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THE BEGINNINGS OF MODERN ASTRONOMY AT THE UNIVERSITY OF ST ANDREWS

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Abstract: Although the University of St Andrews is much older, teaching of and research in modern astronomy began there little more than sixty years ago. Their inception was strongly associated with one man, Erwin Finlay-Freundlich. Some account is given here of his work in St Andrews and the influence he had on younger generations.[1]

Keywords: modern astronomy, University of St. Andrews, Erwin Finlay-Freundlich.

1 BACKGROUND

The University of St Andrews, Scotland's oldest and the third oldest in the English-speaking world, has recently celebrated the six-hundredth anniversary of its foundation. As in other medieval universities, astronomy figured in the curriculum as one of the subjects in the *quadrivium*. In 1563, John Napier, Baron Napier of Merchiston (1550–1617), the inventor of logarithms, matriculated as a student there at the age of 13. He apparently decided to continue his education elsewhere as there is no record of his having graduated from the University.

About a century later, James Gregory (Figure 1), the inventor of the Gregorian telescope, was appointed the first occupant of the Regius Chair of Mathematics in 1668. He had a temporary observatory and laid out a meridian line (Figure 2) in a building that still stands and is in regular use by the University (see Amson, 2008). He planned a separate observatory some distance away from that building and was authorized by the University to purchase instruments for it, but he decided to move to the newer University of Edinburgh. Apparently he found the other professors in St Andrews too conservative in their thinking, and although his planned observatory was built, possibly after he left in 1674, it did not last long.

Astronomy languished in St Andrews until the nineteenth century when Sir David Brewster (Figure 3; Morrison-Low, 2004) was for a long time Principal of the University. Regular undergraduate courses in modern astronomy did not begin, however, until well after Brewster's time.

One of Gregory's successors in the Regius Chair of Mathematics was Sir Peter Redford Scott-Lang (1850–1926) who long cherished the idea of reviving teaching and research in astronomy in the University. His dream was realized after his death by his bequest, transmitted by his daughter, that endowed a Lectureship in Astronomy, to be named after John Napier. The University thus was in a position to look for someone to occupy this post shortly before the outbreak of WWII.

Figure 1: James Gregory, 1638–1675 (after: molecular.magnet.fsu.edu/optics/timeline/people/gregory.html).

2 ERWIN FINLAY-FREUNDLICH

The man eventually chosen to become the first Napier Lecturer (and later Professor) was Erwin F. Freundlich (Figure 4). His name will be familiar to all those who have studied the history of the acceptance of Einstein's theory of relativity because he was among the first astronomers to realize the potential for testing that theory by astronomical observations. Indeed, Freundlich attempted to measure the deflection of light rays passing near the Sun even before Einstein pub-

Figure 2: Gregory shown at work in what was then the University's library, which he used as a temporary observatory. The wooden meridian line that he set into the floor is clearly visible (after: st-andrews.ac. uk/divinity/rt/kjl/).

Figure 3: Sir David Brewster, 1781–1868 (courtesy: en.wikipedia.org).

Figure 4: Erwin Finlay-Freundlich, 1885–1964 (courtesy: kuriositas.com).

Figure 5: Professor Felix Klein, 1848–1925 (courtesy: thefamous people.com).

Figure 6: The Einstein Tower at the Potsdam Astrophysical Observatory (courtesy: en.wikipedia.org).

lished the final version of general relativity. In a preliminary theory, Einstein was predicting only half the value for the deflection that he gave in his final version. Freundlich organized an expedition to the Crimea in the summer of 1914 to observe a total solar eclipse, but his party, all Germans, arrived in Russia just before the outbreak of WWI and was promptly interned as a group of enemy aliens as soon as hostilities opened. Fortunately the party was soon repatriated in exchange for some Russian officers who had been taken prisoners of war.

In his biography of Einstein, Hoffmann (1972: 133) suggests that the failure of this expedition was fortunate in another way. If Freundlich had found a value for the deflection similar to that found five years later by Eddington, it would not have seemed a confirmation of Einstein's theory, the subsequent modification of which, to agree with observations, might have looked like an *ad hoc* adjustment rather than a brilliant prediction.

Although this episode in Freundlich's career is well documented and is mentioned in nearly every biography of Einstein that has been published (e.g. see Crelinstein, 2006), I find that little is known of the rest of his work in astronomy and especially of the time after he left Germany in 1933. I published a few reminiscences of the man on the occasion of the centenary of his birth (Batten, 1985) and there is an excellent account of his early work by Hentschel (1997), which I reviewed in this *Journal* (Batten, 1999). An account from a rather different angle was given by my late friend and fellow St Andrean, Eric Forbes (1972). Now, fifty years after Freundlich's death, seems a good time to look once again at his work and significance.

