Sea Fleet. Regular astrometric observations of stars for creation a high-precision stellar catalogs and observations of planets for refinement of their orbits and masses were conducted there for 190 years, including 100 years of collaboration with Pulkovo Observatory. At present, the near-Earth space studies, development of astronomical instrumentation, research in history of astronomy are carried out as well.

Thus, Pulkovo Observatory (Russia) together with Astrophysical Observatory and Nikolaev Observatory (Ukraine) form a transnational network, linked by the common theme of the UNESCO project "Route of European astronomical observatories".

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The Sensitization of French Observatory Directors to Astronomical Heritage

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[2]*Ministry of Culture, Paris, France*

Abstract

An inventory of the heritage of historical astronomical observatories was launched in the mid 1990s as part of a collaboration between the Ministry of Research and the Ministry of Culture. This has produced a significant body of knowledge not only on astronomical instruments, but also on the specificities of astronomical sites and on the architecture of observatories. Other major results of this operation are (i) the development of numerous works on the institutional history of observatories and (ii), at the request of a few directors, the protection as historical monuments of some buildings and of collections of instruments. Given that knowledge about astronomical heritage is a prerequisite for proper conservation and intelligent outreach, and given also that the protection of such heritage (as historical monuments) is a major asset that bolsters its cultural value, the long term sustainability of such heritage depends on political decisions and the search for financial support. We shall describe the complex administrative situation of French observatories and outline the various actions undertaken recently to sensitize their directors to astronomical heritage issues.

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The Stranglehold on Time-Domain Astronomy: Preserve the Plates or Lose the Science

Elizabeth Griffin

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Abstract

Many celestial objects of all types exhibit changes within the time-frame of humanity's collective memory. Investigating, analysing and understanding those changes—be they periodic, irregular, slow, recurring or explosive—is at the very heart of most astrophysics. But essential progress in our science is limited to the time-span of the observational data which can be readily accessed and incorporated into modern analyses, and that time-span is currently no longer than that of our all-digital data archives—a mere 15 years *at most*. A great many important changes are longer than that, but we have no way of learning about them even though almost all the observations ever recorded by most observatories still exist. Those inherited data may be absolutely critical to solving a problem, and many enable science that cannot otherwise be even attempted, but they are not in electronic format so today's astronomers cannot get access to the information which they need.

Our wealth of inherited observations, mostly in observatory plate stores, are in increasing danger of loss from a multitude of causes, and moves are afoot to digitize them appropriately in order to provide that much-needed broadening of astrophysical understanding. The scientific case is irrefutable, the technology is understood, and expertise is still available; it is only money that is in short supply. Once the preservation and correct digitization of those older data can be funded, astronomy will quickly be benefiting from a greatly extended baseline for time-domain studies.

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A Fifty-year Photographic Archive on the History of Radio Astronomy in Australia

Jessica Chapman

CSIRO, Australia

Abstract

No Abstract received.

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"Campo del Cielo" Meteorites: Astronomical Heritage and Cultural Colonialism

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Abstract

In the province of Chaco, Argentina, there is a very unique dispersion of metallic meteorites called "Campo del Cielo". One of the meteoric fragments of this dispersion, the meteorite called "El Chaco", consisting of 37 tons, is the second heaviest in the world. These meteorites are of great importance to the worldview of the Moqoit, aboriginal people that inhabit this region. For the local Creole population the meteorites are also relevant, that's why they have being cited in numerous documents and reports since the colonial period.

During the first months of 2012, two Argentine artists and the Artistic Director of the German contemporary art exhibition called dOCUMENTA (13) tried to move "El Chaco" meteorite to Germany in order to exhibit it as an artistic object. Due to the fact that moving the meteorite could have a negative impact according to the Moqoit cosmology and that they were not able to participate in the decision they begun a manifestation against the movement of El Chaco. The opposition made by aboriginal communities and experts in cultural astronomy was able to stop the transfer. The whole process and its impact on the local community have promoted a deep discussion about art, science and cultural colonialism.

In this paper we aim to address this debate and its consequences. This will allow us to think about contemporary forms of colonialism that are hidden in many scientific and artistic projects. Furthermore, we aim to debate about the most effective ways of protecting astronomical heritage in the Third World.

