UNIVERSITY COLLEGE LONDON

THE UNIVERSITY OF LONDON OBSERVATORY
1928-1962

HISTORY

In 1925 Mr. J.G. Wilson offered to the University of London a 24-inch reflector, originally built for Mr. W.E. Wilson, F.R.S., and located at his private observatory in Daramona, County Westmeath, Ireland. The gift was accepted. After consideration of many sites for the telescope, an arrangement was reached with Hendon Urban District Council to lease a site in Mill Hill Park for 999 years at a nominal rental. The Senate of the University granted £5000 towards the cost of constructing a suitable building, and subventions were received from University, King's, Bedford and East London Colleges and from the London School of Economics. The management of the Observatory was entrusted to the University College Committee from the inception up to August 1, 1933. The observatory building was constructed by Messrs. Leslie and Co., with Mr. L. Rome Guthrie as Architect. Construction was commenced in July 1928 and completed in 1929. The Observatory was opened by the Astronomer Royal, Sir Frank Dyson, on October 8, 1929.

The University of London assumed management of the Observatory in 1933. In 1935 the Radcliffe Trustees offered to the University the Radcliffe Twin Refractor, and this gift was accepted. Additional land was rented from Hendon U.D.C., a new building was constructed, being started in 1937 and completed in June 1938. The cost of the building was £2300, with an additional £1000 for auxilliary equipment and furnishings, and the re-erection of the telescope, dome and rising floor. The new building was opened by the Astronomer Royal (Sir Harold Spencer Jones) on July 1, 1938.

The Observatory was closed on the outbreak of War in 1939, and was reopened in 1945. The teaching observatories at University College were closed, and such instruments as survived the War were moved to the Observatory in 1946.

In 1951 administration of the Observatory was transferred to University College, and the Observatory was incorporated in a new Department of Astronomy at the College. A new office building was planned in 1951, commenced in October 1952 and completed in April 1953.

Mr. F. Perren visited the Observatory on July 20, 1940 with a letter of introduction from the Astronomer Royal, and expressed the hope that he could make some worth while contribution to astronomy. After Mr. Perren died in 1943 it was found that much of his considerable estate was left to the University of London for the furtherance of astronomy. As a result of this bequest it has been possible to establish the endowed Perren Chair of Astronomy in 1951. The bequest also contributes in a variety of ways to the progress of astronomy within the University of London Observatory. Mention should be made particularly of (i) the institution of a Perren Studentship, (ii) funds for the building of a south wing to the Observatory, and (iii) substantial contributions to the Observatory running costs.

The south wing extension to the observatory building was planned in 1958 and was to contain a spectroscopic laboratory and further accommodation. The Perren bequest made this possible. The building was commenced in 1960 and completed in 1961 when the offices were occupied. The laboratory was ready for installation in 1962 and was opened by the Provost of the University College (Sir Ifor Evans) on June 18, 1962.

BUILDINGS AND INSTRUMENTS

Buildings. The original observatory building contained in addition to the dome a spectrographic laboratory and darkroom, computing room and a workshop. A building was erected in 1931 to house the Fry refractor, and a second-hand dome obtained, formerly having been used at a house in West Wickham, Kent. The building erected to house the Radcliffe refractor in 1938 also provided a room for an astronomical library. In 1951 the latter library building was demolished, and replaced in 1953 by a two-storey structure. The ground floor contained an office for a secretary, a measuring room and a room to house the library. The first floor contained a lecture room, an office for the Director and an office for the scientific staff. A building was erected in 1954 to house electric generators obtained from the Admiralty. The increasing number of students soon rendered this accommodation inadequate, and another building was completed in 1961, comprising a second spectrographic laboratory and darkroom, an office for staff, an office for research students and a room for the use of undergraduate students and temporary visitors.

The Wilson Reflector. Dr. W.E. Wilson established an observatory at Daramona, Street, County Westmeath, in 1871 and equipped it with a 12-inch equatorial reflector by Grubb. Dr. Wilson (born in 1851, elected F.R.S. in 1896, an original member of the B.A.A., awarded an honorary D.Sc. by the University of Dublin in 1901, High Sheriff of Co. Westmeath in 1894, observed the transit of Venus in 1882 and solar eclipses at Oran in 1870 and Spain in 1900, published many papers in Proc.Roy.Soc.,Proc.Roy.Dublin Soc.,Proc.Roy Irish Acad., etc., and died in 1908) enlarged his observatory in 1881 and installed a 24-inch reflector by Grubb on the mounting previously used for the 12-inch reflector. Ten years later a new mounting was constructed. It is this mounting which was moved to Mill Hill in 1928. Dr. Wilson used his telescope to make some of the best photographs of his time of star clusters and nebulae, and he worked extensively on problems of solar physics and the solar constant. The telescope may be used in Newtonian and Cassegrain forms; the focal length of the mirror is 10 feet and the equivalent focal length at the Cassegrain focus is approximately 42 feet. The telescope was moved in 1928 from Ireland to University College, where minor modifications were made to the focussing arrangements and plate-holder, and an electric motor was added to rewind the driving clock automatically. A 6-inch objective by Cooke, originally purchased by University College for the 1927 eclipse expedition, was mounted as a guide telescope; its focal length is 12 feet. The telescope was erected in 1929. Special precautions were taken to minimise the effect of traffic vibrations from the Watford

By-pass Road, by excavating the soil around the base of the pier to a suitable depth, revetting the sides of the excavation and filling in with coke breeze to a depth of 4 feet below the surface of the ground. The 18-foot dome was constructed by Messrs. Cooke, Troughton and Simms, Ltd., and was equipped for rotation by an electric motor.

The coordinates of the centre of the axes of the Wilson reflector were determined to be

Longitude 0° 14' 26".50 W ($0^h\ 0^m\ 57^s.77$)

Latitude 51° 36' 46".28 N.

Altitude 266.5 feet.

[A Bench Mark on N.E. Angle is at height 255.50 feet, Newlyn datu

The mirror was originally silvered, but was aluminized from 1935 onwards. In 1935 a 4-prism spectrograph by Tremblot was installed at the Cassegrain focus.

Since its erection in Mill Hill the telescope has been used for proper motion measurements, for stellar spectroscopy, for occasional observations of comets, supernovae, Pluto, and other objects, and for experimental work on photoelectric photometry and the recording of artificial satellite transits. It has also been used by students.