Freundlich was born in Biebrich am Rhein, Germany, on 29 May 1885. From 1905 to 1910 he studied at the University of Gőttingen (with one term at the University of Leipzig). Although he apparently took at least one course from Karl Schwarzschild, he did not then have a great interest in astronomy. His principal teacher was Felix Klein (a fact of which he was quite proud), and he regarded himself as a pure mathematician. Klein (Figure 5), however, recommended him for a position at the Royal Observatory in Berlin, then under the direction of Hermann Struve.[2] According to Hentschel (1994), Freundlich was exceptional among German astronomers in being interested in the then new techniques and problems of astrophysics, and virtually alone in seeing the possibility of testing relativity theory using astronomical observations.

This latter interest of Freundlich's led to a period of collaboration with Einstein, of which Freundlich was also proud. The relationship cooled after a few years, but not until after Freundlich had raised funds to build the Einstein Tower

in Potsdam (Figure 6) as an observatory dedicated to testing the theory of relativity, in particular the predicted gravitational redshift of light from the Sun. Naturally, he became the Director of this Observatory and would probably have ended his days there but for the rise of Hitler. Freundlich had a Jewish grandmother and had married a Jewish wife. Moreover, he openly expressed his contempt for the Nazis and, understandably, left Germany soon after Hitler came to power, but not before he had led three other eclipse expeditions. The last of these, to Sumatra in 1929, was successful and indicated a deflection of light *greater* than Einstein's prediction. In 1933, however, he was invited to the University of Istanbul, to found an astronomy department there, build an observatory and write a textbook that could be translated into Turkish. While doing these things, he also taught, his best-known student there being Paris (Pariz) Pişmiş (Figure 7), who later emigrated to Mexico.

Having completed the tasks he agreed to do, Freundlich moved again, in 1937, this time to the German University in Prague. I have often puzzled over this move: surely by 1937 it was already clear what was likely to happen in Czechoslovakia. Perhaps Freundlich was homesick for Germanic culture, which he could find in the Czech capital, and placed more reliance than was prudent on the Franco-British guarantees to that small country. Inevitably, he had to move again, but not before he had taught Zdeněk Kopal (Figure 8), who although at Charles University attended Freundlich's lectures.

It was at this time that the University of St Andrews was looking for its first Napier Lecturer. According to several obituary notices, Sir Arthur Eddington played a role in bringing Freundlich to Britain. No doubt the latter's interest in testing relativity theory helped to bring him to Eddington's attention and it is entirely in accord with Eddington's manner that he should quietly help the victims of Nazi persecution. Some years ago, at a meeting in Cambridge to mark the sixtieth anniversary of Eddington's death, Hermann Bondi testified how Eddington had helped him to come from Vienna to Cambridge. There were other factors that perhaps helped. Freundlich's mother, born Ellen Finlayson, was a Scot, while his brother, Herbert, was a well-known physical chemist and probably knew the then Principal of St Andrews, Sir James Colquhoun Irvine, who had earlier been Professor of Chemistry at the University.

Whatever the relative importance of these various factors, Freundlich came to Britain and was installed in St Andrews shortly before the outbreak of WWII. He adopted British citizenship and the name Finlay-Freundlich, derived from his original surname and his mother's maiden name. Usually in St Andrews, however, he was addressed simply as Professor Freundlich (the Napier Lectureship became a Chair in 1951).

Figure 7 (left): Dr Paris Pişmiş (1911–1999), one of Freundlich's early students (courtesy: www.aras.am/FamousAstronomers/pishmish.html).

Figure 8 (right): Professor Zdeněk Kopal (1914–1993), another one of Freundlich's early students (courtesy: img.radio.cz).

3 MODERN ASTRONOMY AT ST ANDREWS

As Gregory had been before him, Freundlich was commissioned by the University to build an observatory, a task that he undertook for the third time in his life. A small building was completed in 1940 which still stands, although now much modified. In the early 1950s, I attended almost all my astronomy lectures there. Any large instrument, however, had to wait for the end of the War. During that conflict, much of Freundlich's time and energy was dedicated to teaching astronavigation to the aircrew at the nearby RAF base of Leuchars, and he even penned a book on the topic (Figure 9). I have often wondered what the young RAF officers made of someone with a heavy German accent (he never lost it) teaching them how to navigate safely during their attacks on the Luftwaffe and Germany. An added irony