HISTORICAL ASTRONOMICAL INSTRUMENTS, OBSERVATORIES, AND SITES

Organised by Historical Instruments
Working Group of C41

C41/ICHA Science Meetings
International Astronomical Union, XXVIII General Assembly
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Octants and Sextants before the 1860s Preserved in Japan

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Abstract

The octant was invented in 1731 independently in the UK and US, and the sextant by John Campbell around 1757. Octants were brought to Japan in the 1770s by ships of the Dutch East India Company. A Dutch booklet manual on octants "Beschryvinge van het Octant en deszelfs Gebruik" (Description of the octant and its usage) written in 1749 by Cornelis Douwes was translated into Japanese at Nagasaki in the 1780s–90s. This translation triggered serious attention of Japanese astronomers to octants. Because those instruments had no chance to be used in ocean navigation due to the strict seclusion policy forced by the then Shogunal government, the Japanese instead devised methods to use octants and sextants for land surveying. Sextants specially designed for the ground measurements were made, and even precursor instruments of the modern range finder were also produced.

In this paper we report results of our recent survey investigation of octants and sextants preserved in Japan, which were imported or home-made before the 1860s. About ten objects were identified. We describe their characteristics in terms of originality and influence from overseas products. We also plan to report on accurate measurements of some of domestic products of the 19th century using a modern standard scale, in an attempt to infer how the Japanese artisans at that time could inscribe the graduation without such as a Ramsden's dividing machine.

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The Astronomical Instruments from the Tomb of Xiahou Zao (? - 165BCE) Revisited

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Abstract

In 1977, archaeologists unearthed a piece of lacquerware from the tomb of Xiahou Zao (?–165BCE), the 2nd Marquis of Ruyin of the Western Han dynasty (206BCE–24ACE). It has been named "A Lacquerware Article of Unkown Name" for no one understands its function. Our analysis shows that the article is actually a gnomon for the determination of 4 major seasons in ancient Chinese calendar, viz. Spring Equinox, Summer Solstice, Autumn Equinox and Winter Solstice, and the size and function of the article coincide quite well with those of the "Earth Gnomon-Scale" as described in the Rites of Zhou, a Confucian Classic appeared in the middle of the 2nd century BCE. This is the earliest example of its kind that we have hitherto seen in a complete form. Moreover, the "Disks with 28 Lunar Lodges" from the same tomb have caused a lasting dispute over their possible function. While some scholars believe it to be a pure astrological instrument, others guess that it was an instrument for the measurement of celestial coordinates. Our analysis shows that, with the so-called "Supporting Frame for the Cosmic Boards" unearthed from the same tomb, the disks can actually be mounted onto the plane of the celestial equator and thus form the earliest and definitely dated example of an equatorial device for astronomical observation that still can be seen in the world.

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Restoration Model Research of *Heumgyeonggaknu* in Sejong Era

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Abstract

Heumgyeonggaknu (an alternative, namely *"Ongnu*) is an astronomical clock was made by *Jang Yeong-sil* in 1438 and it was designed to run on water-hammering method. The structure of Heumgyeonggaknu is divided into three parts, mountain, flatland and support. The appearance of Heumgyeonggaknu is the figuration of Gasan (pasted-paper imitation mountain) and the *Binpungdo* (landscape of hard farming work scene) is painted on flatland which is located on the fringe of the *Gasan*. The sun-movement device, *Ongnyeos* (jade female immortals; I) and Four Gods (shaped of animal-like immortals) are equipped on near the top of the mountain and Musas (warriors) and Sasin (time manager) are equipped on the foot of the mountain. Twelve Gods (Ongnyeos) and *Gwanin* are equipped on flatland.

We did an analysis of the Heumgyeonggaknu's appearance in advance and in this study, inner structure based on working mechanism, shape of connector and control device of water wheel.