The Radcliffe Twin Refractor. On July 24, 1934 Sir Frank Dyson wrote to the Secretary of the Committee of Management of the Observatory stating that the Radcliffe Trustees were willing to present to the University of London the Radcliffe Twin Refractor, then in Oxford, and no longer required by the Trust upon the latter's impending removal of the Radcliffe Observatory to South Africa. The offer was accepted by the Senate of the University in 1935, and the telescope was dismantled and removed to London in March and April 1935, and stored. The dome and rising floor were also dismantled. The collection of plates taken with the Radcliffe telescope were brought to Mill Hill with sundry other equipment. The mounting in the new building during 1937-38 was made difficult by the massive nature of the telescope, the declination axis and cross-head weighing about 3½ tons.

The telescope was made by Grubb, Dublin in 1901. It consists of a 24-inch photographic objective of focal length 22 feet 9 inches and on the same mounting an 18-inch visual objective of the same focal length. With the initial fittings the telescope was available for astrometric photography and visual observing. Later attachments have enabled two colour photography and photo-electric work to be carried out.

The telescope was dismantled upon the outbreak of War in 1939, the objectives being stored for safety. It was re-commissioned in 1946.

Since its erection in Mill Hill the telescope has been used for parallax work, proper motion studies, cluster photometry, photo-electric photometry and miscellaneous observations of supernovae, comets, asteroids and other objects. It has also been used by advanced students.

The Fry Telescope. This 8-inch Cooke refractor (made in 1862) was presented by Mr. H.R. Fry of Barnet in January 1930, and he met most of the cost of its reconditioning and re-erection. It has a focal length of 126 inches. Observational work with the Fry telescope has included magnitudes of novae, double-star observations and occultations. The telescope has been extensively used for demonstrations to visitors and for student instruction.
[A Bench Mark on Fry wall is at a height of 247.50 feet, Newlyn datum].

Smaller Instruments.

(a) In 1932 the Trustees of the late Mr. Johnson of Liverpool presented to University College a 6-inch Cooke equatorial refractor (made in 1863) which was mounted in the Chadwick (north) dome in the courtyard in place of a 4-inch refractor which had been there previously. In 1946 this 6-inch refractor, which survived the War, was moved to the Observatory, erected under the Radcliffe floor, and used for student instruction on cloudy nights.

(b) A 10-inch Calver reflector, which was housed in the Brocklebank Observatory on the roof of University College, was used for teaching up to 1939, but was lost by enemy action together with other smaller instruments.

(c) A 3½-inch transit circle by Cooke was housed in the south dome in the courtyard at University College and used for teaching up to 1939. It survived the War, was moved to the Observatory in 1946, and used under the Radcliffe floor for student instruction on cloudy nights.

(d) A portable transit circle was also moved from University College to the Observatory in 1946 and is now used on the stand close to the Fry telescope.

(e) A Reversible Transit was purchased from Dr. R.L. Waterfield in 1949 and erected behind the Radcliffe building.

(f) A Grubb Chronograph was moved from University College to the Observatory in 1946; it was modified in 1948 to make two simultaneous recordings.

(g) A 10-foot Rowland Grating was transferred from University College to the Observatory in 1929.

(h) A spring-driven Coelostat, 7½-inch aperture, was installed on the Observatory roof in 1929, under a cover designed by L.N.G. Filon and C.C.L. Gregory. A new mounting was designed by Gregory so that a single setting on a divided circle would set for any star, apart from setting the hour circle. A 7-inch objective of 12-foot focal length was used.

(i) The spectrograph being constructed in 1962 for the new spectroscopic laboratory will use a plane grating in a stigmatic Ebert type mounting with an 18-inch mirror of 129-inch focal length. It will be mounted vertically in the laboratory pit provided for the purpose, and will use both photographic and fast photoelectric recording. The style of this instrument will be similar to an earlier version set up by E.W. Foster in the Imperial College in 1957.

(j) A spectrograph was constructed at the Observatory in 1958, containing Hilger glass and quartz optical trains.

(k) A Hilger Recording Microphotometer was purchased in 1954.

(l) Calculating machines were purchased in 1937 (Brunsviga), 1951 (Marchant) and 1960 (Marchant).

(m) Generators were obtained on indefinite loan from the Admiralty in 1954.

(n) Two Hilger plate measuring machines are in use, one was purchased in 1951, and one on loan from the Royal Society.

(o) A Grubb plate measuring machine was presented to the Observatory by the Radcliffe Trustees.

(p) Other instruments and equipment are available for laboratory, expedition, workshop, office, and teaching purposes.

SCIENTIFIC INVESTIGATIONS

Proper Motions. Mr. W.E. Wilson obtained with his telescope a number of photographs of various regions of the sky during 1894-1899. C.C.L. Gregory repeated some of these photographs between 1929 and 1934. These pairs of plates were measured and reduced by Violet F. White, and discussed in five published papers. Proper motions were obtained for 1645 stars to magnitude 15 in a total of 7 regions of the sky. The regions studied were near M27, 52 Cygni, M 31, M 37, M 13, the Orion Nebula and the Ring Nebula in Lyra. Satisfactory accuracy was obtained in spite of the moderate size of the instrument, on account of the long time interval between the two sets of plates.

Although the Radcliffe Telescope and the plates of the Radcliffe proper motion programme are both in Mill Hill the question of continuing this proper motion work was not considered until a request came from Groningen for a re-measurement of the standard areas 3, 4, 5 and 20. Repeat plates were then taken during 1958-60 and the areas 3, 4, and 5 were re-measured (mainly by vacation students).

Occultations. From 1930 to 1937 a programme of observations of lunar occultations was followed, by C.C.L. Gregory and F. Robbins, using the Wilson and Fry telescopes. In all 166 successful observations were obtained, the results of which were published.

Stellar Parallaxes. A parallax programme was started with the Radcliffe telescope in 1939, suspended at the outbreak of War, resumed in 1946 and continued until 1955. A total of 57 stellar parallaxes were determined and published. Many members of the staff took part in this work. In 1955 T. Kiang investigated the use of the Hilger microphotometer for measuring parallax plates.