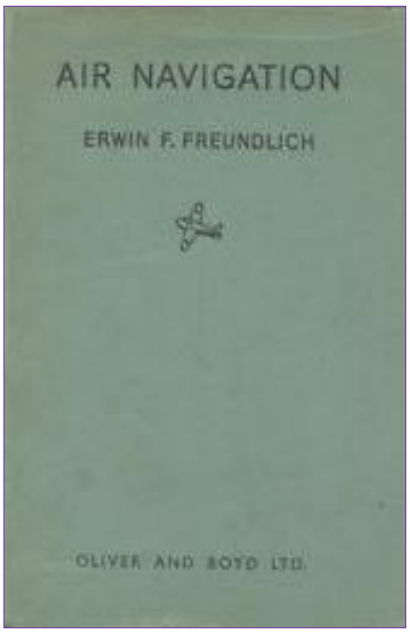

Figure 9: Cover of the 1945 first edition of Freundlich's book (courtesy: ebay.co.uk).

Figure 10: Robert Waland (left) and Professor Freundlich in the Optical Shop at St. Andrews in 1947, examining an 18.75-in mirror (courtesy: Dumfries Museum and Camera Obscura).

is that, at the same time, a young technician, who would one day become the President of the International Astronomical Union, was at the same RAF base testing early forms of radar which would eventually render astro-navigation obsolete (see Hanbury Brown, 1991: 48-50).

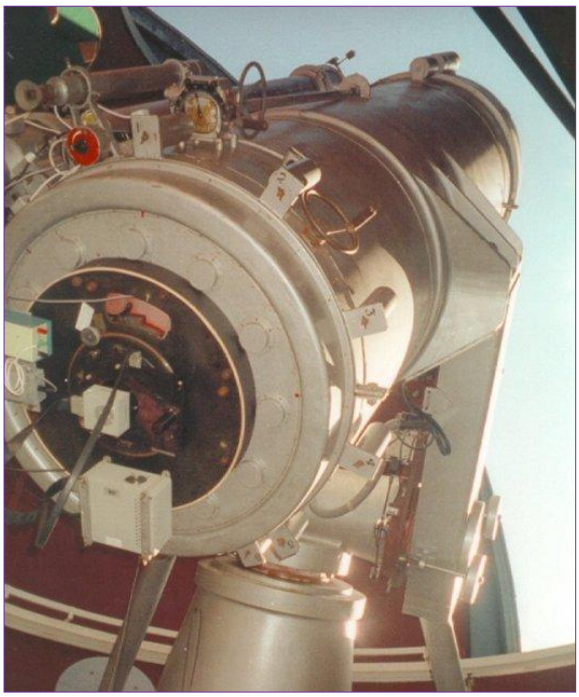

Figure 11: The 0.9-m James Gregory Telescope (courtesy: st-andrews.ac.uk).

The end of the war enabled Freundlich to turn his attention, for the third time in his life, to building a new observatory. He decided to attempt the construction of a Schmidt-Cassegrain telescope. Although this design is now familiar to us in the form of Celestrons and similar telescopes, it was an untried design in the 1940s—and, even now, you cannot easily buy a Celestron of 0.5-m or even 1-m aperture, which is precisely what Freundlich decided to build. For the theoretical design, he relied heavily on the advice and calculations of E.H. Linfoot (1905–1982; Fellgett, 1984) in Cambridge. For the practical realization of the project, he relied on the skill of R.L. Waland (Figure 10), a local amateur telescope maker whom Freundlich 'discovered' while giving popular lectures in and around St Andrews. Freundlich was so impressed by the quality of Waland's work that he hired him as the chief technician for the project. The 0.5-m pilot model was built first, and it had not long been in operation when I arrived at St Andrews in the fall of 1951. It proved useful and the decision was made to go ahead with the full-size model. Unfortunately, this took longer to build than had been hoped, and it was not completed until about the time of Freundlich's retirement (Figure 11). This fact, coupled with disagreements between Freundlich and his successor, D.N.W. Stibbs, and Waland's consequent resignation, meant that the full-size model never realized its full potential.

Research was not Freundlich's only concern, however; he also instituted an honours undergraduate programme in astronomy. It is of interest that, at that time, three of the four universities then established in Scotland were offering an undergraduate programme in astronomy, while no university in England did so. In those days, the University was much smaller and less well-known than it is today. The total number of students in the early 1950s was about 2,000, of whom 500 or so were in University College, Dundee, then a part of the University of St Andrews. Astronomy classes were correspondingly small. Typically, the first-year course attracted 20 to 25 students. The senior years were often taught all together. In my final year, I *was* the class, and received no formal instruction at all.

