Pergamon

Vistas in Astronomy, Vol. 36, pp. 389–407, 1993

0083-6656/93 $24.00

0098-2997(93)E0006-A

GLASGOW AND THE HEAVENS

Archie E. Roy
Department of Physics and Astronomy, Glasgow University,
Glasgow, U.K.

Abstract

The history of teaching and research in astronomy at Glasgow and its oldest university is described, particularly the massive changes brought about in the past quarter century by theoretical and technological advances in the subject itself.

1 Introduction

The study of astronomy has a long history in the University of Glasgow. It was one of the subjects allotted to the Professor of Natural Philosophy and was included in the M.A. degree examination. The University had a telescope in 1693, two centuries before the creation of the Faculty of Science. In 1751 Alexander Macfarlane, merchant in Jamaica and brother of the Laird of Macfarlane, the antiquary, left to the University his astronomical equipment. This collection was shipped to Glasgow. Its original inventory, in French, is still in existence and of considerable interest - one of the listed pieces of equipment is 'One artificial eye'!

The celebrated inventor and engineer James Watt was employed by the University to put this collection in order, an observatory being built for it on the Dowhill in 1757 and named the Macfarlane Observatory. The Dowhill, where, according to legend St. Kentigern sat, stood near the south-eastern corner of the Old College grounds. "Well-equipped with astronomical instruments", as the novelist Tobias Smollett, himself a Glasgow student, put it in *Humphrey Clinker*, it was undoubtedly an excellent example of its kind (Murray, 1927). Towards the end of the 18th century, it possessed a reflecting telescope made by Sir William Herschel, the best telescope maker in Europe of his time.

The Faculty of Arts, with the aid of the Duke of Argyll, founded a Chair of Practical Astronomy and Alexander Wilson, M.D. (1733-86) was appointed first Professor and Observer in the year 1760. His work on sunspots, leading to the discovery of what is still known as the Wilson effect, was awarded in 1772 the Gold Medal of the Royal Society of Sciences in Copenhagen. Among his successors were his son Patrick Wilson (1743-1811), the Professor of Natural Philosophy, William Meikleham (1771-1846), the Rev. James Couper, minister of Baldernock who on his death in 1836 was succeeded by John Pringle Nichol (1804-1859). Nichol was one of the most remarkable men who ever held a Chair in the University. He was not only a great observer but also a great teacher. His influence, as David Murray states in his *Memories of the Old College of Glasgow* (Murray, 1927), "was not limited to the students whom he taught, but extended to the whole students of the University as a body... His influence with the citizens of Glasgow was equally great. As a lecturer to a popular audience he was unrivalled."

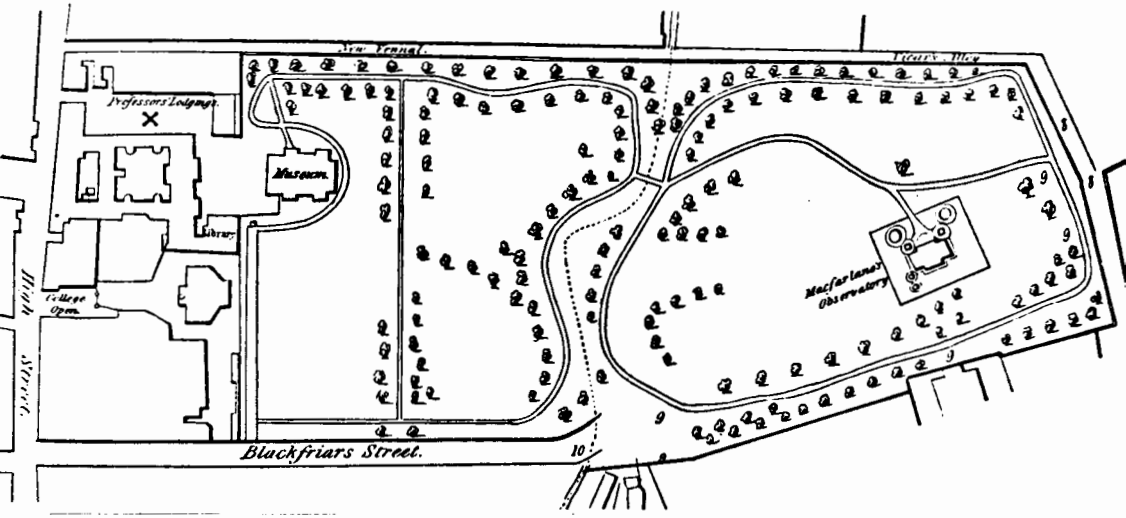


FIG. 1. The Macfarlane Observatory on the Dowhill. From a road survey by Allan and Ferguson in 1936.

The Dowhill Observatory had a long record of useful work. Its observations were published in scientific journals. Its fate, however, was to fall victim to the growing city's rising level of smoke pollution and to be surrounded by a number of tall buildings, restricting its view. Nevertheless, work was continued as long as possible. Lord Kelvin was taught by Professor Nichol in the Macfarlane Observatory and John Nichol recorded how " I used to mount up the rising ground on the College Green to the Old Observatory... and see my father with his fur cap on winter nights peering through the tube of the old telescope. I was alive to the wonders of the old tube. I remember seeing Orion through it for the first time, and Jupiter and the moon" (Murray, 1927).

A second observatory had in fact been built on the Garnethill between Scott Street and Thistle Street by 'The Glasgow Society for promoting Astronomical observation'. Under its foundation stone lay a plate dated 11 May 1810, stating that the building was "intended to promote the study of astronomy, and to record observations the most interesting, it is hoped will long remain... a magnificent monument of the scientific taste, and public spirit, of the City of Glasgow, and of the present time". For some years it was popular but ultimately a decline in interest set in. It was offered to the University of Glasgow but the offer was declined, partly because of the restrictive conditions attached, and partly because the University saw it even then suffering the fate of the Macfarlane Observatory, surrounded and polluted in its seeing conditions by the fast-spreading city.

2 The Dowanhill Observatory

It was Professor Nichol's lecture courses in 1836 that inspired a new venture, set up by 'The Friends of Astronomical Science in Glasgow' to erect a new observatory. A site in Dowanhill, a rural region far outside the city boundaries, was purchased. The buyers were careful to extract a stringent obligation from the Dowanhill Trustees not to erect in the vicinity of the site any view-restrictive building or any smoke-emitting furnace. Those modern citizens of Glasgow familiar with the present built-up Dowanhill- Hillhead-Hyndland area will find John Nichol's account of his first visit to the new observatory in 1840 of some interest (Murray, 1927):

"One afternoon in the autumn of 1840, I and my father and uncle William went to take...a very long walk into the country. We passed the outskirts of the town- then about Sauchiehall street, left behind a few detached houses, which remain to recall the old days of St George's Road; crossed over the fields where the Queen's Crescent was afterwards erected; and went on by an ill-made narrow road that skirted the great black quarry; and reached a farm-house on Horselet Hill, and plunged through the ploughed fields to the top where a crowd of masons were planting the foundations of the future Dome."