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The French Jesuit Mission to Thailand in the 1680s and the Establishment of a Major Astronomical Observatory

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Abstract

The first great Thai ruler to encourage the adoption of Western culture and technology was King Narai, and his enlightened attitude led to the rapid development of Thailand. King Narai also had a passion for astronomy, and he pursued this interest by allowing French Jesuit missionaries to set up a large modern well-equipped astronomical observatory in Lopburi Province between AD 1685 and 1687. This was known as the Wat San Paolo Observatory, and King Narai and the missionaries observed a total lunar eclipse on 10 December 1685 and a partial solar eclipse on 30 April 1688. These observations and others made at Wat San Paolo Observatory during the 1680s marked the start of modern scientific astronomy in Thailand.

In this paper we discuss King Narai's scientific and other interests, the founding of the Wat San Paolo Observatory, the missionaries who conducted the astronomical programs, their instruments and their observations. We also describe the surviving ruins of the Observatory and their interpretation as a site of national scientific importance in Thailand.

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Algiers, La Plata, Nice: Three Prestigious and Emblematic Astronomical Observatories in the 1880s

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[2] *Ministry of Culture, Paris, France*

Abstract

We shall describe the political and scientific contexts of the concomitant foundation on three continents of three observatories particularly well equipped instrument-wise: the "ideal" observatory erected in Nice by the sponsor Raphal Bischoffsheim, the one developed in Algiers by the French State in a very good observational site, and the one in La Plata embedded in the urbanistic utopic project for the new capital of the Province of Buenos-Aires. We shall also explore their similarities and differences, especially as regards their instruments and their makers, their scientific aims and training of their staff.

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The Astronomical Observatory of the University of Coimbra (1772–1799): its Instruments and Scientific Activity

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IGUC (Instituto Geof´ísico Universidade de Coimbra, Portugal).
CFV (Centre François Viète d'Épistémologie, Histoire des Sciences et Techniques) Université de Nantes, France

Abstract

The establishment of scientific education at the University of Coimbra was one of the most important features of the Reform of the University in 1772. One of the best examples is the creation of the Faculty Mathematics and of the Astronomical Observatory (OAUC) - it was here that Alexandre Gouveia (1731–1808), who would be bishop of Beijing (1785–1808), obtained his degree in Mathematics.

The foundation of the OAUC was fundamental in the institutionalization of astronomical science in Portugal, during a period when astronomy, supported by the great theoretical advances of the celestial mechanics and applied mathematics, could finally provide some important solutions to the most prominent scientific problems since Newton (questions about celestial mechanics, navigation, geodesy, etc.). Such questions were also central in the conception and planning of OAUC the first Portuguese university-based astronomical observatory, although with aspects of a National Observatory.

Jose Monteiro da Rocha (1734–1819) was the central personality in the conception, planning and construction of OAUC, as well in its instrument's provision (purchased and assembled throughout the 1780s) and posterior scientific activity.

The construction of the OAUC was originally planned for the site of the Castle of the city of Coimbra. In 1775, when only the

first floor of the Observatory was built, the construction stopped. However, to fulfill the teaching needs a small provisional Observatory was built inside the courtyard of the University. This provisional Observatory would eventually run for about 15 years! The definitive OAUC was built between the years 1790–99.

In this communication we pretend to study the establishment of the OAUC and its primary astronomical collection (a transit instrument, a portable quadrant, a sector, several telescopes, etc.) and how that collection was responsible for the construction plan of the OAUC and the establishment of its Astronomical Ephemeris (1803).

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Nikolaev (Mykolayiv) Astronomical Observatory as the Object of the Ukrainian Tentative List WH UNESCO

Gennadiy Pinigin and Zhanna Pozhalova

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Abstract

Nikolaev Astronomical Observatory (NAO), one of the oldest scientific institutions of the South-Eastern Europe, was founded as a naval observatory in 1821 for providing the needs of the Russian Black Sea Navy. It is a historical and astronomical complex with a reserved territory of total area 7.1 hectares, situated in the central part of Mykolaiv city, Ukraine. The beginning of scientific research at the Observatory is connected with the activity of Karl Knorre, its first director. From 1912 up to 1991, NAO was one of the Southern departments of Pulkovo Observatory with the main purpose to spread the system of absolute catalogs to the Southern hemisphere and to carry out regular observations of the Solar system bodies. Since 1992 NAO has become an independent leading institution of Ukraine in the field of positional astronomy, dynamics of Solar system bodies, research of near-Earth space, astronomical instrumentation. In 2007, it was inscribed in the Tentative UNESCO List of WH (#5116).

