Plaskett's decisions were shaped by his research interest. The challenge was that while he, his friend Theodore Dunham of Princeton and Mount Wilson, and Milne accepted the common belief that stars with different surface conditions had different spectra, they were uncertain about interpreting line intensities in stellar spectra in terms of atomic counts based on laboratory experiment. They suspected that the distribution of energy among wavelengths in the continuous spectrum interacted with the reversing layer. They believed that solar spectra were the key to these stellar problems because very refined spectra of solar granulation could be used to measure energy distribution in the Sun's continuous spectrum. For this they needed to develop new instruments and techniques, produce replicable data, and develop a convincing analysis of it. That required co-operative effort.

As to filling the Radcliffe Travelling Fellowship, in November 1936 Dunham was considering resigning from the Princeton post he had held for two years in order to pursue observational spectroscopy. For the Fellowship, H.N. Russell recommended Dunham to Dyson and to Plaskett as his best graduate for twenty years.[70] Against Lindemann's view that the Fellowship should be awarded to an Oxford man, Knox-Shaw and Plaskett preferred a non-Englishman to start with because they considered it desirable to establish the Fellowship as a prestigious post for the very best international talent. However Dunham then decided to continue part-time at Mount Wilson, with regular visits to Oxford. Thus in 1937 Herman Zanstra (1894–1972), a theoretical physicist of Amsterdam University, was appointed to the Fellowship.

Meanwhile Milne had 'brought new life' to applied mathematics at Oxford,[71] and together with Plaskett attracted able students. By 1939 research had become an imperative in Oxford science, and astrophysics was one of nine significant schools that offered research-led teaching. Plaskett had identified a narrow field of observational research that could be accessed by a world-class but affordable instrument operated effectively on the existing site. He minimized other commitments. He diverted observatory assistantships to graduates doing their own original work, capitalized on the vital studentships to include post-doctoral researchers regardless of nationality, and he fostered visits by senior researchers. He pursued curricular change, dropped elementary teaching, but offered astrophysics to Honours finalists in mathematics and physics; with Milne he ensured a flow of distinguished seminar speakers who would attract wider interest in the University. By these means Plaskett made the University Observatory an international centre of excellence in solar and stellar physics by 1937. By diplomacy he and Milne had at last gained the support of the University to complement the new inter-department and inter-personal co-operation that they both found essential.

Glasgow

The 1889 statutes which implemented the findings of the 1876 Royal Commission on Scottish Universities modernized the chairs, but otherwise left astronomy untouched. A B.Sc. in pure science was established at all four Scottish universities and included practical work, but there was no B.Sc. in astronomy which subject therefore faced

increased competition from the other sciences including botany and geology. In 1889 Glasgow completed a new physics laboratory for £40,859 (half provided by the Carnegie Trust), and in 1904 built a large temporary chemistry laboratory at a cost of £13,000.[72]

In Chapter 3 it was explained how Professor Robert Grant had managed to complete his second meridian catalogue in 1892, the year of his death. He was succeeded by Ludwig Becker (1860–1947), one of the German Ph.Ds who had made Dun Echt so successful before he was transferred as an assistant to Edinburgh. Becker was 32 when in 1892 he was elected Regius Professor in Glasgow. The Horselethill site was now appalling, the stars barely visible due to smoke and pollution, and spectroscopy was impossible. Tests in 1905 measured an annual deposition of more than one and a half tons of soot per acre per year at the observatory site.[73]