Professor Nichol took up residence in the observatory in April 1841. Unfortunately the institution, like its Garnethill predecessor, ran into serious financial difficulties. The University of Glasgow agreed to take over the observatory, pay its debts, and the Old Dowhill equipment was as a consequence transferred to Dowanhill. It may be noted that in the University of Glasgow's Bute Hall, a beautiful window, presented by Professor Jack, commemorates Professor John Pringle Nichol, his son Professor John Nichol and his daughter, Mrs Jack.

Robert Grant succeeded Professor Nichol, being appointed Professor of Practical Astronomy in 1859. In the winter of that year he carried on the class of natural philosophy when Lord Kelvin met with an unfortunate accident. Grant, born at Grantown-on-Spey in 1814, was not only a noted scholar on the history of astronomy but also a practical solar researcher. In 1852 he was appointed editor of the *Monthly Notices of the Royal Astronomical Society*, a task to be relinquished on his appointment to the University of Glasgow.

Grant was a worthy successor to Nichol. To the instruments he found at Dowanhill he added, in 1863, the Ochtertyre equatorial telescope and a small three-inch aperture transit telescope. Over the years of his professorship he extended Nichol's stellar work, observed minor planets and published in 1883 *A Catalogue of 6415 stars for the epoch 1870, deduced from observations made at the Glasgow University Observatory during the years 1860-1881.* As a continuation, *A Second Glasgow Catalogue of 2156 stars* was published just a few weeks after his death on 24 October 1892. Although an invalid by that time he examined every proof-sheet in the catalogue, looking over the last sheet on the morning of his death.

Other notable work carried out at the Dowanhill observatory in the second half of the 19th century included the setting up of a system for controlling a number of public clocks in the City and Port of Glasgow by direct current from the observatory so that they might show the correct Greenwich Mean Time. The system, once instituted, continued as a time-keeping service far into the present century. The observatory was chosen in 1868 as a principal meteorological station by the Meteorological Office in London. Again, this service, once begun, was continued until the observatory was demolished in 1936.

Grant, in addition to his lecturing schedules, carried out all this work with the aid of one assistant, Mr James Connell. In recognition of his work, he was awarded two honorary degrees; he was elected a Fellow of the Royal Society in 1865 and he received the Gold Medal of the Royal Astronomical Society in 1856 for his *History of Physical Astronomy.*

It is tempting to suggest that the history of the University of Glasgow's Department of Astronomy in the century from the creation of the University's Faculty of Science in 1893 to

the present can, like Caesar's Gaul, be divided into three parts, namely the Becker, Smart and Sweet incumbencies in the Regius Chair of Astronomy, for their span of years occupies all but six years of the Department's history in that century.

3 Professor Ludwig Becker

Ludwig Becker was appointed to the Regius Chair in January 1893, at the age of 33, a position he was to hold for 42 years. He was a highly experienced practical astronomer and a pioneer in spectroscopy. Additionally, he was a first class mathematician and quickly proved himself to be an inspiring lecturer. Born in Wesel on 8 January 1860, he studied mathematics and physics at Berlin University. From 1879 to 1881 he studied at Bonn, specialising in astronomy. In 1885 he accepted a post at Lord Crawford's observatory in Dunecht, Aberdeenshire. There he extended greatly his experience as an observer, making spectroscopic observations with a 15-inch refractor. He also completed a series of observations of some 200 nebulae. For his work in observing the solar spectrum near sunrise and sunset through three summers from a hill - the Barmerkin of Echt - he was awarded the Macdougall - Brisbane prize of the Royal Society of Edinburgh.

In 1889, Dr Copeland, the Director of Lord Crawford's observatory, was appointed Astronomer Royal for Scotland and Becker became Assistant at the Royal Observatory. Much of the preparations for moving the instruments from Dunecht to Edinburgh fell to Becker and in particular he was responsible for adjusting the piers to support the transit circle. While the work was still in progress he was appointed Regius Professor of Astronomy at Glasgow.

His first task was the renovation of the instruments. For this work he was fortunate in receiving a grant of £1.000 from the Bellahouston Trustees. The 6-inch Ertel transit circle was reconditioned and the 20-inch Breadalbane reflector was overhauled and provided with a large spectrograph, a really powerful instrument for that time. He started observing as soon as the instruments were ready. With the transit circle his programme was to observe stars close to the pole and in particular two faint stars so close to the pole that they were always within the field of view of the telescope. By observation of the same stars at intervals of several hours he was able to determine the position of the pole relative to the instrument and then accurate positions of the stars. His intention was to determine accurately the constants of nutation and aberration. Although hampered by the unsuitable climate and the neighbourhood of a large industrial city, he carried on observations single-handed for ten years. The results were published in the *Memoirs of the Royal Astronomical Society*. With the spectroscopic observations, weather was also a disturbing factor but very long exposure spectrograms were made of novae, comets and nebulae. Spectra of the major planets were also photographed. Some results were published in the *Monthly Notices of the Royal Astronomical Society*.

Becker was a most approachable professor, not only to his students but to others within and without the University. As a student, Alexander Thom, who later in life became Professor of Engineering Science at Oxford University and renowned internationally as a pioneer of the discipline of archaeo- astronomy, came to Becker to seek his advice in computing orbits. Ever afterwards he recalled Becker's friendliness and brilliance in grasping and solving the particular problem Thom was faced with. Soon after term began, Becker would give his students a key to the observatory and tell them that the observatory was open from "noon till noon"- the limit of the astronomer's day before 1925[1]. For most of his career he probably had larger classes than any other professor of astronomy in the U.K. His lectures were not based on popular or

[1]Before 1925, Greenwich Mean Time (G.M.T.) universally signified the mean time reckoned from mean noon at Greenwich.

merely descriptive astronomy but contained a sound theoretical development of spherical and dynamic astronomy. Students were taught how to compute the ephemeris of a planet from the orbital elements and made to do so: in practical astronomy they had to learn to observe with a variety of instruments and determine clock error, latitude and azimuth.

The outbreak of the First World War began a period of considerable sadness for Becker. The yearly Glasgow observatory reports in *Monthly Notices of the Royal Astronomical Society* are almost unchanging in their content from year to year during the War, being short and devoid of the enthusiastic descriptions of instrument-refurbishing and research achievements of pre-war years. For the duration, they blandly stated that "The Director has been on leave of absence. The usual routine work connected with the time service and meteorological observations has been carried on by the assistant". In fact, although Becker had long been a naturalised British subject, most of his relatives were in Germany and his absence from Glasgow was enforced upon him as a result of local agitation, a mindless and vicious xenophobia still existing in our present day.

Becker was entering his sixties when he returned. Too old to undertake regular night observing as well as carrying out his day duties, he concentrated on teaching, innovations dealing with equipment such as improved sextants for use at sea or in the air, and theoretical research. It was not merely a matter of age and his numbing war-time experience that produced this change in direction. As an observational observatory, Dowanhill was suffering the fate of its predecessors on the Dowhill and on Garnethill.

