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Historical Note

The Man who found a City in the Moon

by Richard Baum

Anyone interested in the development and progress of selenography will sooner or later come across the name of Franz von Paula Gruithuisen (1774–1852). Some amusement may be generated, along with a thought or two about human frailty, but the impact will be slight and both the man and his work will soon recede to be remembered only as an eccentric footnote to history.

Gruithuisen, the son of a falconer, was born at Haltenberg Castle, near Kaufering am Lech, in Bavaria, on March 19, 1774. His education, though rudimentary, apparently included training in surgery, for at 14, after a childhood in the picturesque setting of castle, forest and mountain, he was packed off to war to serve as a field surgeon in the conflict between Austria and Turkey. Later employment opened doors, and brought patronage, which enabled him to enter Landschut University where he studied philosophy and medicine. He graduated in 1808 as a 'Doctor of General Medicine', and took up a position as instructor in the Landarztlichen Schule in Munich, lecturing on physics and chemistry, zoology and anthropology, besides publishing several articles on medical subjects. There can be no doubt about Gruithuisen's industry. Houzeau and Lancaster in the second volume of their celebrated *Bibliographie générale de l'astronomie jusqu' en 1880* (1882), credit him with 177 papers, besides the editorship of three astronomy orientated journals, and rank him seventh in a league of the most prolific astronomers up to that time.

Exactly when Gruithuisen became interested in astronomy is not clear, but in his eighteenth year he had observed all the principal formations on the moon maps of Riccioli and Hevelius, having acquired his first telescope after his return from the Austro-Turkish war.

Some eight years earlier experiments by the Swiss artisan Pierre Louis Guinand resulted in improvements in the making of optical-glass. Achromatic refractors of 4 to 5 inches in diameter had always been difficult to make, simply because the flint blanks developed streaks and veins. Consequently most of the important telescopes had been reflectors, such as those used by William Herschel and J. H. Schröter. But all this was about to change. Pierre Guinand found that if flint glass was stirred as it cooled, the problem could be eradicated. By 1799 he was producing flawless flint discs as large as 6 inches in diameter. In 1805 Guinand moved to Munich. Eventually he joined forces with Joseph Fraunhofer, an association that upgraded the German optical glass industry, and gave us the modern achromatic refractor. For under Guinand's instruction Fraunhofer not only became extremely proficient in glass-making, but practically devised the science of correctly designing achromatic objectives. In 1812 he succeeded in producing a fine achromatic objective of 7.5 inches in diameter.

That same year Gruithuisen purchased two small refractors from him, one of 18 inches the other of 30 inches focal length. Later he added a 5-foot, of 4 inches aperture. Now at 38 his interest in astronomy fully aroused, he began a general, though rather aimless survey of the lunar surface. But advantaged by better instruments, and endowed with exceptionally keen eyesight, he was able to discover a wealth of fine detail that had escaped the attention of Schröter. Sadly his attachment to pluralism, coupled to an over active imagination induced expectations that affected his objectivity, a weakness that caused Carl Friedrich Gauss to complain of his 'mad chatter', and Wilhelm Olbers to call him 'peculiar'. J. H. Mädler was even more scathing. For with everything new, Gruithuisen in his ignorance genuinely believed he had detected traces of lunar inhabitation. Here the influence of Johann Hieronymous Schröter is very obvious, a fact reflected in the title and content of *Selenognostiche Fragmente*, a long paper published in serial form (1821 and 1823), in which Gruithuisen frequently refers to Schröter's *Selenotopographische Fragmente*, argues for lunar lakes and the existence of a thin atmosphere, approves Schröter's sightings of lunar industries and, in anticipation of Percival Lowell and the Martians, does his best to save the Selenites from extinction.

Yet stranger things were to come. At first light on 12 July 1822, with the Moon at last quarter and the terminator 'over the western rim of Clavius ... in the one direction and Newton in the other', Gruithuisen focused his small refractor on crater, alp and sea. The image quaked a little in the unsteady air, but the Bavar-

(continued on page 159)

A new lunar occultation package for microcomputers

Gordon E. Taylor

This report is a brief description of a suite of programs designed to enable occultation observers to predict all lunar occultations of SAO stars during one night. The computer time will normally be only a few minutes.

Report of the Computing Section *Director: Gordon E. Taylor*

Introduction

The vast increase in computing power over the last three decades has meant that it is now possible for the astronomical computer user to generate his own lunar occultation predictions of stars only a minute or so before going out to the telescope to observe such occultations.