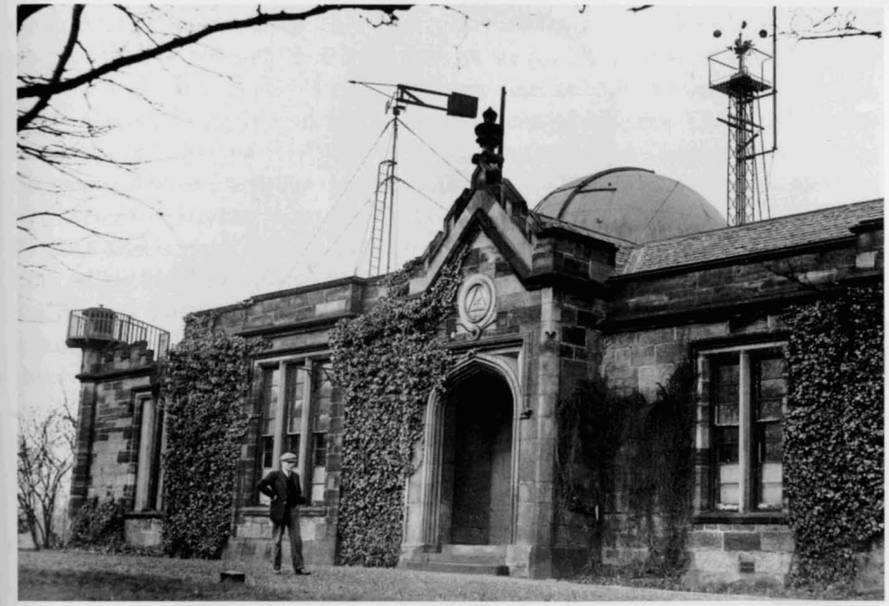

Fig 7.7 Glasgow's Horselethill Observatory at Dowan Hill, *c.*1936
The meteorological instruments on the roof are clearly visible, and practical classes in astronomy were still given, but observation for research was no longer possible. In 1938 the site was sold to the Convent of Notre Dame who demolished the building and built a school.

Therefore, in 1893 Becker had proposed that the University should build a research station away from Glasgow to house the 9" Cooke, the ancient Breadalbane Ramage reflector refurbished in 1855 with a 20" silver on glass mirror, and a coelostat with a large spectrograph. He estimated the cost at £27,000.[74] This relocation scheme based on three instruments, without a clear research plan or relevance to students or

curriculum, was a hopeless plea. He received £1,000 from the new Bellahouston Trust to renovate the meridian circle and to equip the reflector with a new mirror.[75] This was the first capital expenditure on Horselethill for fifty years. Obliged to teach in the University, Becker was a former professional astronomer, a potential astrophysicist, condemned now to a near-hopeless site for research. He refurbished the old instruments and set himself to observe the constants of aberration and nutation over an 18.6 year cycle. He worked single-handedly for ten years, then gave up observing because of his health and the observing conditions.[76] No significant observing was done at Glasgow after 1903, and only routine observations for time until 1918. Sadly, xenophobia compelled him to leave the city during 1915 for the remaining years of the war,[77] but he resumed his very successful teaching afterwards.

Fig. 7.8 William M. Smart (1889–1975)
As Director of the Glasgow Observatory, 1937–59, in 1938 he closed the Horselethill Observatory at Dowan Hill and started a new Department of Astronomy.

Becker retired in 1935. Astronomy was still not an autonomous academic subject, and had its opponents. However, the chair was saved, and William Smart arrived from the

Cambridge Observatory to take over in 1938. Smart's background indicates much about the weakness of Scottish degrees, including the new B.Sc. of 1895. After four years at Glasgow University he had graduated in 1911 with a first-class Honours M.A. which included some astronomy within the mathematics, and some physics within the Natural Philosophy. Since a Glasgow B.Sc. would neither stretch his ability nor open the doors he aspired to, he went on to Trinity College, Cambridge, in 1911 for a second undergraduate degree. There he won the Sheepshanks Exhibition in 1914 and the Rayleigh Prize in 1916. His Cambridge B.A. and the academic prizes were his steps on to the career ladder, in 1919 gaining him appointment by Eddington to assistantship at the Cambridge Observatory, where he made an outstanding contribution. The electors at Glasgow had no superior local candidate.

With the site no longer viable, and with no prospect of new instruments, Smart closed the Horselethill Observatory, and it was demolished in 1938. Of its 95 years under three professors, it was engaged in observational research for 42. Grant built a tradition of good research, then Becker one of successful teaching of undergraduates and engineers, but modern instruments were unaffordable. William Smart's new policy was apparently modelled on the very successful Students' Observatory at the University of California at Berkeley, and the effectiveness of Kapteyn's laboratory at Groningen.[78] He succeeded in establishing a new department and assistant's post. But war interceded. His last research paper was in 1941, and he did not regularly attend the RAS after serving as its president from 1949 to 1951. A fraction of the proceeds from selling the site built a new student observatory in the University garden close to Smart's new Department of Astronomy. Opened in April 1939, with a library and lecture room, it was equipped with the 9" Ochtertyre refractor. The teaching observatory was supplemented by a small transit house. Funding was found for his assistant Thomas R. Tannahill, a Glasgow M.A. and B.Sc. – precisely the qualifications Smart had transcended in order to gain high office in Scotland. For research Smart chose to work on proper motions based on plates from the Cape Observatory.[79] Thus work started with the benefit of having high-quality data from a southern outstation obtained by just the sort of co-operation Turner had agreed upon in 1929, but without the additional dimension of a visiting studentship.