In his memoir *The Climatology of Glasgow*, published in 1925 by His Majesty's Stationery Office for the Meteorological Office, Becker laments how "The Observatory...has been encircled more and more in the course of time by buildings which, from the east round by south to west, now extend to a distance of from two to ten miles. In other directions the houses in the immediate neighbourhood are detached villas." He might have added that increasing air pollution from factories had rendered serious observing totally impractical. From then until he retired in 1935 he carried on successfully with his teaching and theoretical research but the observatory, now used almost entirely for practical instruction, grew ever more dilapidated. Whoever succeeded Becker, he was going to have to do some hard thinking concerning astronomical policy in the University of Glasgow. The University itself, as will be seen, had its own radical thoughts on the matter.

4 Professor William Smart and the University Observatory

Ludwig Becker's successor in the Regius Chair was William Marshall Smart. He came to the Chair of Astronomy in 1937 with a distinguished academic and research reputation. He was not yet fifty years of age. Born in Doune, Perthshire on 9 March 1889, he had been educated at McLaren High School, Callendar before proceeding to the University of Glasgow where he read mathematics, natural philosophy and chemistry. He received the Cunningham Medal for Mathematics and the Breadalbane and Ferguson Scholarships. Among his classes was astronomy, his teacher being Ludwig Becker. Becker's skilled exposition of the ways mathematics served as the handmaiden of a number of astronomical disciplines must have aroused Smart's interest for on graduation from the University of Glasgow in 1911 with First Class Honours, he became a scholar of Trinity College, Cambridge and holder of the Sheepshanks Exhibition in Astronomy. There he read pure and applied mathematics (including astronomy) obtaining a first in Part I of the Mathematics Tripos and becoming a Wrangler in Part II. He graduated in 1914, was awarded the Tyson Medal and in 1916 received the Rayleigh prize.

The First World War intervened in his career. In 1915 he entered the Royal Naval College, Greenwich and a year later entered active service until the end of the war. As Instructor-Lieutenant, he served on *HMS Emperor of India*, the flagship of a division of battleships of the Grand Fleet. To the end of his long life he was able to reminisce with affection about his naval experiences and sometimes, during his lectures to University of Glasgow undergraduates, allusions to navigation, naval strategy and sea battles would lighten for his students stretches of spherical trigonometry or discourses on the combination of observations.

An early interest in celestial mechanics was temporarily sidetracked by the First World War. A paper on the Trojan Asteroids (published in 1917) was followed in 1921 by a paper on the anomalous rate of revolution of Mercury's perihelion and one in 1925 on the evolution of binary star systems as a result of mass-loss by radiation. In fact, in the 1920s, it seemed that the great days of celestial mechanics were over; the Hill-Brown lunar theory seemed the culmination of work in that field and theories of the planetary movements left little to be desired. Nevertheless, one of Smart's most successful books was his *Celestial Mechanics*, published in 1953 and still being used in the late 1980s as a textbook and a work of reference. As in all his work it exhibited his rigorous mathematical training.

The First World War gave him a lifelong interest in navigation. A paper in the *Monthly Notices of the Royal Astronomical Society* in 1919 on the simplification of tables for nautical navigation was followed in 1922 by the *Admiralty Manual of Navigation* and in 1924 by *Position Line Tables*, both co-authored by Cdr. F.N. Sharme, R.N. In the next 22 years he wrote four books on navigation and during the second World War he taught navigation to RAF cadets taking short courses at the University of Glasgow. No doubt he read with much interest the paper *On a New Aircraft-sextnnt for Use with Visible Horizon*, published in 1936 in the *Monthly Notices* by the Regius Professor of Astronomy in the University of Glasgow, his predecessor.

Perhaps his most famous book was *Spherical Astronomy*, first published in 1931. There are probably few university or observatory libraries in the world that do not have a copy of one of the many editions of this highly successful work on their shelves. Generations of astronomers, navigators and university students have used it to master the intricacies of celestial coordinate systems and time and grasp the many subtle ways in which precession, nutation, aberration, parallax and refraction can tinker with the directions celestial objects seem to lie in. Only recently has it had to be at first up-dated and then replaced by Robin M. Green's text of the same name to take into account the much greater accuracy to which these matters are observed in our modern space age.

After the First World War, Smart became John Couch Adams Astronomer and Chief Assistant at the University Observatory, Cambridge, which was then under the direction of A.S. Eddington. The post not only involved theoretical research but also carried an obligation to do practical work using the Sheepshanks 12-inch Coudé refracting telescope. A series of papers on photographic photometry using sodium/argon and potassium/argon photoelectric cells was published between 1921 and 1937. Much of this pioneer practical research work was carried out on variable stars; the papers exhibit Smart's cautious, painstaking attitude in evaluating and taking into account error sources. His 1958 book *Combination of Observations* shows how experienced he was in practice as well as theory.

Further research work involved a long programme designed to study proper motions. With H.E. Green he used a set of parallax plates taken with the Sheepshanks telescope in 1903-04 as a set of first-epoch plates. The second- epoch plates he took with Green were exposed through the glass so that the first and second epoch plates could be compared 'back-to-back'. A careful discussion of the reliability of this method appeared in a 1921 paper, with proper motions determined for the Pleiades. It was followed in the *Monthly Notices* by ten papers, his last research paper in this topic appearing in 1941.

Perhaps the best example of his patient, painstaking and honest approach to laborious, important, yet non-spectacular research was his series of over 30 papers on stellar kinematics, published between 1923 and 1940, occasionally co-authored with H.E. Green (Cambridge), T.R. Tannahill (Glasgow) and S. Chandrasekhar (India and the United States). When the series began, it was only a decade since the existence of the galaxy as a relatively small entity in a huge universe had begun to be established. The dynamics of the stars pursuing their colossal orbits about the galactic centre was only beginning to be understood. Various models of systematic trends in stellar motions such as the two-stream theory and the ellipsoidal theory had been proposed. Smart's work over two decades collected and analysed tens of thousands of proper motions. Apart from the series of papers, he wrote in 1938 a book called *Stellar Dynamics* which became a much-used standard text. 30 years later it was up-dated and published under the title *Stellar Kinematics*.

The person who came to Glasgow to occupy the Regius Chair in Astronomy in 1937 was therefore by any standards a man of high attainments not only in practical and theoretical research in astronomy but also in navigation and mathematics. He was also a writer of great distinction, noted for his clear exposition of recondite matters. He had a well-deserved international reputation.

The situation he found in Glasgow was a challenging one. It was also a source of great disappointment to him. The old Dowanhill observatory was now a century old. Built originally outside the city boundaries, it was now surrounded by the suburbs of Hillhead and Dowanhill with consequent major light pollution, apart from the gross deterioration in seeing conditions due to the increasingly filthy atmosphere of the industrial city. In the latter years of Professor Becker's directorship, the scientific work of the observatory in meteorology and astronomy had come almost to a standstill. The buildings themselves were in a poor state of repair and there is no doubt that astronomy in Glasgow was at its nadir.