I emphasize these facts because from this small pool of students some five or six emerged over the years who had successful careers in astronomy. Leonard Searle (1930–2010; Figure 12) went from St Andrews to Princeton for his doctorate, and spent most of his career at Mount Wilson Observatory, becoming Director in 1989. William Nicholson spent his working life in the Nautical Almanac Office. Eric Forbes (1933–1984; Meadows, 1985), my exact contemporary, after some detours, became a well-known historian of astronomy, based at the University of Edinburgh. I myself went to Manchester for my doctorate (Figure 13; see, also, the biodata entry photograph at the end of this paper), and spent most of my career at the Dominion Astrophysical Observatory in Canada. Thorstein Saemundsson went to London for his doctorate and returned to Iceland for a career in geophysics. In addition to these undergraduates, Alan Jarrett (Figure 14; Glass and Koorts, 2007) was a graduate student and later became Director of the Boyden Observatory in Bloemfontein, South Africa.

Freundlich continued in research, still concerned with the astronomical evidence for general relativity. Remember that the laboratory tests of the theory that are now possible, to say nothing of the observations of pulsars, were simply unknown in the 1940s and early 1950s. I have already mentioned that Freundlich's results from the Sumatra eclipse expedition seemed to show a deflection greater than predicted by general relativity. This fact sowed the first seeds of doubt in his mind about that theory and he ended his life quite skeptical about it. He published a theory of photon-photon interaction (Freundlich, 1954) to account for the cosmological redshifts. It was a variation of tired-light theory that never won wide acceptance and is now almost forgotten. Also in 1954, despite having suffered a heart attack the year before, Freundlich led yet another eclipse expedition, this time to Sweden. Once again, he was foiled by clouds. Ironically, I saw the eclipse from the climatically less-favoured west

Figure 12: Leonard Searle (courtesy: en.wikipedia.or).

Figure 13: Erwin Freundlich flanked by two generations of his students: Zdeněk Kopal (left) and the writer. This photograph was taken in Manchester by T.W. Olle, in 1957 (Batten Collection).

coast of Sweden—while he was on an island in the Baltic Sea. He was well aware of the difficulties of getting a conclusive result from this type of observation, but had he found a similar result in Sweden to the one he obtained earlier in Sumatra, his doubts about general relativity would certainly have increased.

Freundlich finally retired from St Andrews in 1959 and returned to his native Germany, indeed to Wiesbaden close to his place of birth, where he was made an honorary professor by the

Figure 14: Alan Jarrett, 1925–2007 (right) and Gordon Malcolm at the Boyden Observatory (after Glass and Koorts, 2007).

University of Mainz. He died on 24 July 1964. About a month later, the International Astronomical Union met in Hamburg. It had been my intention to visit him on my way home from that meeting and he had already agreed to receive me. It is one of my regrets that his death prevented that final meeting with him.

4 RETROSPECTIVE

As I look back on Freundlich's career, I am struck by the fact that his own research, important as it seemed at the time, has proved ephemeral, but his influence on the younger generations has lasted. His early work on stellar statistics, which I have not discussed, is quite superseded, even though, as Kopal (1986: 95-99) tells us, he came close to discovering galactic rotation. Both his attempts to verify, and his later doubts about, general relativity are likewise now seen as largely irrelevant. His period as Director of the Einstein Tower, however, was one of interaction with several colleagues (Crelinstein, 2006,) and in all three of the universities in which he taught he left a legacy of students who went on to their own careers in astronomy. His tenure was short, both in Istanbul and Prague, but in each city he taught at least one outstanding student. I know from conversations with each of them that they found him an inspiring teacher. He had a much longer tenure in St Andrews but, as I have stressed, a small pool of talent on which to draw. That he produced so many students in two generations testifies to his ability to inspire younger people, and his chief influence seems to have been in his teaching rather than his research.

Under his successor, the Astronomy Department in St Andrews was greatly strengthened and has continued to flourish since Stibbs' retirement even though it is now a part of the School of Astronomy and Physics. Stibbs deserves much credit for the flourishing of astronomy in the University of St Andrews, but he did not start from scratch. Although he and Freundlich had a poor personal relationship (as I heard from each of them) they would, I hope, agree that they each made an important contribution to the present happy state of affairs.

5 NOTES

1. This is an expanded version of a talk given during the National Astronomy Meeting of the Royal Astronomical Society in St Andrews in 2013.
2. Freundlich's relationship with Struve was a rather troubled one and it is slightly ironic that I, in later life, should have chosen to write about the Struve family (see Batten, 1988.)

6 ACKNOWLEDGEMENTS

I am grateful to Dumfries Museum and Camera Obscura for permission to publish Figure 10.

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