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Andrews years, was but a pale shadow of his former self. Unfortunately, a certain impetuosity in Freundlich's nature, still evident when I knew him, led him in those early days to publish some rather questionable papers that did nothing to improve his standing with the old school.

A paradox of Freundlich's life was that, although he began as a staunch advocate of relativity, he became increasingly sceptical of it as he grew older. To two of the classical astronomical tests of the theory, the gravitational red-shift (particularly in the light from the Sun) and the deflection of starlight passing near the Sun during a total eclipse, he made important contributions of his own and he knew at first hand, therefore, the difficulties of obtaining observational confirmation for these tests. As far as I know, he made no investigations of his own on the movement of the perihelion of Mercury, but he would impress on his students that this motion was not observed directly, and that the quoted value was in fact the difference between two very large directly observed quantities, and therefore uncertain. It was not as idiosyncratic in the 1950s as it would be now to be sceptical of general relativity, but Freundlich's scepticism led him to develop a theory of photon-photon interaction (a version of tired-light theory) that would explain the red shifts of distant galaxies without the need of postulating an expanding universe. Hentschel discusses this theory, but it has never, of course, been accepted by the mainstream of cosmologists.

The portrait of Freundlich that emerges from this book is not entirely flattering, but I think Hentschel tries hard to be fair and does make clear that Freundlich was an important figure in German astronomy between the world wars, and well-known outside the country. He also had the courage, as long as he remained in Germany, to stand up to the Nazis and to those among his colleagues who tried to curry favour with them. In my undergraduate years, I revered the man, perhaps excessively, but he has been largely forgotten, by most astronomers, since his death in 1964. I am glad to see a book that does something to restore him to his rightful place in the history of twentieth-century astronomy. This book is a translation (by Ann Hentschel) of a book that first appeared in German a few years ago. The translation reads smoothly, and one is rarely, if ever, aware of reading something that was not originally written in English.

Alan H Batten.

Astronomie der Goethezeit, Textsammlung aus Zeitschriften und Briefen, Franz Xaver von Zachs, Ausgewählt und kommentiert von Peter Brosche (Verlag Harri Deutsch, Thun and Frankfurt am Main, 1998), Ostwaids Klassiker der Exakten Wissenschaften , Band 280, 230 pp., ISBN 3-8171-3400-2, soft cover, 120 × 190 mm.

The Goethe era 1749-1832 is characterized by the French Revolution, the rise of Napoleon, and consequent unrest in Europe. Despite these marked, adverse external circumstances, as the author notes in his introduction, there commenced a silver period of German Astronomy. The Goethe era identifies specifically the achievements of this period, the district of Thüringen and particularly the town of Gotha and Franz Xaver von Zach.

Human curiosity towards the mysticism of natural events and the splendour of the night sky inspired man and woman towards recognition, collection, and interpretation of the obtained information of the external world. The gained experiences stimulated them to pursuit of activity and to succeed in acquiring broad knowledge about Earth and the celestial sphere.

Modern astronomy embraces all aspects of space, matter, and time. In Goethe's time, with no electric light, no motor engines, no railways and travel by horse and carriage, our constrained knowledge of the universe reflected only the basic, observed phenomenon. Nevertheless, at this time the observational study of the position and motion of the celestial bodies and the mathematical study of their orbital motions was

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prospering, in addition to the effort to obtain by geodetic survey the shape and size of the planet Earth.

Franz Xaver von Zach 13.6.1754 - 2.9.1832 as an Engineer with a study of mathematical sciences participated in the geodetic survey of Austria. He travelled extensively through Europe and England and became acquainted with many of the contemporary scientists and astronomers. He came to prominence with the establishment of the astronomical observatory of Seeberg, Gotha, and was its first Director. Zach's life ended in the Autumn of 1832 on the second of September at the age of 78 years and he was buried in the church courtyard at Père de la Chaise in Paris.

Except during his final illness, Zach was untiring in his efforts to promote astronomy by observations, calculations, and publications thereby providing a new impetus for the astronomy of Germany.

Zach secured financial and essential support from Duke Ernst II von Sachsen-Gotha, who from generosity towards advances of science and astronomical observation supported the foundation in Gotha of an observatory and its operation with his own financial means. During his Directorship, the observatory in Seeberg became, over a few years, a converging point of astronomical research and a meeting place for astronomers. He initiated the groundwork for conferences and congresses, publication of the first astronomical periodical and many reports. Devoted, he supported the promotion of a society for co-ordinated research and collaboration between the various disciplines in astronomy and geodesy. With his standing, Zach was able to provide patronage and promotion to talented scientists and astronomers.