The situation was such that from certain quarters in the University considerable pressure was applied to have the Professorship of Astronomy downgraded to a Lectureship. It was argued that Astronomy was not in a fit state to be an autonomous university discipline.

Smart met the challenge and ultimately won though, as Wellington remarked on a previous occasion, it was a damn close-run thing. The Chair was saved; the old observatory was abandoned. The University sold the site and today, all that remains of the third Glasgow observatory is the street name 'Observatory Road' in Hillhead and some instruments, including two telescopes and two clocks, now at the Garscube Observatory. Indeed one of the telescopes, the transit circle, is still in use for student training purposes.

If politics is the art of the pragmatic, Smart's solution was truly political. Believing that serious observational work was now impossible in the vicinity of an industrial city such as Glasgow, he accepted that the future of the Department of Astronomy lay in teaching and theoretical research. The University was persuaded to use a fraction of the proceeds realised from the sale of the Dowanhill site to build a smaller observatory in University Gardens at the main University site in Gilmorehill. Designed mainly for instructional purposes, the substantial building (strong enough to take a second storey if a future need arose) included a large room to house the astronomical library from the old observatory and to provide accommodation for lectures. Generously- sized rooms were also provided for the Director and his Assistant, Dr T.R. Tannahill. There was also an instrument room. On the high ground behind, a dome housed the 7-inch refractor and a smaller building held the transit circle. The Riefler clock, keeping sidereal time, stood in its glass case in the hallway of the new observatory house, sending its pulses to a chronograph in the instrument room. A set of concrete and brick flat-topped pillars about one metre high stood in the grounds at the back. Troughs containing mercury could be placed on these pillars to provide artificial horizons when sextant observations of the sun were

made by students measuring the observatory's latitude and longitude. It is interesting that no room was provided in the new building for a secretary or typist. Professor Smart invariably wrote letters by hand. As much as anything else it was to him a matter of courtesy to do so.

The new observatory was officially opened on 17 April 1939 by Sir Arthur Eddington, O.M., in the presence of a representative assembly presided over by the Chancellor of the University, Sir Daniel Stevenson, accompanied by the Principal, Sir Hector Hetherington and Professor John Walton, Dean of the Faculty of Science. During the proceedings Sir Arthur gave an address on 'The Expansion of the Universe'.

Teaching and research work were already gathering pace. Smart was not only beginning to make his mark on the undergraduate teaching but had also formed a small graduate school including Messrs. Akbar Ali, Archibald Brown and P.C. Chandhuri carrying out research on various problems of stellar kinematics. Six papers published in that year by Smart and one by R.A. Robb and T.R. Tannahill indicate a healthy situation.

The outbreak of the Second World War necessarily curtailed the Department of Astronomy's activities and effectively ended Smart's own research career. Although, after the War, Smart received at Glasgow European astronomers such as Randic (Yugoslavia), Strassl (West Germany) and Eichhorn (West Germany) for research visits, his own publications, apart from textbooks and popular works, ceased to appear. Until he retired at the end of September 1959, almost all research in the Department was conducted by other members of staff and graduate students, an increasingly larger fraction of that research being outside Smart's customary fields. Thus while Dr T.R. Tannahill and Mr D.G. Ewart continued to work on proper motions, Mr P.A. Sweet, who joined the staff in October 1947, was engaged in the investigation of sunspot magnetic fields and, aided by Mr A.E. Roy, was by 1952 researching a number of features associated with rotating stars. In September 1953, Sweet left to take up the post of Assistant Director of the University of London Observatory, being succeeded by Mr Michael W. Ovenden.

Two features of this immediate post-war period are of interest. The number of undergraduate students taking astronomy showed a marked increase. Many of these students were fresh from the armed services and for some, their decision to study astronomy had been spurred by the astounding pageant of the heavens they had witnessed on clear tropical nights abroad. In addition, a growing number of members of the University and of various societies visited the observatory on Thursday evenings during the two winter terms to view the heavens, weather permitting. The Ordinary (first year) class in Astronomy approached and surpassed the one hundred mark in numbers and the number of undergraduates reading Honours in Astronomy or Astronomy with Natural Philosophy or Astronomy with Mathematics also grew to unprecedented numbers.

It was during Smart's last years of his tenure of the Regius Chair that he wrote many of his textbooks such as *Celestial Mechanics* and *Combinations of Observations* and more popular works, among them *John Couch Adams and the Discovery of Neptune* and *Some Famous Stars*.

He was also much sought after as a lecturer so that in his popular books and lectures he followed closely in the steps of his illustrious predecessor, the great populariser of astronomy, Professor John Pringle Nichol. Nichol's books such as *The Architecture of the Heavens* and *The Planetary System* could be seen in the libraries of most educated Glaswegians in the middle of the 19th century while his courses of popular lectures created such enthusiasm that the initial steps were taken to build the old observatory at Dowanhill.

A measure of Smart's skill as a lecturer is evident in the list of his official Lectureships. Apart from his undergraduate lectures he was Thomson Lecturer, Aberdeen; Elder Lecturer, Glasgow; Fison Memorial Lecturer, Guy's Hospital, London, and Halley Lecturer, Oxford. Many courses of lectures were given to the general public, not only in Glasgow; during the Second World War he had lectured to the Armed Forces. His immense efforts in the popularisation of astronomy