Star Clusters. In 1952-54 a number of photographs were obtained in red and blue light of star clusters, and colour-magnitude arrays were obtained. The observations were directed towards those objects that are not clearly of open or globular type. S.K. Wang showed that NGC 6811 has a typical open cluster array. The 18-inch visual was equipped for photographing in red region simultaneously with use of 24-inch for blue plates. V.C. Reddish studied M 5, NGC 7789, Tombaugh 5, NGC 1528 and M 67 (NGC 2682). The colour-magnitude array of M 67 was found to be intermediate between those of globular and open clusters.

V.C. Reddish also investigated some problems in stellar evolution and determined the masses of the dwarfs and giants of Population II and of variable stars.

Laboratory Spectroscopy. In 1930 Miss E. Williamson and C.C.L. Gregory constructed an electric furnace and produced a number of molecular spectra, including the second positive group of nitrogen and the calcium and strontium fluorides bands. A large number of wavelengths were measured and the spectra were compared with the solar spectrum but no identifications were made.

1952 saw the commencement of a drive towards the measurement of atomic oscillator strengths needed for astrophysical purposes. E.W. Foster constructed a fluid vortex stabilized arc with controlled conditions and temperatures ranging from 11,000°K to 13000°K. The spectra were recorded photoelectrically at high speed. Using the fluids H_2O, C_6H_6, $CH Cl_3$, CS_2 and SO_2Cl_2 measurements of absolute oscillator strength have been made in O I, C I, Cl I, and Cl II. Recordings for S I are available. Mr. A.S. Asaad used diluted copper alloys made by Johnson, Matthey and Co., to obtain arc spectra which could make a comparison of the oscillator strengths in the neutral atoms Al, Si, Cr, Mn, Fe, Co, Ni, Cu, Ga, Ag, Sn, Pb and Bi. Later C.W. Allen extended the same procedure to Mg and Ca, and more recently similar progress is being made with Sc, Ti, and V. In an endeavour to use the fluid vortex technique for iron group atoms J..B.. Tatum produced an arc in $Ti Cl_4$ and from the spectrum was able to make extensive measurements in both Ti I and Ti II. The most recent adaptation of this procedure has been the production of a rotatory walled arc in $Mn O_2$ by B.E. Woodgate. Further measurements are planned.

Empirical Spectrum Line Intensities. In 1955 it was noticed by C.W. Allen and A.S. Asaad that all extensive measurements of oscillator strengths showed an unexplained rapid increase with excitation potential. The effect has been studied in all subsequent measurements, including our own, and a fairly complete, although empirical, explanation has been found. With this point settled it is possible to use the f-sum rule to determine absolute oscillator strengths in special cases. For atoms of the iron group an extensive comparison of measured and calculated values has been made.

Theoretical Spectrum Line Intensities. In 1954 R.H. Garstang started an extensive series of calculations on the transition probabilities of forbidden lines in complex atoms. General methods were developed for electric quadrupole calculations and were applied to the spectra [Fe III], [Fe IV], [Fe V], [Ni II] and [Ni III], and in 1962 further unpublished results were available for [Fe II], [Ni I], [Cu II] and [Mn VI]. The relative intensities of the strongest lines in various multiplets were in good agreement with line intensities in peculiar stellar spectra. Among the by-products of this work

was a prediction of the positions of the energy levels of Fe IV. This programme was completed in 1962.

In an investigation in 1955 R.H. Garstang showed that if observed energy levels are used instead of theoretical energies certain forbidden line strengths may be calculated. In 1961 he investigated transition probabilities of permitted and forbidden lines in Fe XIV and made calculations also for Fe X and Si X. Other investigations by Garstang on theoretical spectrum line intensities included a survey (1955) of the transition probabilities of auroral lines, calculations (1959-62) of the oscillator strengths in C I, Si I, Ge I, Sn I and Pb I, work jointly with Dr. A.S. Douglas of Cambridge on Ca II and Si IV, oscillator strengths in O I (1960), and work (1961) on hyperfine structure and intercombination line intensities in the spectra of Mg I, Zn I, Cd I and Hg I. This work has shown the feasibility of making successful calculations of the intensities of many different types of spectrum lines, including many forbidden by the usual selection rules.

Solar-Geophysical Relations. The main variations on the sun affecting the earth are:

(a) the change in the emission of far ultra-violet solar radiation which has a dominating influence on the earth's ionosphere, and

(b) the change in solar particle emission which influences the geomagnetic field and several allied phenomena.

Both of these relations have been studied statistically.

The ultra-violet relation is complicated by the anomalous nature of the ionospheric F 2 region which has therefore been studied on a world-wide basis. The anomalies have been segregated and evaluated in a systematic although empirical manner by C.W. Allen. He also determined the numerical constants describing the precise relation of solar activity data to decimetre radio wave emission.

A renewed attempt to locate and identify solar M-regions has been made by Th. Saemundsson who has correlated all available data on sporadic and recurrent geomagnetic storms. The inter-relations between existing data are now as clear as they can be. More information will be needed before firmer deductions can be made. A real avoidance of active areas by M regions is confirmed.

Theoretical Astrophysics. As might be expected the theoretical researches have been rather diverse since they are related to the changing interests of various staff members. P.A. Sweet

made a detailed study of the interaction of magnetic fields with matter in motion and was able to apply his conclusions to the general atmosphere of the sun, to sunspots, and to interstellar gas clouds. He worked out the neutral point theory which was thought applicable in the production of solar flares and was therefore most effective in directing solar studies to magnetic field details in the neighbourhood of sunspots. His 1952 calculations of the structure of rotating stars have been reconsidered and extended by J.S. Griffith who followed Sweet to Glasgow to further his investigations.

The topological rules established by Sweet were used as a guide in enabling C.W. Allen to propose a model to explain the complex feature of the solar cycle.

Stellar Spectra. An investigation on the spectrum of α Andromedae was performed in 1937-38 by C.M. Chao on 79 plates made available by Prof. F.J.M. Stratton of Cambridge. Line identifications were made and spectroscopic binary orbits obtained. From 1935 onwards spectra were frequently obtained with the Wilson telescope and Tremblot spectrograph of a number of stars, particularly of γ Cassiopeiae. A detailed study was made (by Miss E.M. Peachey) of changes in the spectrum of γ Cassiopeiae which took place in 1940. The spectrum of Nova T Coronae Borealis 1946 was also observed.