Professor Ronald W. Hilditch's overview of Scottish astronomy has identified the completion of the new Royal Observatory at Edinburgh in 1894 as beginning 'the long-term and sustained growth of astronomy as a research and teaching discipline in the Universities of Edinburgh, Glasgow, and later, St Andrews. However, it remained hard to develop home-grown talent. In 1908 a local graduate had failed the numeracy test for the ROE Second Assistant's post, and a Greenwich trained computer was appointed. But by the 1920s Edinburgh and Glasgow were offering astronomy and astrophysics as elements of advanced Honours classes. Edinburgh installed its new 36" Grubb reflector and spectrograph in 1932 to replace the 15" refractor, and pursued spectrophotometry. Smart chose to supplement teaching with a department specializing in theoretical or mathematical analysis of astronomical problems.[80]

Glasgow University's redefinition of its interests and creation of a new department rendered the chair productive again. This restructuring can usefully be compared to the unfolding crises in Ireland.

Fig. 7.9 The 9" Ochtertyre refractor in the new Glasgow University Teaching Observatory, 1938

Dunsink

The decline of the two Irish public observatories in the inter-war period has been detailed fully in the excellent histories by Patrick Wayman for Dunsink and by Jim Bennett for Armagh. Both observatories were eventually revived by a remarkable entrepreneur astronomer, Eric Lindsay (1907–74). Here we note the last independent work of the two Irish observatories, and outline the solution to their problems.

Unused, but still mounted on a huge masonry pillar in the centre of the Dunsink Observatory beneath the small dome of 1785 that surmounted the building, was a 5.2" refractor with a Cauchoix object glass (costing about 120 guineas) completed in 1834 by the Dublin clock-maker Christopher Sharp; there is only one record of it having been used, in 1839. By 1852–53 it was reported to be 'nearly useless'.[81] By 1873 Dunsink had been re-equipped with the 11¾" South refractor and a 6.4" meridian circle.

Robert Ball was appointed Andrews' Professor and director of the Observatory in 1874. A meticulous observer, he personally embarked on an effort sustained over a decade using the recently installed South refractor with a double star micrometer to observe 368 stars in order to detect annual parallax. He was unfortunate that with the instrument he had he was not able to detect a measurable parallax among the stars he had selected. Meanwhile a succession of very able assistants, Ralph Copeland from 1874 to 1876, Charles E. Burton (1846–82) from 1876 to 1878, John L.E. Dreyer from 1878 to 1882, and then Arthur A. Rambaut, worked the meridian circle and enabled Ball during a period of 18 years to achieve a high standard of work at Dunsink, and also to initiate a time service for Dublin. In 1883 Ball began to suffer problems with his right eye. Rambaut, his new assistant in 1882, was a gold medallist in Mathematics and Mathematical Physics at Trinity College, Dublin. Taking up the assistantship enabled Rambaut to marry in 1883, and his three sons were born in the assistant's house at Dunsink. With most observing work delegated to him, he used the South refractor to observe a number of spectroscopic binary stars and he continued the meridian work.

Meanwhile the success of the Astrographic Congress of 1887 had stimulated Ball's aspirations. His Visitors reported on 7 July: 'The Astronomer has pressed strongly upon us the advisability of having a photographic telescope and fixed establishment in the old dome. We have directed him to get an estimate of costs'.[82] One week later his friend Howard Grubb produced a 'Rough Design for Standard Photographic Telescope'. On 4 August 1887 he quoted Ball, who initially wished to join the *Carte du Ciel* project, a total of £1,865 for the new coaxial telescopes (13" astrograph and finder-scope), a new 18 feet diameter dome, and installation.[83] This cost was prohibitive.

Probably hearing at the RAS of Ball's dilemma, Isaac Roberts (1829–1904) offered in 1888 to donate his spare 15" Newtonian reflector, for which the 'most perfect' speculum metal mirror by George H. With had cost £65, and to pay for its installation.[84] Grubb in a letter to David Gill later recalled that Roberts said he had 'a 15 inch reflector of With's', which suggests that With may also have provided the