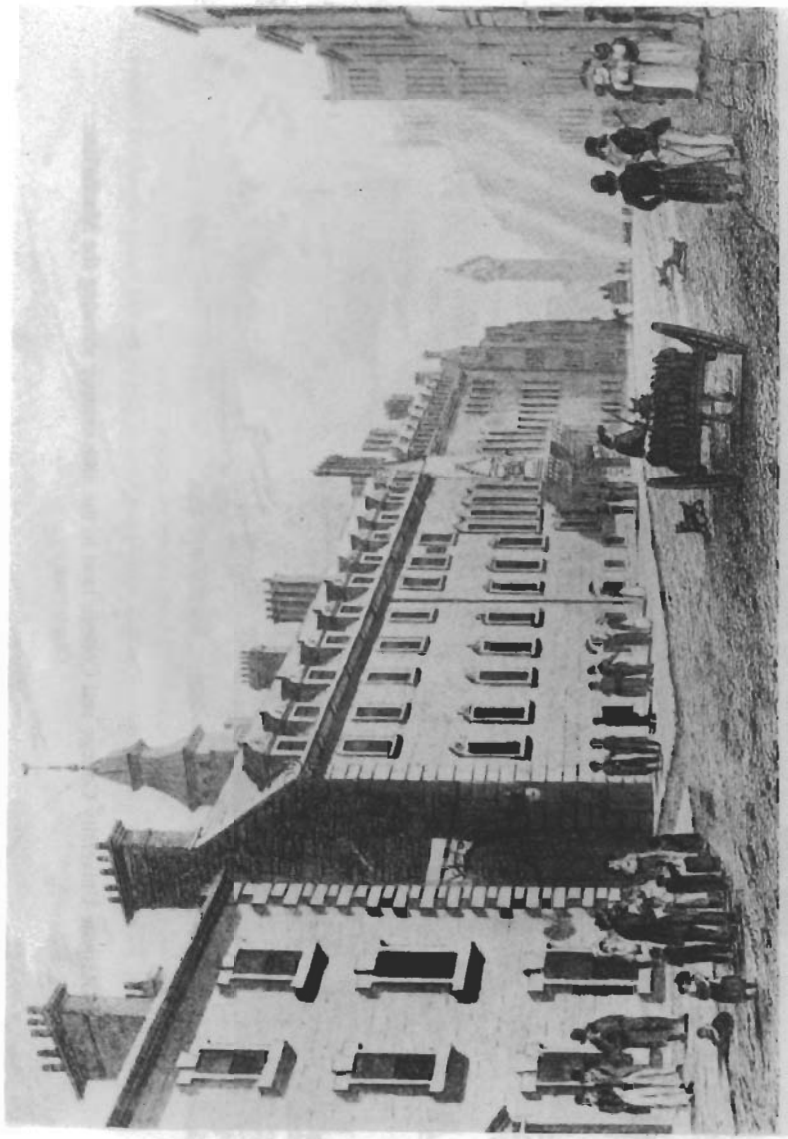
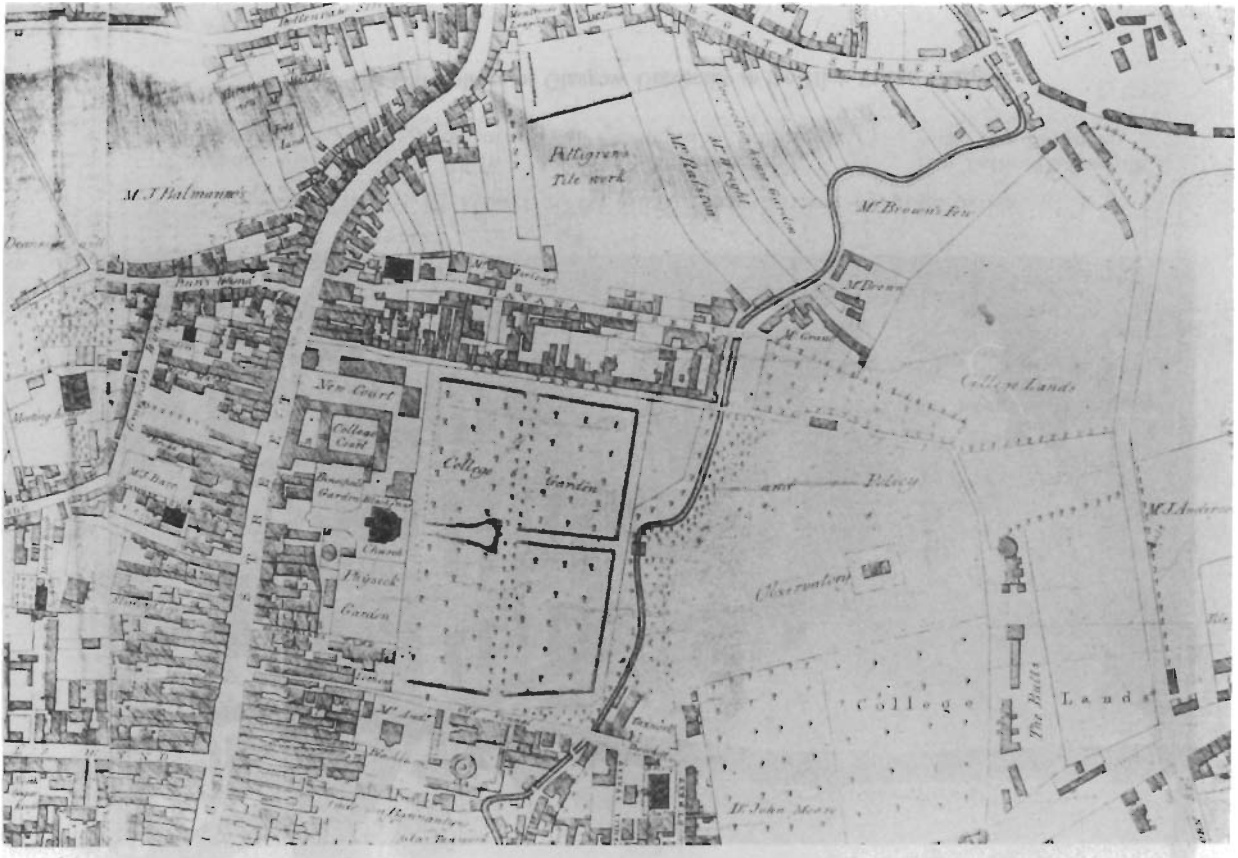


FIG. 2. The Old College of Glasgow University in the High Street, Glasgow.



FROM M'ARTHUR'S PLAN OF GLASGOW, 1778.

Shows the College and College land from High Street to The Butts which were on part of the old Easter Common of Glasgow.

FIG. 3. Glasgow University College and College land in the 18th centruy showing the Macfarlane Obeservatory.

FIG. 4. View of the Dowanhill Observatory in the 19th century.

FIG. 5. The Dowanhill Observatory in the early 20th century.

were recognised by the award to him of the Lorimer Medal of the Edinburgh Astronomical Society.

Further measures of his distinction were his Fellowship of the Royal Astronomical Society (he was secretary from 1931 to 1937, Vice-President from 1937 to 1938 and President from 1949 to 1951) and his Fellowship of the Royal Society of Edinburgh (Council Member from 1949 to 1952 and from 1957 to 1959 and Vice-President from 1952-1955).

When Smart retired at the end of September 1959 he left a department which, though small in numbers of staff and students compared to other science departments such as Natural Philosophy and Chemistry, was healthy in teaching and research, and was expanding steadily. It was thus poised to take full advantage of two strong though unrelated developments, the flood of new discoveries in astronomy, partially due to the advent of space research, and the expansion of higher education.

5 Professor Peter Sweet

Smart's successor in the Regius Chair of Astronomy was Peter Alan Sweet, who had already served as a member of staff from October 1947 to September 1953. A Cambridge graduate and a brilliant mathematician, he had taken his Ph.D. under the supervision of Fred Hoyle and had had close contact with Hoyle's collaborators Hermann Bondi and Thomas Gold. In fact Sweet's pioneering work on the theory of magnetic reconnection in solar flare plasmas subsequently established the direction of some of the main research developments in plasma astrophysics. He had also demonstrated his ability as a Lecturer at Glasgow and at Mill Hill University of London Observatory when he was Assistant Director, and so his appointment to the Regius Chair of Astronomy in Glasgow was welcome.