History

The standard method of computing occultation predictions is for one centre (e.g. the International Lunar Occultation Centre) to use a main-frame computer to generate predictions for many stations throughout the world. The prediction process starts with an apparent geocentric ephemeris of the Moon and the positions (referred to a fixed equinox, e.g. 1950.0) of all stars which could possibly be occulted. At each conjunction of the Moon and star an apparent place of the star is calculated and a set of Besselian elements are produced. These elements describe the motion and direction of the Moon across the face of the Earth, as viewed from the star. Such elements can then be used, together with station coordinates, to provide predictions for each individual station. This is the most efficient method of calculating predictions for many stations, on a world-wide basis, for a year at a time.

Alternative method

For observers who possess a microcomputer as well as a telescope the Director has devised an alternative method of calculation that will generate only those predictions which are likely to be used. This enables an observer to decide at the very last moment whether or not he is going to attempt occultation observations that night. A few minutes later he can have a printout of predictions of every SAO star to be occulted as seen from his location, during that night. The fundamental basic data required are the same as for the standard method, namely an apparent geocentric ephemeris of the Moon (half-daily values of the RA, Dec., and distance) and a star catalogue. The star catalogue used is a subset of the SAO Catalog and contains the positions of 25138 stars, with their magnitudes and proper motions. This occupies 0.4 Mb on a hard disk but can be packed (using an archiving routine) to fit onto one 360k floppy disk. In fact the complete package could be modified to run from one floppy disk since only a small portion of the catalogue would be required for any one night's observing.

The method of prediction is not based on the view from the star but on a frame of reference centred on the observer.

The computer programs

A suite of four programs is run as a batch file. The programs are:-

INPUTOCC.PRG. This program allows the observer to set up the starting data required by the next three programs, such as the date-time, expected duration of observing, ΔT, and observer's position.

MOONINT.PRG. The program interpolates the geocentric lunar ephemeris to one-minute intervals, using sixth differences, during the period requested by the observer. The RA, Dec. and distance are stored.

GEOTOPO.PRG. This program generates a topocentric ephemeris of the Moon, storing RA, Dec. and semi-diameter, at one-minute intervals. It uses the output from MOONINT.PRG in conjunction with the observer's position.

STAROCC.PRG. This program starts by determining the approximate SAO star number of the first star that could possibly be occulted, based on the first RA of the Moon's topocentric ephemeris. For the first likely candidate star, its apparent position is calculated, using subroutines for precession, nutation, and aberration. This position is compared with the Moon's topocentric ephemeris and if the star is in the area of sky covered by the Moon's apparent diameter during the requested period of observation the times and position angles of the phases of the occultations, together with the altitude, are printed out. This procedure is repeated for successive stars until the end time is reached, whereupon the program is terminated.

This occultation package is being placed in the Program and Data Library of the Computing Section. It contains sufficient Moon data to predict occultations for the next 20 years. The intention is that this and other programs and data will be made available in machine-readable form, to other Sections and also to members, at a nominal cost. The Coordinator of the Library is Mr R. Harrold, 10A, Barker Avenue, Roseheyworth Estate, Abertillery, Gwent, NP3 1SE.

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The Man who found a City in the Moon – continued from page 159

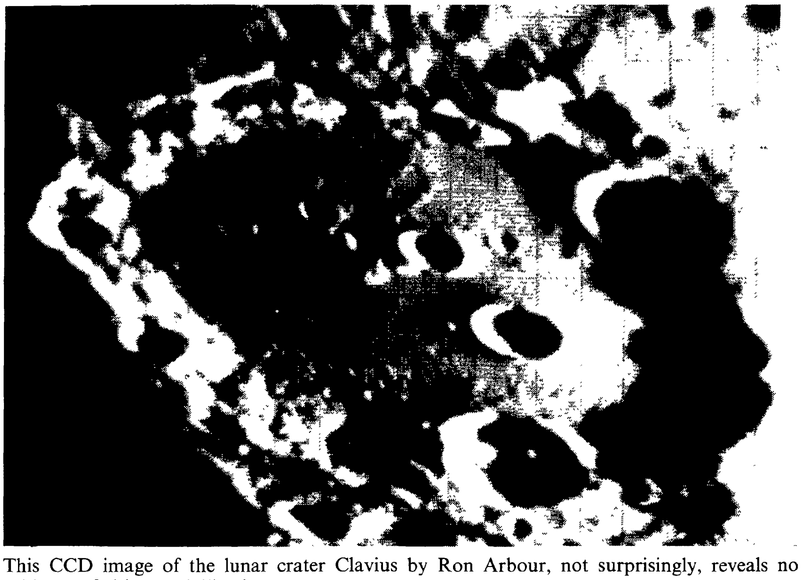
ian scarcely noticed, as he wandered over the glistening scenery. Suddenly, in the gloomy region north of the wrecked ringwall Schröter, he spotted a collection of massive ramparts of diverting and telling arrangement. Overcome with emotion he exclaimed: 'O Schröter, here is that for which you always searched in vain!' 'At first sight of this object,' he tells us, 'I fancied that I was looking down from the height of a steep mountain, through the seething ocean of air, and had the bird's-eye perspective of a city before me.' Gruithuisen was much too excited to make a drawing of the feature, nor did he resort to the five-foot achromatic for a more detailed look, although he does say the air was very unsteady. He did however sketch its appearance when he next saw it (October 1822), and again in 1824. Obviously there is no walled city, only a system of ridges that give an impression of artificiality if seen with a small telescope, in poor conditions under a raking light. Nevertheless the fiction lives on, as starkly etched in human memory as when Gruithuisen first saw it in the dying light of a lunar day.