The most significant part of the complex is the Main building, which was built in the style of Classicism in 1821–1829 (the monument of architecture #535 in the state registry). Also, the astronomical pavilions (1875, 1913, 1955, etc.) and instruments were preserved. Among them three Repsold instruments: meridian circle (1834), portable circle (1868) and vertical circle (1897). The unique astronomical and navigational devices, the collection of astronomical clocks are present in the observatory museum and the paper archive since the foundation of observatory is preserved.

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New Life for Astronomical Instruments of the Past at the Astronomical Observatory of Taras Shevchenko

Liliya Kazantseva

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Abstract

Astronomical instruments of the past are certainly valuable artifacts of the history of science and education. Like other collections of scientific equipment, they also demonstrate *i*) development of scientific and technical ideas, *ii*) technological features of the historical period, *iii*) professional features of artists or companies – manufacturers, and *iv*) national and local specificity of production.

However, astronomical instruments are also devices made for observations of rare phenomena – solar eclipses, transits of planets of the solar disk, etc. Instruments used to study these rare events were very different for each event, since the science changed quickly between events.

The Astronomical Observatory of Kyiv National Taras Shevchenko University has a collection of tools made by leading European and local shops from the early nineteenth century. These include tools for optically observing the first artificial Earth satellites, photography, chronometry, and meteorology. In addition, it has assembled a library of descriptions of astronomical instruments and makers'price-lists. Of particular interest are the large stationary tools that are still active in their pavilions. Almost every instrument has a long interesting history.

Museification of astronomical instruments gives them a second life, expanding educational programs and tracing the development of astronomy in general and scientific institution and region in particular. It would be advisable to first create a regional database of these rare astronomical instruments (which is

already being done in Ukraine), then a common global database. By combining all the historical information about astronomical instruments with the advantages of the Internet, you can show the full evolution of an astronomical instrument with all its features. Time is relentless, and much is destroyed, badly kept and thrown in the garbage. We need time to protect, capture, and tell about it.

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Analysis of Time Data in Chinese Astronomical Almanacs of the Late 18th Century

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Abstract

We investigated the time data in Chinese astronomical almanacs of the late 18th century in order to estimate the accuracy of the Shixian calendar. It is known that the calendar was enforced during the period of the Ching dynasty (1664–1912), and several astronomical almanacs using the calendar are preserved in the Kyujanggak Institute for Korean Studies of Korea; these almanacs cover the years 1772, 1773, 1774, 1780, 1781, 1783, 1785, and 1787. We compiled the times of the new moon, sunrise/sunset, and twenty-four seasonal subdivisions from the almanacs and compared them with the results of modern calculations. As a result, we found that the times of the new moon and twenty-four seasonal subdivisions show average differences of $\sim 3.35 \pm 4.43$ and $\sim 9.67 \pm 13.24$ min, respectively.

Regarding he sunrise/sunset time, however, we found that the difference was less than 1 min when we defined the time as the moment that the zenith distance (z) of the Sun is 90°, unlike the modern definition, $z = 90°50'$. We expect that this study to contribute to the understanding of the accuracy obtained by Shixian calendar in calculations of the movements of celestial bodies.

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Kharkiv Meteor Radar System (the XX Age)

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Abstract

Kharkiv meteor radar research are of historic value (Kolomiyets and Sidorov 2007). Kharkiv radar observations of meteors proved internationally as the best in the world, it was noted at the IAU General Assembly in 1958. In the 1970s Kharkiv meteor automated radar system (MARS) was recommended at the international level as a successful prototype for wide distribution. Until now, this radar system is one of the most sensitive instruments of meteor radars in the world for astronomical observations. In 2004 Kharkiv meteor radar system is included in the list of objects which compose the national property of Ukraine.

Kharkiv meteor radar system has acquired the status of the important historical astronomical instrument in world history. Meteor Centre for researching meteors in Kharkiv is a analogue of the observatory and performs the same functions of a generator and a battery of special knowledge and skills (the world-famous studio). Kharkiv and the location of the instrument were brand points on the globe, as the place where the world-class meteor radar studies were carried out. They are inscribed in the history of meteor astronomy, in large letters and should be immortalized on a world-wide level.