During a visit to Haute Provence Observatory in 1949 E.M. and G.R. Burbidge obtained many spectrograms of Be stars. The intensities of hydrogen and helium lines were measured, and a further study made of rapid changes of line intensities in the spectrum of γ Cassiopeiae. The shell spectrum of HD 217050 was also examined.

In 1951-52 K.R.W. Brewer made a study of the peculiar A star HD 50169 from 8 spectra obtained at Mount Wilson. Wavelengths were measured, intensities estimated and line identifications made. In 1953 R.H. Garstang measured many equivalent widths in the spectrum of 9 Pegasi, and later he and B. Warner extended wavelength and intensity measurements to a number of other stars and determined atomic abundances in these stars.

Solar Spectrum. In 1960 C.W. Allen compared the intensities of far ultra-violet lines recently derived from rocket spectra with calculations from coronal and chromospheric models. He found a much thicker transition zone than his earlier calculations had indicated. In 1961 R.H. Garstang calculated oscillator strengths for two solar ultra-violet lines of C I, and predicted the equivalent widths of these lines in the solar spectrum.

Venus Spectrum. In 1960 B. Warner found evidence of neutral and ionized oxygen on the night side of Venus.

Interstellar Matter. From 1960 D. McNally worked on problems concerning the condensation of interstellar clouds. In particular he considered the production of the interstellar molecules CH and CH^+ and was able to show that if CH can be produced by surface reactions then the observed densities of these molecules will only be obtained provided the interstellar radiation field is sufficiently dilute in the far ultra-violet.

The Moon. The aim of lunar studies introduced in 1960 by G. Fielder was to coordinate our understanding of the varied surface features of the moon. In particular the system of global rock joints known as the grid system was found to be intimately associated with the form and statistics of many other surface structures. Such associations point to interpretation of the lunar surface in terms of widespread mechanical stresses. G. Fielder, B. Warner, and Carole Jordan have contributed varied measurements and analyses to such problems.

Statistical Astronomy. The absence of any systematic method of expressing the space density of various objects in the sky led Allen in 1954 to analyse the question of whole-sky statistics. The methods proposed have not yet been fully applied. The starting point of further statistical work was a two-fold recognition. 1. Frequency distributions of astronomical objects are greatly distorted by observational selection. 2. The practice of assuming normal curves for these distributions is a mere habit formed at a time when the science of statistics was synonymous with biometric studies. It is in this spirit of caution and doubt that T. Kiang examined the luminosity function of galaxies, and resolved the discrepancy between Hubble's and Zwicky's points of view. The scrutiny is being continued on asteroids. The total number of accessible asteroids has been estimated anew.

EDUCATIONAL ACTIVITIES

Teaching. The University of London is the only University in England and Wales to provide a course leading to an undergraduate degree in Astronomy. Astronomy had been taught at the University College for many years in the Department of Applied Mathematics, and this continued until 1939. University of London practical examinations and University College practical classes were also carried out at the College until 1939. After the War all practical examinations and classes were held at the Observatory.

From 1951, when the Observatory became the headquarters of the Department of Astronomy at University College, regular undergraduate courses were reinstated. The theoretical lectures were given at the College and practical work at the Observatory. The numbers of undergraduate students admitted to full-time courses for the B.Sc.(Special) Degree in Astronomy were as follows: 1952, 3; 1953, 4; 1956, 5; 1957, 4; 1958, 3; 1959, 4; 1960, 6 ; 1961, 3. In addition a number of occasional students have taken lecture courses. Lectures have also been provided from time to time for the final year of the B.Sc.(Special) Degree in Mathematics. The lecturing schedule is as follows, subject to minor variations from year to year:

First Year
Descriptive Astronomy (50 lectures)
Spherical Astronomy (40 lectures)
Observational Astronomy (20 lectures)
Practical Class (20 evenings, 5 afternoons).

Second Year
Astrophysics (50 lectures)
Spectroscopy (20 lectures)
Celestial Mechanics (20 lectures)
Spherical Astronomy (20 lectures).
Other short courses on occasion.
Practical Class (40 afternoons and evenings)

Third Year
Three courses of about 40 lectures each, selected from the following:

Stellar Structure
Astronomical Spectroscopy
Stellar Atmospheres
Celestial Mechanics
Galactic Structure
Radio Astronomy
Solar Physics
Mathematical Astrophysics.

Other short courses on occasion.
Practical Class (40 afternoons and evenings)

Students take Ancillary Mathematics and Physics as well as the Astronomy courses.

Seminars are held from time to time and distinguished visitors have been invited to give University Lectures in Astronomy. Among those invited were Dr. Cecilia Payne-Gaposchkin, Prof. A. Unsold, Prof. V. A. Ambartsumian, Dr. Y. Ohman, Prof. M. Nicolet, Prof. O. Heckmann, and Prof. G. Righini.

Special arrangements are made for External Students to visit the Observatory in order to prepare for examinations.

OTHER ACTIVITIES

Services to outside organizations. Owing partly to the small numbers of astronomers in the London Area, the staff have received frequent calls on their services. The following list normally includes chairman and secretaries of advisory boards, commissions, special and standing committees, etc., but not general members.

Royal Astronomical Society.

C.C.L.Gregory, Council 1947-52.
C.W.Allen, Council 1953-54, Secretary 1954-57, Vice-President 1957-59, Council 1961-62, Foreign Secretary 1962-
P.A.Sweet, Council 1955-58, 1959.
R.H.Garstang, Hon.Auditor 1953-55, Council 1957-61.
T. Kiang. Hon. Auditor 1958-59.

British Astronomical Association.

R.H. Garstang, Council 1953-56, Vice-President 1957-60.
G. Fielder, Director Lunar Section 1960-

International Astronomical Union.

C.W.Allen, President Commission 11 (Outer Layers of the Sun) 1955-58.

Joint and Inter-Union Commissions on Solar and Terrestrial Relationships.

C.W.Allen,	Secretary, Joint Commission	1955-58
	Convenor I.C.S.U.Advisory Committee	1958-61
	President Inter-Union Commission	1961-

Inter-Union Committee of the Ionosphere.

C.W. Allen, Secretary 1962-

British National Committee on Space Research.

C.W.Allen. Chairman, Optical Methods (later, Tracking) Working Group 1958-

Rocket Research.

C.W. Allen, Consultant to U.K. Atomic Energy Authority 1961-

The Observatory Magazine.