Besides previous publications in BAJ *Astronomisches Jahrbuch Berlin*, the first periodical publication, *Allgemeine Geographische Ephemeriden,* containing astronomical and Geographic-Geodetic information, was published by the director of the Duke Observatory in Gotha, F. von Zach. These published transitory positions, calculated in advance, were relevant for observers to swiftly compare their observed results.

Zach did not hide his interest in all aspects of geodesy and is considered the founder of Gotha cartography, publishing numerous single maps of sea and land and, of course, star charts.

The first astronomical conference in Gotha was also the first international congress for the establishment of a metric measuring system, as proposed by France but which now failed due to strong opposition, particularly from Germany. Nevertheless Lalande's friendship with Zach was an important link between the French and German astronomers at that time.

Several significant conclusions were reached at this point in time:

◊ The periodic nature of comets was recognized.
◊ The number of known planets was increased by one to six following the discovery of Uranus by Herschel in 1781.
◊ The extraterrestrial nature of meteorites was commonly accepted.
◊ The discovery of the first asteroid, Ceres, by Piazzi in 1801 although not entirely unexpected as this closed the long known gap in the Titius-Bode-Law of a 'missing' planet between Mars and Jupiter. Soon a further three asteroids were detected, two by Olbers and one by Harding.
◊ Black Holes were proposed by Laplace as consequence of the deflection of light by gravity, despite the fact that Laplace was not the first to postulate this.
◊ The cosmological consideration by Anton Baron von Zach (brother of Franz Xaver von Zach) that Earth once had countless moons, the closest smaller and the remotest larger, which after collisions accreted to form an enlarged Earth - with the largest, our Moon, remaining.
◊ The development and application of the mathematical *Least Squares Solution* by Gauss.

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◊ The publication of the first astronomical periodical and, lastly, the foundation of the first Astronomical Society.

From his early years, Zach was concerned with land survey, contributing much towards the astronomical determination of geographical coordinates and azimuth, measurement of base lines, and triangulation. He was very excited when in 1803 the King of Prussia commissioned him to pursue such an endeavour. He set out the project needed to obtain maps of high precision, incorporating the curvature of Earth's ellipsoid to conform with its projection onto a plane. Due to the outbreak of war, only the outlines of this project were realised, and its completion had to await later activity by Captain Müffling of the Prussian Survey Corps.

Zach performed astronomical determinations of geographical position in the south of France by means of gunpowder flash signals reflected on the clouds. This innovation permits time transfer over long distances and the derivation of an accurate chronometer correction – thus improving the astronomically-obtained geographic positions used to confirm the accuracy of the triangulation network. Since in astronomy improvements were achieved in the determination of refraction, precession, parallax, declination of the Sun and stars, and aberration and nutation, Zach deemed it necessary to now repeat observations to improve their accuracy. With this enhancement, a comparison with the measured baselines and triangulation network positions (considered to be measured accurately and less influenced over time) yields a more satisfactorily correlation.

As indicated in the title, the author selects text from journals and letters from Baron Franz Xaver von Zach then annotates his own comments to contemporary scientific events and progress at this time in history. Peter Brosche also intends concurrently to promote the life and achievements of Baron Xaver von Zach, though not well known, was certainly a significant researcher, observer, communicator and organiser, who certainly deserves an ample and lasting recognition for his achievements.

The style of this early period in German literature, filled as it is with somewhat excessive courtesy, provides easy and stimulating reading and is recommended to everyone interested in the history of science, astronomy, and geodesy.

Ivan Nikoloff

The Eddington Enigma, by David S. Evans, (privately published 1998, copies available from: Xlibris Corporation, PO Box 2199, Princeton, NJ, 08543~2199, USA) 200 pp., ISBN 07388-0131-3, hardcover, US $25 + $4.95 shipping and handling, ISBN 0-73880132-1, softcover, US $15 + $4.95, 210 × 135 mm.

This is another book in which I must declare an interest; not only have I written on the subject of Eddington myself, but the author is a long-time friend. He had hoped to produce this book in time for the fiftieth anniversary of Eddington's death in 1994, but this did not prove to be possible. Evans is one of the declining band of those who actually knew Eddington, although, as he makes clear, his contacts with the great man were few.

The chief enigma about Eddington, of course, is why one who had contributed so much to astronomy in his earlier years should have devoted himself almost exclusively, in later years, to the pursuit of the theory that all the major laws and constants of nature could be derived by pure thought. Eddington never convinced more than a few of his contemporaries, and most people ignore his ideas now, although they are not so very different from the modern search for a 'theory of everything'. Evans argues that one cannot understand Eddington's position unless one first understands his religious faith as a Quaker, and the importance it had for him. I agree with this completely, and have, in fact argued the same myself.

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