References

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The Collaboration between SHAO and NAO by Expanding to the Joint Project

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Abstract

The process of collaboration between SHAO and NAO, which has been implemented near 15 years since October 1996, is reviewed. The scientific results, such as link between optical and radio reference frames. The first collaborative project "Angles refinement of connection of radio sources and optical reference frames on basis CCD observations for optical counterpart of radio sources" between SHAO and NAO was implemented during 1996–2003. The positions of optical counterpart of extragalactic radio sources (ERS) were determined by SHAO using telescopes, such as 1-m telescope at Kunming and 2.16-m telescope at Beijing. The catalogue of second reference stars around the ERS was compiled by NAO using observations made with the Axial Meridian Circle. Later the project was expanded. A total of about 300 optical counterparts of ERS were observed mostly during 2000–2003 within the international Joint Project (JP) between astronomical observatories from China, Turkey, Russia, and Ukraine. Observations were carried out mainly with two telescopes: Russian-Turkish Telescope (RTT150) and the Chinese 1m telescope at Yunnan. The optical CCD positions of selected ERS in the declination zone $40^\circ \leq \delta \leq 80^\circ$ were measured in the system of reference UCAC2 and 2MASS catalogues. It was made data processing, analysis and a comparison between measured optical positions and the radio positions. The estimation of the link between optical and radio reference frames has shown that orientation angles are near zero within their accuracy about 5 mas. The link accuracy becomes 3 mas when the

observations are combined with other studies. The results were published in 2010.

Chinese-Ukrainian network of optical telescopes for observation of fast moving objects, in particular asteroids, satellites and space debris, as well as astronomical instrumentation, software and the use of rotating CCD drift scan technique (suggested by NAO in 2000 year), were included in the agreements during 2004–2011. The latest joint project is called "Joint observation of space debris on the low orbits with rotating CCD drift-scan camera". Two special telescopes with rotating CCD drift-scan camera were constructed and made by SHAO (D = 300 mm, F = 250 mm) and NAO (D = 268 mm, F = 750 mm) for observation of small space debris (size about 10 cm) on low Earth orbit. Space debris objects from coordinated list are observed on these telescopes. Orbit calculation software is being developed by both sides. After orbit calculation and results comparison, a joint web site of space debris orbits will be created. Nowdays the collaboration between SHAO and NAO is continued.

Historic Radio Astronomy Working Group

RADIO SOURCE COUNTS AND COSMIC EVOLUTION

Organised by Ken Kellermann

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Albrecht Unsöld: a Pioneer in the Interpretation of the Origin of the Cosmic Radio Emission

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Abstract

Albrecht Unsöld was born 20th April 1905 in Bohlheim (Württenberg) and died in 1995 in Kiel. He was appointed in 1932 at the age of only 26 to the Chair of Astronomy and Theoretical Physics at the University of Kiel. This appointment initiated a very successful development of the studies of stellar atmospheres in Kiel under his life-long direction. Unsld developed an active cooperation with astronomers in the USA. During a Rockefeller Foundation fellowship he used the Mount Wilson 100″ telescope for spectral work. A major book published by him (Unsöld, 1938) "Physik der Sternatmosphren (mit besonderer Berücksichtigung der Sonne)" dealt with stellar atmospheres and became a classic in this research area. Prof. Unsöld kept the good contacts to colleagues in the USA having a visiting professor appointment in Chicago in 1939. At the Yerkes Observatory, working with Otto Struve (1888–1956), he became familiar with the observations of Karl Jansky (1905–1950) and Grote Reber (1911–2002). He immediately realised the close connection between the observed radio waves and the stellar atmospheres research.

The origin of the radio emission observed by Jansky and Reber at first eluded interpretation. The major conclusion in the early days was that 'the black-body radiation theory failed to account for Jansky's observations by a factor of 104 in the most favourable case'. Unsöld started his investigations based on the data available to him in 1940, at first trying to bring the free-free emission to explain the radio observations. Unsöld from that time on began to use the Effective Temperature definition as obtained from the Rayleigh–Jeans approximation. This was a great step forward, going away from the intensity definitions (mVolts/m) used

by radio engineers up to that time. A paper submitted in 1944 to the German journal 'Die Naturwissenschaften' was published only in 1946. In this paper the conclusion is drawn that only electron temperatures of some 100 000 K must be present in the interstellar space to account for a free-free emission of the radio waves.