E.M.Burbidge,	Editor	1948-51
P.A.Sweet	"	1953-57
R.H.Garstang	"	1953-60
D.McNally	"	1961-

Symons Memorial Lecturer for Royal Meteorological Society,

C.W.Allen 1958.

Outside Lectures. The staff receive numerous requests from outside organizations for lectures on astronomical subjects. These requests come particularly from amateur astronomical societies and from scientific societies attached to Universities, Colleges and Schools. These invitations are accepted whenever the other committments of the staff permit.

Visitors. The Observatory has been opened to Visitors on selected afternoons and evenings. This facility has been used by local residents and by parties from schools, astronomical societies, scientific societies in the University and its Colleges, and by other organizations. The number of visitors has generally been limited to not more than 20 at one time. The demonstrations have been shared by various members of the staff and students, F. Robbins and T. Kiang having taken the largest shares in this work. From the opening of the Observatory in 1929 up to the end of 1961 a total of 7512 visitors have been recorded. Excluding the war years this is an average of about 278 per year.

Observations away from London. Owing to the limited scope and conditions for observing in the London Area it has been found necessary from time to time to travel elsewhere to make astronomical observations.

In 1949 E.M. Burbidge spent 21 nights at Haute-Provence Observatory and obtained 157 spectra of Be stars.

In 1954 an expedition consisting of C.W. Allen, E.W. Foster and C.R. Spratt went to Syd Koster, Sweden, to observe the total eclipse of 1954 June 30. The programme was the photometric and spectroscopic study of the outer corona. A new occulting disk method of photometry was tried for the first time. The eclipse was observed through thin cloud. Another expedition to Polonnaruwa, Ceylon, on 1955 June 20, was clouded out, as was an expedition to the Canary Islands on 1959 Oct. 2.

In 1961-2 B. Warner went to the Radcliffe Observatory Pretoria, in order to obtain the spectra of certain special southern stars.

PUBLICATIONS.

An Annual Report on the work of the Observatory has been communicated by the Director to the Royal Astronomical Society and published in Monthly Notices (up to 1959) and (since 1960) Quarterly Journal.

The results of the scientific work of the Observatory have been published in papers in various journals. Many such papers are reprinted with special covers entitled "COMMUNICATIONS FROM THE UNIVERSITY OF LONDON OBSERVATORY" and numbered serially. A list of these Communications is given in Appendix IV. Other papers have, for various reasons, not been included in the numbered series; these are listed in Appendix V.

"COMMUNICATIONS" are circulated to (in 1962) 180 other Observatories and astronomical libraries, mostly in exchange for their publications.

In addition to the papers, notes and review articles listed in Appendices IV and V, the Observatory Staff have contributed several hundred topical notes, personal notes and book reviews to various scientific journals and a number of contributions to encyclopaedias and other collective works. These contributions are too numerous to list individually.

APPENDIX I

Staff

Prof. L.N.G. Filon	Honorary Director, 1928-37.
Mr. C.C.L. Gregory	Wilson Observer, 1928-50. Director, 1938-50. Research Associate, 1950-51. [Also Lecturer and later Senior Lecturer in Astronomy at University College]
Dr. A. Beer	First Assistant, 1937-40.
Mr. R.W. Pring	Second Assistant, 1939-46. First Assistant, 1946-48.
Dr. E.M. Peachey-Burbidge	Second Assistant, 1942-48. Assistant Director, 1948-51.
Miss A.C. Robinson	Assistant Observer, 1948-49.
Mr. S.K. Wang	Plate Measurer, 1950-51. Assistant Observer, 1951-52.
Dr. G.R. Burbidge	Assistant Lecturer, 1950-51.
Mr. T. Kiang	Assistant Observer, 1951-61. Lecturer, 1961-
Prof. C.W. Allen	Perren Professor and Director, 1951-
Dr. P.A. Sweet	Lecturer and Assistant Director, 1952-59.
Dr. R.H. Garstang	Lecturer, 1952-60 Assistant Director, 1959- Reader, 1960-
Mr. E.W. Foster	Lecturer, 1953-
Dr. D. McNally	Assistant Lecturer, 1960-
Dr. G. Fielder	Hon. Research Assistant (ICI Fellow) 1960-
Mr. C.R. Spratt	Technician 1928-1946 Senior Technician 1946-55 Chief Technician 1955-
Mr. J.R. Coy	Junior Technician, 1953-54
Mr. R.V. Thornton	Junior Technician, 1954-55.
Mr. E.P. Hayne	Technician, 1955-60.
Mr. B. Orloff	Junior Technician, 1961-
Mr. W.F. Healey	Junior Technician, 1961-62.
Mr. R. Cook	Junior Technician, 1962.
Mrs. F.B. Harland	Secretary, 1953-54.
Mrs. J.M.U. Armstrong	Secretary, 1954-55.
Mrs. M.K. Beacham	Secretary, 1955-

APPENDIX II

Research Students

Miss V.F. White, 1931-32. Proper motions in clusters.

Mr. C.V.C. Herbert, 1931-34. "Application of Photoelectric Methods of Photometry to Astronomical Measurements".
Mr. C.M. Chao, 1937-38. M.Sc. Thesis "The Spectroscopic System α Andromedae".
Mr. I.H.A. Rahman, 1938-39. Stellar Spectroscopy.

Mr. P.C. Chaudhuri, 1938-39. Transferred to Glasgow on outbreak of War. Ph.D. Thesis "Investigation of Proper Motion of Open Cluster Stars with Radcliffe Telescope and General Investigation on Open Clusters."
Miss E.M. Peachey (later Burbidge), 1939-42. Ph.D. Thesis "The Variable Spectrum of Gamma Cassiopeiae".
Mr. R.W. Pring, 1948 (while on staff) "An Investigation of Magnitude Equation and its Causes in Astronomical Photography".
Mr. F. Steel, 1949-51. M.Sc. Thesis "Determination of Stellar Parallax (Trigonometric)".
Mr. K.R.W. Brewer, 1950-52. M.Sc.Thesis "The Spectrum of HD 50169."
Mr. V.C. Reddish, 1952-54. Ph.D. Thesis "Star Clusters in relation to Stellar Evolution".
Mr. A.S. Asaad, 1953-56. Ph.D. Thesis "Oscillator Strengths from Arc Spectrum of Diluted Copper Alloys."
Mr. J.B. Tatum, 1957-60 (Perren Student). Ph.D. Thesis. "Intensities in the Spectrum of Titanium".