The Department that Smart's successor came to in 1959 had 95 first-year, 14 second-year and 4 Honours students. Apart from the Director, who continued his research in magnetohydrodynamics, Dr Ovenden, in collaboration with Dr A. Wasserstein of the Greek Department, was researching the origin of the stellar constellations. Together with Dr A.E. Roy, who had replaced Dr T.R. Tannahill on his resignation as Lecturer, they were continuing their work on the dynamics and stability of the solar system, a work which became a major research theme over the next 30 years. Dr Roy was also conducting research (in mathematical biophysics) on the storage of information in neural networks. He and Mr J.S. Griffith, who had joined the Department as an Assistant Lecturer, were running an active Moonwatch team, made up of volunteers who on every clear night operated a 'fence' of 12 telescopes, with auxiliary recording equipment, set up to track artificial Earth satellites; measurements of the sightings of these satellites were sent regularly to the Smithsonian Astrophysical Observatory where they were used to update the predictions of the satellites' positions. In addition, Mr R.M. Green had joined the department as a research student and Mr W. Edgar was appointed as a mechanic.

The '60s saw major developments in the teaching, research and equipment of the Astronomy Department. In the academic year 1961 to 1962, the staff complement consisted of Professor Sweet, Dr M.W. Ovenden, Dr A.E. Roy, Mr R.M. Green amd Mr R.B. Hunter. Miss L.C. Muir joined the staff in October 1961 as departmental secretary. There were 115 first year students, 12 second year students, eight Honours students and two research students, placing the Department among the biggest institutions teaching astronomy in the U.K.

The building in University Gardens had not been built for such staff numbers let alone student numbers. For lectures and tutorials the first-year class could still be accommodated in the old astronomy classroom in the Gilbert Scott Building and the other smaller classes in the observatory. For staff accommodation, however, changes had to be made. The original

over- generous provision in 1936 of very large rooms in the observatory for the Director and his Assistant, and for lectures, now paid off. An ingenious re-planning of the observatory interior by Professor Sweet provided a Director's room, two small staff rooms, a lecture room, and two small alcoves for research students to work in, the original Assistant's room now being shared by two members of staff. The old instrument room was divided into a workshop and a store-room. While it was a satisfactory solution at the time to the accommodation problem, it was recognised it could not be a permanent solution. Any further expansion of staff and the provision of a modernised practical undergraduate course involving fresh and more versatile equipment for observations and laboratory work required a fresh start. The University Gardens building had served its purpose and although it had been built originally strong enough to take a second storey, that was not the answer. And so the planning began for a new observatory to be sited on the University of Glasgow's estate at Garscube, near Maryhill on the outskirts of the city. It would become Glasgow's fifth observatory following the Dowhill, Garnethill, Dowanhill and University Gardens establishments. The University Gardens site, after demolition of the observatory building, dome and transit circle would have the Queen Margaret Students Union built upon it.

At this period, in the late'50s and early'60s, the influence of the changing scene in astronomy and the advent of space research was apparent in the Department's research. Visits were made by Dr Ovenden to the Dominion Astrophysical Observatory, Victoria, Canada, to take spectra of certain spectroscopic binary stars with the 72-inch telescope. He also spent seven weeks at the Kitt Peak National Observatory, Tuscon, Arizona, making photoelectric observations of the star 57 Cygni with a 16-inch reflector. The observations were subsequently reduced using the University of Glasgow's KDF9 computer.

Dr Roy visited the Smithsonian Astrophysical Observatory in Cambridge, Mass. and Goddard Space Flight Center, Washington, for research discussions. Under a grant from the Department of Scientific and Industrial Research he began a theory of the orbits of close lunar satellites, taking into account the evolution of such orbits under the gravitational influence of the Sun and the Earth and the departure of the Moon's shape from a perfect sphere. Dr Green took spectrograms of the Sun at the University Observatory, Oxford, to obtain a test of the theory of the limb effect by comparing the centre-limb red-shifts of Swan bands of molecular carbon relative to atomic lines.

The Director, in collaboration with Dr Green, carried out theoretical work on the production of sheet currents in hydromagnetic systems. He also worked on instabilities in stellar systems and the stability of magnetohydrostatic systems in relation to the solar flare problem. An account of some of his work on the origin of solar flares was given at the AAS-NASA Symposium on the Physics of Solar Flares, Washington in October 1963. He was helped in his work by Mr D. MacGregor, who had come to the Department as a research student from the Department of mathematics at the Royal College of Science and Technology, Glasgow. During this period, Dr Roy completed a second section of his work on the storage of information in neural networks and continued the work in collaboration with Dr Ovenden.

Mr R.B. Hunter and Dr Roy investigated the stability of Jupiter's outer satellites and by extensive use of the University's computer, established how asteroids could be captured by Jupiter as temporary satellites then released to re-enter the asteroid belt or be slung further out into the solar system. Two research students, Mr R.C. Smith and Mr W. McD. Napier were engaged in research into solar magnetic fields and binary stars.

By 1964, the Department had vacated the University Gardens site and had been placed in temporary accommodation in Ashton Road.

Six years later a new and fruitful chapter began in the Department's history. After a rather longer time in the Ashton Road temporary accommodation than expected, the Department

found itself in possession of a brand-new observatory in the Garscube estate. Part of the staff complement was also housed on the top floor of the new Department of Mathematics building stretching along one side of University Gardens, the Astronomy quarters actually lying across the Gardens from the site of Professor Smart's observatory.

6 The Garscube observatory

The new observatory, near one of the University's Halls of Residence, was formally opened in March 1969 by the Astronomer Royal for Scotland. A combination of its choice of site, the Clean Air Acts and the decline of the heavy, smoky industry in Glasgow had provided a marked improvement in seeing conditions for Glasgow astronomy. The heavy, dirty, killer fogs still remembered by Glasgow's older residents were a thing of the past. The present author still recalls vividly how frequently because of the fog he had to send his students home in the evenings an hour early from tutorials in the Gilbert Scott Building and then fumble his own way through the damp throat-stinging, confusingly thick fog to his own home, the nearby street - lamps dimly glowing in the murk, like stars barely illuminating the dense enveloping nebula they were embedded in.

A great deal of careful planning had been put by the Department staff into the new observatory, its equipment and its teaching laboratories. It was equipped to provide student practical information and to support research in the field of instrument design and preliminary testing at a small telescope. The capital equipment comprised a 20-inch reflecting telescope by Grubb Parsons, a Joyce-Loebel microdensitometer and an Askania iris diaphragm photometer. The building was designed to house a coelostat with a high dispersion tunnel spectrometer. These facilities were supported by a fully equipped workshop, library, lecture room and a Goto-Eros planetarium, teaching and research laboratories and an on-line connection to the KDF9 computer in the University.