In 1947 Unsöld examined the results of the radio observations of the Milky Way, the Sun and the Moon. Cleary the thermal component of Solar emission was identified. However the then published results about much higher effective temperatures during Solar eruptions lead to a conclusion that 'Ultrastahlung' (ultra-radiation) in addition to thermal free-free emission must be present. This 'ultra-strahlung' was in fact synchrotron radiation, bremsstrahlung of energetic electrons in magnetic fields. We think that the radio emission was interpreted by Alfvén or Kiepenheuer. The contributions of Unsöld to this important aspect of radio astronomy is somewhat forgotten.

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The Dutch Effort to Observe the HI Line: some Little-known Details

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Abstract

Van de Hulsts 1944 suggestion that 21-cm HI from the Milky Way might be observable, Ewen and Purcell's 1951 detection and the subsequent Kootwijk confirmation by Muller constitute the basic facts of the HI line discovery. I will discuss some less well-known aspects of the prediction and detection. There is concrete evidence as to when Oort first became aware that radio emission had been detected from the Galaxy, and what his reaction was. In the post-war Dutch effort, the Leiden physicist Gorter and the theoretician Casimir played minor roles. I will discuss how both were involved in the physics of hyperfine structure before 1940, and their contributions after 1945.

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The IAU Early Japanese Radio Astronomy Project: A Progress Report

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Abstract

Japan was one of those nations that make an early start in radio astronomy, when solar observations began at both the Tokyo Astronomical Observatory (TAO) and at Osaka University in 1949. The research at the TAO accelerated during the 1950s and 1960s under the capable direction of Professor Hatanaka, while an equally-vibrant program was developed independently at Toyokawa by Professor Tanaka from Nagoya University.

In this paper, after briefly describing the Osaka University initiative we will outline the instruments developed at Toyokawa and Mitaka, review the research programs carried out with them and introduce the scientific staff who played so important a role in the early development of Japanese radio astronomy.

Following the success of the WG's Early French Radio Astronomy Project (seven papers were published), an ambitious IAU project to systematically document early developments in Japanese radio astronomy and publish the results in a series of research papers in the Journal of Astronomical History and Heritage was launched in December 2010. Further research visits to Tokyo were made by the second author in 2011 and 2012, and two papers have now been completed and a start made on a third.

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Early Radio Source Counts: Differentiating the Data and Integrating the Implications

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Abstract

There are a number of essentials needed to produce statistically reliable source counts; A complete and reliable survey with accurate flux density measurements, and a statistically correct analysis of the resulting source counts. I will discuss how difficulties with the above, individually and/or collectively, affected analyses of the early source counts.

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How Fred Hoyle Reconciled Radio Source Counts and the Steady State Cosmology

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Abstract

In 1969 Fred Hoyle invited me to his Institute of Theoretical Astronomy (IOTA) in Cambridge to work with him on the interpretation of the radio source counts. This was a period of extreme tension with Ryle just across the road using the steep slope of the radio source counts to argue that the radio source population was evolving and Hoyle maintaining that the counts were consistent with the steady state cosmology. Both of these great men had made some correct deductions but they had also both made mistakes. The universe was evolving, but the source counts alone could tell us very little about cosmology. I will try to give some indication of the atmosphere and the issues at the time and look at what we can learn from this saga. I will conclude by briefly summarising the exponential growth of the size of the radio source counts since the early days and ask whether our understanding has grown at the same rate.

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Eddington, Ryle and Hoyle: how a Major 20th Century Discovery was lost in Confusion and Noise

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Abstract

The Steady-State vs Big-Bang controversy of the 1960s, also known as the source-count controversy, was almost unparalleled in bitterness and rancour. Vestiges linger to this day. The very personal struggle between Ryle and Hoyle changed the course of the lives of both men. It resulted essentially in the loss from the record of a major cosmological discovery which astronomers and cosmologists finally recognized and revisited far too late.