Mr. J.S. Griffith, 1957-59 (transferred to Glasgow in 1959) Internal structure of rotating stars.
Mr. Th. Saemundsson, 1959-
Correlation of recurrent geomagnetic storms with solar activity.
Mr. B. Warner, 1961-
Spectra of Ba II stars, and other special types.
Mr. B. Woodgate, 1961- (Perren Student).
Oscillator strengths with a rotating walled arc.

APPENDIX III

Volunteer Assistants (and Vacation Students)

Miss E. Williamson, 1929-31.
Mr. F. Robbins, 1930-37.
Miss V.F. White, 1932-37.
Dr. G. de Vaucouleurs, 1950.
Mme A. de Vaucouleurs, 1950-51.
Mr. S.N. Svolopoulos, 1953.
Mr. P.J. Nind, 1954.
Miss G.C. Goldwin, 1958.
Mr. L.M. Dougherty, 1959-
Mr. B. Warner, 1960.
Mr. M. Price, 1960.
Miss C. Jordan, 1960.
Mr. M. Friedjung, 1960, 1961.
Mr. M.F. Britten, 1961.
Dr. M. Dizer, 1961-62.

APPENDIX IV

Communications from the University of London Observatory

1.	A. Beer and C.C.L. Gregory	Observed Photographic Magnitudes of the Supernova 145.1937 Persei in NGC 1003 M.N., 98, 216, 1938.
2.	P.C. Chaudhuri	The Photographic Proper Motions of Stars belonging to the Cluster Praesepe, from plates taken with the Radcliffe telescope. M.N., 100, 378, 1940.
3.	E.M. Peachey	Some Recent Changes in the Spectrum of γ Cassiopeiae. M.N., 102, 166, 1942.
4.	C.C.L. Gregory and E.M. Peachey	The Spectrum of T Coronae Borealis on 1946 February 11. M.N., 106, 135, 1946.
5.		Stellar Parallaxes determined at the University of London Observatory, Mill Hill. M.N., 109, 478, 1949.
6.	E.M. Burbidge and G.R. Burbidge	Hydrogen and Helium Line Intensities in some Be stars. Ap.J., 113, 84, 1951.
7.		Stellar Parallaxes determined at the University of London Observatory, Mill Hill. M.N., 110, 618, 1950.
8.	E.M. Burbidge, G.R. Burbidge and S.K. Wang.	Rapid Changes in Line Intensities in the Spectrum of Gamma Cassiopeiae. Ap.J., 115, 66, 1952 [Also = Pub. Haute Provence, 2, No. 31.]

9. C.W. Allen — A System of Quantitative Astronomical Observations. Vistas in Astronomy, 1, 149, 1955.

10. R.H. Garstang. — The Calculation of Atomic Transition Probabilities. Vistas in Astronomy, 1, 268, 1955.

11. C.W. Allen — World-Wide Diurnal Variations in the F2 region. J.Atmos.Terr.Phys., 4, 53, 1953.

12. K.R.W. Brewer — HD 50169, A Spectrum Variable with Emission at Hα. Ap.J., 118, 265, 1953.

13. C.W. Allen — The Physical Condition of the Solar Corona. Reports on Progress in Physics, 17, 135, 1954.

14. V.C. Reddish — Stellar Evolution. The Observatory, 74, 68, 1954.

15. P.A. Sweet — The Structure of Sunspots. Vistas in Astronomy, 1, 675, 1955.

16. R.H. Garstang — Intermediate Coupling Line Strengths M.N. 114, 118, 1954.

17. C.W. Allen — Whole-Sky Statistics of Celestial Objects. M.N., 114, 387, 1954.

18. P.A. Sweet — Field Reversal in Magnetic Variable Stars. M.N., 114, 549, 1954.

19. R.H. Garstang — Stellar Populations. J.Brit.Astron.Ass., 65, 122, 1955.

20. V.C. Reddish — Colour-Magnitude Arrays in the Clusters Tombaugh 5, NGC 7789, NGC 1528 and NGC 2682. M.N., 114, 583, 1954.

21. V.C. Reddish — The Masses of the Stars of Population II. M.N., 115, 32, 1955.

22. R.H. Garstang — The Effect of Configuration Interaction on Forbidden Line Strengths. Proc.Camb.Phil.Soc., 52, 107, 1956.

23. C.W. Allen and A.S. Asaad — Atomic Oscillator Strengths and Excitation Potentials. M.N., 115, 571, 1955.

24. C.W. Allen — Solar Sources of the Ionospheric Regions. Solar Eclipses and the Ionosphere, p.150, 1956.

25. C.W. Allen — Influence of Solar Atomic Emission on the Orbits of Interplanetary Particles. The Observatory, 76, 101, 1956.

26. R.H. Garstang — The Computation of Quadrupole Line Strengths. Proc.Camb.Phil.Soc., 53, 214, 1957.

27. C.W. Allen — The Quiet and Active Sun. Radio Astronomy, IAU Symposium No.4, p.253, 1957.

28. P.A. Sweet — The Production of High Energy Particles in Solar Flares. Supp.Il Nuovo Cimento, 8, Ser.10, 188, 1958.

29. W.R. Piggott and C.W. Allen — Observational Aspects of Solar Corpuscular Radiation. 9th Report, Commission on Solar-Terrestrial Relations, p.77,1957.

30. P.A. Sweet — The Neutral Point Theory of Solar Flares. Electromagnetic Phenomena in Cosmical Physics, I.A.U. Symposium No.6,p.123,1958.

31. P.A. Sweet — Magneto-hydrostatic Equilibrium in an External Magnetic Field. Electromagnetic Phenomena in Cosmical Physics, I.A.U. Symposium No. 6,p.499,1958.

32. R.H. Garstang — Recent Experimental and Theoretical Investigations on Atomic Properties of Interest for Emission Line Stars. Mem.Soc.R.Sci.Liège,20,497,1957.