A drive and guidance system was created for the 20-inch telescope. The basic drive was provided by a heavy-duty stepping motor. For sidereal rate, the motor required to be driven at 200 pulses per second. This frequency was obtained from a quartz crystal oscillator and electronic dividing circuits. By using a hand control, guidance in right ascension could be applied. Push buttons operated relays which controlled the divide circuitry, and the rate at which the stepping motor was driven was altered accordingly. Slow motion in declination was provided at two rates and the position of the secondary mirror could also be controlled by an oscillator whose frequency could be adjusted by the observer at the telescope. Some simple instrumentation for the telescope was also constructed. The equipment available also comprised an attachment for a 35mm camera, a single-channel photoelectric photometer and an experimental photometer using a type of photodiode which had a voltage to frequency converter in its encapsulated shell.

The new teaching laboratories provided a long-sought opportunity to extend the range of undergraduate teaching in observational astronomy the Department had previously provided. Dr David Clarke, who had joined the Department as Lecturer in January 1967 from the University of Hull, was mainly responsible for much of the new development. In subsequent years, as Deputy Director of the observatory, he continuously up-dated these teaching provisions, skilfully utilising innovations in equipment to let students see all aspects of any particular astronomical measurement. The general aim was for the student to collect her/his own data, reduce it and then interpret it. For this purpose, in some of the teaching laboratories, a series of star simulations was designed and equipment provided so that the experiments could be performed during the day and independent of the weather. There were artificial stars which lent them-

selves to visual observation and the determination of a double star orbit. There was a star field which could be photographed and the resulting plate compared directly with the real positions of stars in a catalogue. There was also a star whose brightness could be controlled, allowing photoelectric observations to be made and a light curve obtained which was then suitable for analysis. Other equipment in the laboratories was fairly standard and provided experiments for teaching basic optics or for analysing astronomical photographic plates.

The scope and range of the teaching when the new observatory was opened can be summarised as follows:

First year: The students had two demonstrations in the planetarium and performed quantitative exercises on the Earth's precession and on the motions of the planets. Other experiments and exercises included: the determination of stellar magnitudes by diameter measurements on photographic plates: the investigation of the distribution of Wolf-Rayet stars and the consideration of galactic coordinates: the determination of the parallax of an open cluster by finding the convergent point: the investigation of the usefulness of the Cepheid and RR Lyrae variable stars for distance determinations: the observation of lunar positions during the course of the winter to determine orbital elements: and sextant observations of the sun in summer.

Second year: Besides the standard optical experiments on prisms and diffraction gratings, usually found in physics laboratories, the students performed practical work and exercises on: blackbody radiation: double star measurements, followed by Zwiers' graphical method: star field photography, followed by positional determinations: a simulated Michelson stellar interferometer: stellar radial velocity measurements: line profile measurements by microphotometry by a spectrum recorded on a photographic plate: and transit telescope observations when weather permitted.

Third and fourth years: the students performed the practical work on a project basis, some of which could last a number of weeks. Some of the projects consisted of: the determination of satellite orbits by photographic observation: the production of a Hertzsprung-Russell diagram from the analysis of plates taken in two colours: the measurement of equivalent widths of solar spectral lines by recording the spectrum photographically and performing microphotometry; the determination of the height of lunar mountains by photography and subsequent micro-densitometry: the determination of the selectivity of a telescope-photometer system: the observation of a light curve (artificial star) and the subsequent analysis of an eclipsing binary system.

Academics are singularly privileged in their continual encounter with each young generation as it arrives at university, demonstrating that the falsest of all myths is that 'the younger generation is not what it used to be'. The present writer, incidentally, once read that that statement was translated from a cuneiform clay tablet dug out of the ruins of King Ashurbanipal's library in ancient Nineveh! Over the past 10 years, an increasing number of students, undergraduate or postgraduate, entered the Department of Astronomy and graduated B.Sc. or Ph.D., some of them spending a further number of years doing research before seeking new posts elsewhere, many of which, it is satisfactory to note, lay in astronomy or space research scattered around the world.

7 The Growth of International Collaboration

In the '70s and early '80s, members of the department markedly increased their number of research collaborations with colleagues outside or in the UK. India, Brazil, France, Canada, Greece, Japan, Spain, Italy, the United States and the Netherlands were among the countries involved in such collaborations. A number of foreign senior scholars and graduate students

from some of these countries arrived for extended visits to conduct research at the Department, their presence and input greatly enriching the lives of its staff and students.

While there was some decline in first-year student numbers to new competing subjects during the '70s and '80s, it was a period that saw the size of the Honours class treble and graduate student numbers quintuple, changes associated with new appointments, diversification of research and departmental restructuring. These changes are too numerous to detail in the present short history and can only be chronicled briefly below. Alongside these, the Department gave hundreds of extramural and schools lectures, many under the auspices of the Royal Society of Edinburgh Cormack Committee, and organised numerous public visits to the Garscube observatory including Halley Comet evenings during the 1986 apparition. In the late '80s, the 20-inch research telescope was moved to a new site on the University's Cochno Estate just outside Glasgow to escape the increasing city light pollution, the main teaching facilities remaining at Garscube. Other major teaching activities were service lecture courses in the Departments of the History of Science, Geography/Topographic Science, and Aero Engineering, and, in W.M. Smart's footsteps, publication of six well received textbooks by A.E. Roy, by A.E. Roy and D. Clarke, by R.M. Green, and by I.J.D. Craig and J.C. Brown.

To appreciate the success of Glasgow astronomy in recent times, it is useful first to comment on the trying times in which this progress was set, with chill winds of inflation, of recession, and of government policy unsympathetic to education and research. Research councils moved from funding all 'alpha' and some 'beta' rated research applications to funding only a fraction of those in the 'high-alpha' category. The period saw the brain drain turn to a haemorrhage, and a spate of disillusioned early retirements, leaving institutions bereft of some of their best youth and greatest fonts of wisdom. At the time of writing the British government still seems to persist in the notion that higher education of our youth can be achieved on the cheap, taking no account of the cost of ignorance. The situation is worsened by the market dogma that all research must yield quick returns - ie, be immediately applicable - and the idea that the best direction of research can be decreed by central committees. One wonders how the fundamental researches of Faraday, Maxwell and Rutherford, driven by genius and pure curiosity, of no foreseeable immediate use but leading eventually to our present day world of electric power, television and atomic energy, would fare under today's grant system.

Appointment to Lectureships in the Department in the late 1960s of Drs D. Clarke and J.C. Brown led to the steady growth of new research areas on top of existing strengths. These were observational spectropolarimetry of very high precision, and diagnostic modelling of high energy processes in solar flares, utilising data from international space missions. The Solar Modelling Group grew out of P.A. Sweet's theoretical interests but also has practical ramifications for earth and space environments, and in turn led on to current interests in image processing, neural network data analysis, and collaborations with the Plasma Physics Group. In the polarimetry work, substantial observing campaigns were conducted here and abroad, and collaboration established with J.C. Brown on interpretation. Research in these fields, together with astrodynamics, produced a growth in the Science and Engineering Research Council (SERC) funded research staff from none to four, with parallel growth in research students.