POSTER PAPERS

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A Review of Islamic Astronomical Artifacts in Sultan Haji Hassanal Bolkiah Islamic Exhibition Gallery, Brunei Darussalam

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Sultan Haji Hassanal Bolkiah Islamic Exhibition Gallery, Bandar Seri Begawan, Brunei Darussalam

Abstract

The study of ancient artifacts is a branch of an ethnographic which includes a socio-cultural community that contributes to the development of civilization. In this case, it can be seen how a community showcase their respective cultures that would have triggered the views and thoughts within their civilization. How culture evolved can be seen from a perspective that although the Persian and Arab neighboring but very different in terms of creativity and their cosmological view. Results demonstrate both artifacts although there are similarities in the symbols of the constellation, but not all in the same cosmos thinking because it is influenced by the myth of the local people. Thus the study of artifacts is to consider the effects of a branch of archaeoastronomy and separate studies that approach on events using celestial navigation apart from the assimilation of science and technology. The study of such artifacts is very important in review of the purpose and scope of the establishment of a gallery and museum as a valuable item such as a heritage and artistic treasures of the world that must be given priority and documenting all the artifacts of which are for aesthetic value.

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Analysis of observational records of Dae-gyupyo in Joseon Dynasty

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Abstract

It is known that Dae-gyupyo (the Large Noon Gnomon) and So-gyupyo (the Small Noon Gnomon) were constructed in the reign of King Sejong (1418–1450) of the Joseon Dynasty. Gyupyo is an astronomical instrument for measuring the length of the shadow cast by a celestial body at the meridian passage time; it consists of two basic parts: a measuring scale and a vertical column. According to the Veritable Records of King Sejong and of King Myeongjong (1545–1567), the column of Dae-gyupyo was 40 Cheok ($\sim$ 8 m) in height from the measuring scale and had a cross-bar, like the Guibiao of Shoujing Guo of the Yuan Dynasty in China. In the latter Veritable Records, three observations of the Sun on the date of the winter solstice and two of the full Moon on the first month in a luni-solar calendar are also recorded. In particular, the observational record of Dae-gyupyo for the Sun on Dec. 12, 1563 is $\sim$ 1 m shorter than the previous two records. To explain this, we investigated two possibilities: the vertical column was inclined, and the cross-bar was lowered. The cross-bar was attached to the column by a supporting arm; that should be installed at an angle of $\sim 36.9°$ to the north on the basis of a geometric structure inferred from the records of Yuanshi (History of the Yuan Dynasty). We found that it was possible that the vertical column was inclined $\sim 7.7°$ to the south or the supporting arm was tilted $\sim 58.3°$ downward. We suggest that the arm was tilted by $\sim 95°$ $(= 36.9° + 58.3°)$.

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110th Anniversary of the Engelhardt Astronomical Observatory

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Abstract

The Engelhardt Astronomical Observatory (EAO) was founded in September 21, 1901. The history of creation of the Engelhard Astronomical Observatory was begun in 1897 with transfer a complimentary to the Kazan University of the unique astronomical equipment of the private observatory in Dresden by known astronomer Vasily Pavlovichem Engelgardt. Having stopped astronomical activity owing to advanced years and illnesses Engelgardt has decided to offer all tools and library of the Astronomical observatory of the Kazan University. Vasily Pavlovich has put the first condition of the donation that his tools have been established as soon as possible and on them supervision are started. In 1898 the decree of Emperor had been allocated means and the ground for construction of the Astronomical observatory is allocated. There is the main historical telescope of the Engelhard Astronomical Observatory the 12-inch refractor which was constructed by English master Grubbom in 1875. The unique tool of the Engelhard Astronomical Observatory is unique in the world now a working telescope heliometer. It's one of the first heliometers, left workshops Repsolda. It has been made in 1874 and established in Engelgardt observatory in 1908 in especially for him the constructed round pavilion in diameter of 3.6 m. Today the Engelhard Astronomical Observatory is the only thing scientifically - educational and cultural - the cognitive astronomical center, located on territory from Moscow up to the most east border of Russia. Currently, the observatory is preparing to enter the protected UNESCO World Heritage List.