33. R.H. Garstang — The Surface Temperature of the Moon. J.Brit.Astron.Ass.,68,155,1958.

34. R.H. Garstang — Further Computations of Quadrupole Line Strengths. Proc.Camb.Phil.Soc.,54,383,1958.

35. C.W. Allen — Solar Radiation. Q.J.R. Meteorological Soc.,84,307,1958

36. E.W. Foster — A Fast Recording Spectrograph for Absolute Intensity Measurement of Bright Sources. Proc.Inst.Electronics,3,No.3,2,1958.

37. R.H. Garstang — Peculiar Stars. Occasional Notes,R.A.S.,3,234,1959.

38. P.A. Sweet — Coulomb Scattering in a Magnetic Field. Phil.Mag.,4,1155,1959.

39. C.W. Allen — A Sunspot Cycle Model. The Observatory, 80,94,1960.

40. R.H. Garstang — Mutual Magnetic Interactions and Oscillator Strengths in the First Spectrum of Oxygen. Proc.Camb.Phil.Soc., 57,115,1961.

41. J.B. Tatum — Oscillator Strengths of Neutral and Ionized Titanium. [Mimeogram] 1961.

42. C.W. Allen — Solar Ultraviolet and X-Ray Line Emission. Mem.Soc.R.Sci.Liège, 4,241,1961 (1960 Liège Symposium on Far Ultraviolet Spectra of Astronomical Bodies).

43. B. Warner — Stresses in the Surface of the Moon. J.Brit.Astron.Ass.,71,388,1962.

44. B. Warner — The Lunar Maria, Planet. Space Sci., 5,283,1961.

45. G. Fielder — The Contraction and Expansion of the Moon. Planet. Space Sci., 8,1,1961.

46. B. Warner — Accretion and Erosion on the Surface of the Moon. Planet.Space Sci., 5,321,1961.

47. A.S. Douglas and R.H. Garstang — Transition Integrals for Si IV and Ca II. Proc.Camb.Phil.Soc., 58,377,1962.

48. E.W. Foster — Measurement of Transition Probabilities in the Visible Spectra of O I and C I and Estimation of Vacuum Ultraviolet Radiation Standards. Proc.Phys.Soc., 79,94,1962.

49. B. Warner — The Initial Mass Function and the Occurrence of Stars of Small Mass. Pubs. Astron. Soc. Pacific, 73, 439, 1961.

50. R.H. Garstang and B. Warner — Identifications 5880-6867A for late Type Stars. [Mimeogram] 1962.

51. G. Fielder and B. Warner — Stress Systems in the Vicinity of Lunar Craters. Planet. Space Sci., 9, 11, 1962.

52. G. Fielder and C. Jordan — Selenological Implications drawn from the Distortions of Craters in the Hipparchus Region of the Moon. Planet. Space Sci., 9, 3, 1962.

APPENDIX V

Other Publications (Papers, Notes and Review Articles)

1.		Occultations of Stars by the Moon observed at the University of London Observatory during the year 1930. M.N., 91,949,1931.
2.	V.F. White	Photographic Proper Motions of Stars in Two Regions. M.N., 92,519,1932.
3.	V.F. White	The Proper Motions of Stars in the region of M 31. M.N., 93,105,1932.
4.		Occultations of Stars by the Moon observed at the University of London Observatory. M.N., 93,111,1932.
5.	V.F. White	The Proper Motions of Stars in the Region of Cluster M 37 (NGC 2099) M.N., 93,647,1933.
6.		Occultations of Stars by the Moon observed at the University of London Observatory. M.N., 94,91,1933.
7.	V.F. White	The Proper Motions of Stars in the Region of the Cluster M 13 (NGC 6205) M.N., 94, 783,1933.
8.		Occultations of Stars by the Moon observed at the University of London Observatory between 1933 November 3 and 1934 October 1. M.N., 95,188,1934.

9. Occultations of Stars by the Moon observed at the University of London Observatory between 1934 October 2 and 1935 December 31.
M.N., 96,709,1936.

10. V.F. White — The Proper Motions of Faint Stars in two regions.
M.N., 97,202,1937.

11. C.C.L. Gregory and A. Beer — Observation of Comet Finsler (1937 f).
IAU Circ.667,1937.

12. Occultations of Stars by the Moon observed at the University of London Observatory in the year 1936.
M.N., 97,546,1937.

13. F. Robbins — Occultations of Stars by the Moon observed at the University of London Observatory.
M.N., 98,428,1938.

14. C.C.L. Gregory — Note on the Disintegration of Saturn's Ring.
J.Brit.Astron.Ass., 55,142,1945.

15. C.C.L. Gregory — Observations of (51) Nemausa.
IAU Circ. 1060, 1946.

16. E.M. Peachey — The Variable Spectrum of Gamma Cassiopeiae.
Univ. of London Obs. Typescript Circ.No.1,1947.

17. C.C.L. Gregory — Observations of Comet 1948g Honda-Bernasconi.
(IAU Circ. 1157, 1948.
(Harv.Ann.Card.905, 1948.
(BAA Circ. 299,1948.

18. C.C.L. Gregory — Theory of a Loop revolving in air, with observations on the skin friction.
Q.J.Mech.Appl.Math., 2,30,1949.

19. — Second Parallax Programme.
Univ. of London Obs. Typescript Circ.No.2,1949.

20. E.M. Burbidge and G.R. Burbidge — The Spectrum of HD 217050
(Ap.J.,113,703,1951
(Pub.Obs.Haute Provence, 2,No.21,1951.

21. C.W. Allen — The Framework of Astronomy.
Inaugural Lecture, University College, London, 1952.

22. R.H. Garstang — Stellar Associations.
J.Brit.Astron.Ass., 64,43,1953.

23. R.H. Garstang — The Rotation of Extragalactic Nebulae.
J.Brit.Astron.Ass., 64,182,1954.

24. R.H. Garstang — The Stellar Corona of the Galaxy
J.Brit.Astron.Ass., 64,207,1954.

25. T. Kiang — Colour Excesses of B stars and the Inner Spiral Arm.
Ann.d'Astrophys.,18,76,1955.

26. R.H. Garstang — Isotopes in Astronomy. J.Brit.Astron.Ass., 65,371,1955.

27. T. Kiang — Parallax Measurement with a Recording Microphotometer. The Observatory,75,227,1955

28. C.W. Allen — Astrophysical Quantities. The Athlone Press,London, 1955.

29. R.H. Garstang — Accurate Positions of Minor Planets. Minor Planet Circular 1285,1955.

30. C.W. Allen — A New Technique for Eclipse Observations of the Solar Corona. in "Meteors",J.A.T.P.Special Suppt.No.2,1955,p.147.