A great deal of departmental research in recent years was influenced by the advent of the space age following Sputnik in 1957. From that time much work was done by A.E. Roy's celestial mechanics team on developing fast numerical methods to compute spacecraft orbits - a need which was especially great in those days when computers were extremely sloth-like and expensive by today's standards. (Around 1968, the Department bought a Frieden 4-function electronic calculator, the size of a television set, for £1,000 - ie, £10,000 at 1990 prices - which had a wheel to adjust the decimal place and took about ten seconds to find a square root - a special feature adding £100 to the cost!) NASA's Skylab Missions of the post-

Apollo era brought Glasgow's involvement in analysis of astronomical data from spacecraft, including interplanetary dust (D. Clarke) and solar x-rays (J.C. Brown), the latter work evolving through the past 20 years to Glasgow's present involvement with the Yohkoh and Compton space observatories. The astronomical polarimetry programme too has used spacebased data, currently from a Wisconsin UV experiment aboard the Space Shuttle. Perhaps most interesting of all is the interdisciplinary space interest which emerged from astrophysics work on radiation pressure effects around stars, which became a celestial mechanics problem, and then a joint project with Aerospace Engineering on solar-sailed spacecraft.

8 Mergers and New Directions

When P.A. Sweet retired in 1982, the Regius Chair was frozen, with many others, as an economy, Professor A.E. Roy being appointed as the (last as it transpired) Head of the Astronomy Department. At the same time proposals had been floated for amalgamation of the Astronomy and Natural Philosophy departments. These discussions extended over several years, during which the University was persuaded to advertise a new Chair of Astrophysics with the remit of promoting interdepartmental collaboration in research and teaching. This contest was won in 1984 by J.C. Brown, then Reader (aged 37), who, in the same year, had been awarded a D.Sc. for his solar plasma work and elected Fellow of the Royal Society of Edinburgh. Professor Brown was replaced by Dr J.F.L. Simmons, who further broadened departmental research interests into cosmology and statistical studies. In the last year of the separate Astronomy Department, Mrs L. Williamson was replaced on her retirement as secretary by Miss D. Davidson. The departmental merger was finally achieved in 1986, with agreement, currently being implemented, eventually to fund Astronomy accommodation in a refurbished and extended Natural Philosophy building. This departmental merger was the first in a national trend, the UK's last separate Astronomy department (Edinburgh) being about to join Physics.

While the merger marked the formal end of Astronomy's history as a department, it by no means represented an end to the subject. Professor Roy formally retired in 1989, but he remains as active as ever in teaching and research: following the successful conclusion of a consortium (initiated by him in 1983) with Queen Mary and Westfield College London, Liverpool, Royal Greenwich Observatory and Pisa, to study the long term dynamics of the solar system over 10^8 years, he has now created a second international research undertaking in celestial mechanics. Such international collaborations are indeed a hallmark of astronomy everywhere, Glasgow currently having joint projects with Sao Paulo, Sydney, Tokyo, Montréal, Madison, Maryland, Berkeley, Alabama, New Hampshire, Copenhagen, Utrecht, Amsterdam, Leiden, Paris, Genoa, Pisa, Rome, Kiev, Budapest and Prague. Additionally, Glasgow astronomers have directed four NATO Advanced Study Institutes in the last seven years.

After Professor Roy's retirement and Dr Green's half-time appointment as Principal Adviser in the Faculty, the University was (eventually!) persuaded to appoint a new Lecturer in Astronomy and Astrophysics in 1990. The appointee, Dr D.A. Diver, brought extra plasma expertise to the Astronomy Group which, in 1991, merged with Professor E.W. Laing's Plasma Theory Group and became the Astronomy and Astrophysics Group, headed by Professor Brown. In 1991, Dr A.L. MacKinnon, then a SERC Advanced Fellow in Astronomy, was appointed as Lecturer in Physics and Astronomy to the Department of Adult and Continuing Education, but remains an active member of the Astronomy and Astrophysics Group. The Group thus now has more staff, research staff, graduate students, and grant income from many sources than ever in the subject's history and in 1993 becomes a SERC funded node in the Starlink computer network. First year astronomy numbers have recovered from a low of 40 to 80 and a

new Arts course ('Exploring the Cosmos') has attracted 40 in its first year and 80 in its second. Combined with the astronomy interests of the widely renowned Gravitational Wave Group, led by Professor J. Hough, this puts Glasgow Astronomy in its strongest position ever, so that it can look forward to a healthy future in the Faculty of Science, studying the mysteries of the cosmos.

9 Acknowledgements

It is a pleasure to record my thanks to Professor John C. Brown for his help in preparing this document.

10 References

Becker, L. (1925). The Climatology of Glasgow. H.M. Stationery Office, London.
Becker, L. (1933). On a New Aircraft-sextant for Use with Visible Horizon. Mon. Not. Roy. Astron. Soc., **93** ,185-190.
Craig, I.J.D. and Brown, J.C. (1986). Inverse Problems in Astronomy. Adam Hilger, Bristol.
Grant, Robert (1853). History of Physical Astronomy. Henry G. Bohn, London.
Grant, Robert (1883). A Catalogue of 6415 Stars for the Epoch 1870, deduced from Observations made at the Glasgow University Observatory during the Years 1860-1881.
Grant, Robert (1892). A Second Glasgow catalogue of 2156 Stars.
Green, R.M. (1985). Spherical Astronomy. Cambridge University Press. Cambridge.
Murray, David (1927). Memories of the Old College of Glasgow. Jackson, Wylie and Co., Glasgow.
Nichol, J.P. (1838). The Architecture of the Heavens. Hippolyte Bailliere, London.
Nichol, J.P. (1851). The Planetary System: its Order and Physical Structure. Hippolyte Bailliere, London.
Roy, A.E. (1965). The Foundations of Astrodynamics. The Macmillan Co., New York.
Roy, A.E. (1978). Orbital Motion. Adam Hilger, Bristol.
Roy, A.E. and Clarke, D. (1977). Astronomy: Principles and Practice. Adam Hilger, Bristol.
Roy, A.E. and Clarke, D. (1977). Astronomy: Structure of the Universe. Adam Hilger, Bristol.
Smart, W.M. (1928). The Sun, the Stars and the Universe. Longmans, Green and Co., London.
Smart, W.M. (1931). Textbook on Spherical Astronomy. Cambridge University Press, Cambridge.
Smart, W.M. (1938). Stellar Dynamics. Cambridge University Press. Cambridge.
Smart, W.M. (1942). Foundations of Astronomy. Longmans, Green and Co., London.
Smart, W.M. (1942). Introduction to Sea and Air Navigation. Longmans, Green and Co., London.
Smart, W.M. (1943). A Handbook of Sea Navigation. Longmans, Green and Co., London.
Smart, W.M. (1947). John Couch Adams and the Discovery of Neptune. **No.11**, Occas. Notes of the Roy. Astron. Soc., London.
Smart, W.M. (1950). Some Famous Stars. Longmans, Green and Co., London.
Smart, W.M. (1953). Celestial Mechanics. Longmans, Green and Co., London.
Smart, W.M. (1958). Combination of Observations. Longmans, Green and Co., London.