Gruithuisen fully described the 'city' in *Entdeckung vieler deutlichen Spuren der Mondbewohner, besonders eines colossalen Kustgebäudes derselben* (The Discovery of many evidences of Lunar Inhabitants, in particular a colossal artificial structure built by the same), a lengthy three part paper issued in 1824, in which under three headings (i) Evidence of Vegetation on the surface of the Moon, (ii) Evidence of Animal Life on the Moon, and (iii) Artificial Works on the Surface of the Moon's Visible Hemisphere, he expounds his case for an inhabited Moon. During the 1830s he extended his advocacy to Mercury, Venus and the comets. His interpretation of the ashen light of Venus in particular, vivified the public imagination: 'I believe,' he conjectured in 1833, 'that the best explanation is that we are seeing a festival illumination put on by the inhabitants of Venus.' Ingenious, but extravagant, and in the end we must agree with Flammarion, '... that these ideas of Gruithuisen are most fantastic.' Inevitably they attracted a lot of attention, and in the case of the *Entdeckung* probably contributed to his career advancement. Two years after its publication he was appointed professor of astronomy at Munich University. Even so in the long term it was his undoing. There are no cities; no tree-lined avenues and temples; nothing but the desolate Moon of Beer and Mädler. Yet it must not be forgotten that early in the nineteenth century, the lunar surface was imperfectly known, and that announcements of change and variation were commonplace. Caught up in a web of preconception, imagination and inadequate resolution, Gruithuisen simply misinterpreted his observations in the context of current opinion.

In 1868, the Rev. T. W. Webb noted that Gruithuisen had, 'assuredly thought, and published, an uncommon amount of nonsense.' True, but that is too simplistic. It overlooks the fact that Gruithuisen was a man of great energy, and extensive learning, a keen-eyed observer who used small refractors to good effect; a man who discovered fine detail on the Moon and was the first to recognise the bright cusp caps of Venus, features that correspond to the bright polar cloud swirls imaged by Pioneer Venus; a man who foreshadowed aspects of Lowell's Martian hypothesis, and W. H. Pickering's 'new selenography'. In the 1830s, while recoiling from opposition to his fantasies, he turned to selenological speculation and from the accretion theories of the brothers Marshall von Bieberstein (1802) and Karl Ehrenbert von Moll (between 1810 and 1820), concluded an impact origin for the lunar craters.

Almost a century after the Rev. Webb gave his judgement, Ernst E. Both signalled a shift in attitude: 'Gruithuisen's position in the history of lunar studies has never been adequately appreciated, perhaps because of the rarity of his writings.' Hermann J. Klein and T. Gwyn Elger had earlier come to the same conclusion. History may judge Gruithuisen a man of little sense; the truth is otherwise.

Sources: 'Entdeckung vieler deutlichen Spuren der Mondbewohner, besonders eines colossalen Kunstgebaudes derselben', von Franz von Paula Gruithuisen, Archiv fur die gesammte Naturlehre, (Nurenberg, 1824). Selenognostische Fragmente, (Vienna 1821 and 1823). Gruithuisen's observing books were published by H. J. Klein (Wochenschrift fuer Astronomie, Vols. 22–24, 1879–1881). Ernst E. Both, 'A History of Lunar Studies' (New York, c. 1961). Camille Flammarion, 'Dreams of an Astronomer' (London, 1923). M. J. Crowe, 'The Extraterrestrial Life Debate 1750–1900: The Idea of a Plurality of Worlds from Kant to Lowell', (Cambridge, 1986). *The author is also deeply indebted to Dr William Sheehan for his masterly translations of part of the Gruithuisen corpus.*



This CCD image of the lunar crater Clavius by Ron Arbour, not surprisingly, reveals no evidence of cities or civilizations.