31. R.H. Garstang — Transition Probabilities of Auroral Lines. "The Airglow and the Aurorae",1956,p.324.

32. C.W. Allen — Coronal Photometry at the Eclipse of 1954 June 30. M.N.,116,69,1956.

33. — Stellar Parallaxes determined at the University of London Observatory, Mill Hill (third list). M.N.,116,267,1956.

34. C.W. Allen — Spectrophotometry of the outer corona. M.N.116,413,1956.

35. R.H. Garstang — Transition Probabilities for Forbidden Lines of Fe III and Fe V.
M.N., 117, 393, 1957.

36. C.W. Allen and A.S. Asaad — Oscillator Strengths from Arc Spectra of Diluted Copper Alloys.
M.N., 117, 36, 1957.

37. C.W. Allen — The Variation of Decimetre-wave Radiation with Solar Activity.
M.N., 117, 174, 1957.

38. R.H. Garstang — Positions of Comet Arend Roland
M.N., 117, 505, 1957.

39. C.W. Allen — Absolute Oscillator Strength Measurements in Mg, Ca and other atoms.
M.N., 117, 622, 1957.

40. P.A. Sweet — The Topology of Force-Free Magnetic Fields.
The Observatory, 78, 30, 1958.

41. R.H. Garstang — Transition Probabilities for Forbidden Lines of Ni II and Ni III.
M.N. 118, 234, 1958.

42. R.H. Garstang — Energy Levels and Transition Probabilities in Fe IV.
M.N., 118, 572, 1958.

43. J.B. Tatum — Flashing of Rocket 3.
BAA Circ. 402, 1958.

44. R.H. Garstang — Transition Probabilities for Forbidden Lines of Ne IV.
M.N., 120, 201, 1960.

45. B. Warner — The Emission Spectrum of the Night Sky of Venus. M.N., 121, 279, 1960.

46. R.H. Garstang — Variable Star Observations of Stanley Williams. . . Q.J.R.A.S., 2, 24, 1960.

47. C.W. Allen — Commission 11 Report. Trans.I.A.U. 10, 164, 1960.

48. C.W. Allen — Oscillator Strengths of Neutral Atoms of the Iron Group. M.N., 121, 299, 1960.

49. B. Warner — Rilles near the Lunar Crater Plato. J.Brit.Astron.Ass., 70, 299, 1960.

50. G. Fielder — A Theory of the Origin of Lunar Rilles, with particular reference to the Ariadaesus-Hyginus Rille System. J.Int.Lunar Soc., 1, 166, 1960.

51. J.B. Tatum — Oscillator Strengths of Neutral and Ionized Titanium from a Vortex-stabilised Arc. M.N., 122, 311, 1961.

52. B. Warner — Inner Rings in Lunar Craters. J.Brit.Astron.Ass., 71, 115, 1961.

53. B. Warner — On the Lunar Grid System. J.Brit.Astron.Ass., 71, 116, 1961.

54. G. Fielder — Stresses in the Moon. Planet.Space Sci., 5, 286, 1961.

55. G. Fielder — On the Origin of Lunar Rays. Ap.J., 134, 425, 1961.

56. B. Warner — The Clouds of Venus. J.Brit.Astron.Ass., 71, 200, 1961.

57. B. Warner — The Observation of Detail on the Planet Venus. J.Brit.Astron.Ass., 71, 202, 1961.

58. B. Warner — A Classification of the Profiles of Lunar Craters. J.Brit.Astron.Ass., 71, 246, 1961.

59. B. Warner — The Nature of the Surfaces of the Lunar Maria. Pubs.Astron.Soc.Pacific, 73, 349, 1961.

60. T. Kiang — The Galaxian Luminosity Function. M.N., 122, 263, 1961.

61. G. Fielder — Selected Lunar Observations made at the Pic-du-Midi Observatory in 1956 and 1959. J.Brit.Astron.Ass., 71, 207, 1961.

62. G. Fielder — Small-scale Explosion Craters, Impact Craters, and the Physical Structure of the Moon's Surface. M.N., 123, 15, 1961.

63. G. Fielder — Lunar Wrinkle Ridges and Terrestrial Mid-Oceanic Ridges. The Observatory, 81, 140, 1961.

64. G. Fielder — The Lunar Section's Official Programme of Observations. J.Brit.Astron.Ass., 71, 304, 1961.

65. R.H. Garstang — Stellar Magnitudes. J.Brit.Astron.Ass., 71,134,1961.

66. B. Warner — The Form of the Initial Mass Function. The Observatory,81,230,1961.

67. B. Warner — Holistic Approach to Selenology Nature,191,586,1961.

68. G. Fielder — Lunar Domes. J.Brit.Astron.Ass., 72,24,1962.

69. G. Fielder — Ray Elements and Secondary-Impact Craters on the Moon. Ap.J.,135,632,1962.

70. G. Fielder and T. Kiang — The Segmental Structure of Wrinkle Ridges and the Lunar Grid System. The Observatory,82,8,1962.

71. G. Fielder — Origin of the Mare Imbrium. Nature,193,258,1962.

72. Th.Saemundsson — Statistics of Geomagnetic Storms and Solar Activity. M.N.,123,299,1962.

73. T. Kiang — The Effect of a Resisting Medium on Elliptical Orbits. M.N.,123,359,1962.

74. B. Warner and G. Fielder — Stresses around Lunar Craters. Nature, 193,762,1962.

75. T. Kiang — Asteroid Counts and their Reduction.
M.N., 123,509,1962.

76. R.H. Garstang — Transition Probabilities for Permitted and Forbidden Lines of Si X, Fe XIV and Fe X.
Ann. d'Astrophys., 25,109,1962.

77. R.H. Garstang — Two Solar Ultraviolet Lines of Neutral Carbon.
The Observatory,82,50,1962.

78. B. Warner — Stellar Rotation and Space Velocities.
The Observatory, 82,77,1962.

79. T. Kiang — On the Usual Method of Correcting for Incompleteness of Discovery.
The Observatory, 82,57,1962.

80. R.H. Garstang — Introduction and Comparison [of Radio Astronomy] with Optical Astronomy.
Memoirs B.A.A. 40,7,1962.