Journal for Occultation Astronomy

# 18th century occultation observation

## by J. H. Schroeter – early usage of astronomy's Swiss knife

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### Introduction

Occultation observations allow for the determination of many different parameters and complex information about the bodies involved. A few years ago, this instance led amateur astronomer Christian Leue to coining the term "astronomer's Swiss army knife". This article showcases early uses of said technique; and is based on a talk given at ESOP XXXII, Barcelona, 2013.

### J.H. Schroeter – an early amateur astronomer

Johann Hieronymus Schroeter (1745-1816) was a German astronomer and ran the observatory with the biggest telescope of the European continent at the time. Between 1761 and 1767, Schroeter studied law in Erfurt and began a career as public servant for the Kingdom of Hannover, now a part of Germany. During his studies, he came in contact with the systems of jurisprudence, but never got a methodical education in science. From 1782 on, he was district governor in Lilienthal, a small town near Bremen, Germany. He organised his job as district governor efficiently in order to be able to devote time and money to astronomy. In 1782, he founded a small observation station and subsequently shaped Lilienthal into a centre for European astronomy. The main instruments were bought or designed and produced in Lilienthal by himself. SCHROETER published articles in the Berliner Astronomisches Jahrbuch (editor in this period BODE) and a number of own books. During the active time of the Lilienthal observatory, it became a centre of astronomy in Europe. Schroeter created the name of the light emitting part of the sun, "photosphere"; organised the first German congress of astronomy and founded a network to find the hypothetical planet between Mars and Jupiter. He died 1816 in Lilienthal.

### The instruments

Typical for the 18th century, they are referred to by focal length in feet (dimensions given in mm):

- 50/ 915 mm Dollond achromatic lens telescope
- 165/2140 mm Herschel mirror à 7feet telecope HERSCHEL
- 165/2140 mm made in Lilienthal à 7feet SCHRADER
- 240/3960 mm made in Lilienthal à the 13feet
- 508/8230 mm made in Lilienthal à27feet „Riesenteleskop"

- 100/3048 mm lens telescope DOLLOND
- 305/5570 mm made in Lilienthal

All instruments were bought by the King of Great Britain and Ireland in 1799, but destroyed in the Napoleonic Wars in 1813. The 27 feet telescope (Riesenteleskop) was designed as alt-azimuthal telescope rotating around a central building (shown as model and in painting in pictures 1 and 2). Due to the activity of dedicated friends of astronomy a full scale re-construction is ready to use and visit in Lilienthal since 2015 on.

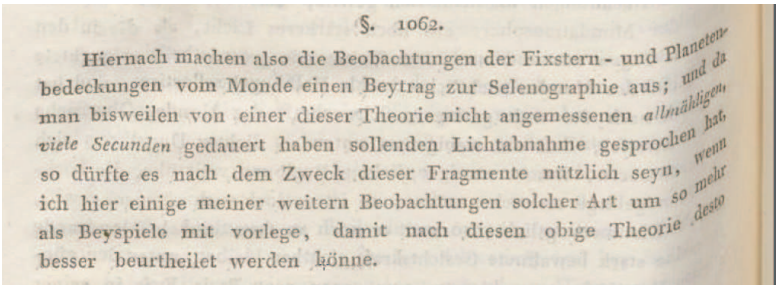
### The observational work and published results

At Lilienthal observatory, SCHROETER and his staff observed planets, comets and the moon. They tried to measure physical parameters in a period of astronomy where the main focus of observations were general positions and calculation of orbits.

An extensive part of observation of the moon and published work are the two issues of the „Selenotopografischen Fragmente" (1791 and 1802). The term used, *Fragmente* = fragments was aptly chosen: He published short-sentenced paragraphs based on observations and so it is mainly without conclusions or deductions an observational report.

In part one (1791), SCHROETER reports the first observation of moon's atmosphere*. SCHROETER "believed to see" the twilight on the moon and measured the depth of the atmosphere at 0.345 miles (Earth: 8 to 10 miles), the density was found to 1/28 of Earth's atmosphere's density. Also published in part 1 (1791), he planned to find a second proof for the atmosphere. He wrote: "Observation of occultation from stars and planets by the moon can give an input to the selenography. Based on published, non-sudden occultations, I plan to do observations from lunar occultations to prove the theory."

German original:



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Hiernach machen also die Beobachtungen der Fixstern- und Planetenbedeckungen vom Monde einen Beytrag zur Selenographie aus; und da man bisweilen von einer dieser Theorie nicht angemessenen *allmähligen, viele Secunden* gedauert haben sollenden Lichtabnahme gesprochen hat, so dürfte es nach dem Zweck dieser Fragmente nützlich seyn, wenn ich hier einige meiner weitern Beobachtungen solcher Art um so mehr als Beyspiele mit vorlege, damit nach diesen obige Theorie desto besser beurtheilet werden könne.

* In 17th and early 18th century, many astronomers assumed that the moon has an atmosphere. The man who ended the discussion by correctly interpreting the suddeness from a lunar occultation was BESSEL.

| Dd/mm/yyyy | Object/observation | Remark/result |
|---|---|---|
| 05/09/1793 | Annular eclipse | "light of twilight" |
| 25/02/1792 | Occ. small star** | Reduction of brightness and sudden disappearance |
| 28/03/1792 | Occ. Small star*** | Remarkable disappearance |
| 07/04/1792 | Occ Jupiter | No gradual reduction or growth of brightness |
| 11/11/1792 | Aldebaran = α Tau | Sudden disappearance |
| 13/04/1793 | γ Tau | No dimming, fast as a lightning |
| 05/01/1794 | Small star | No gradual reduction |
| 02/06/1794 | Bright star | No gradual reduction |
| 02/06/1794 | Small star | Also no gradual reduction |
| 08/11/1794 | Aldebaran = α Tau | Shimmer diverge for 3 sec**** |
| 08/11/1794 | Aldebaran = α Tau | Reappearance sudden |
| 23/09/1795 | Jupiter | Small gap of 2 arcsec to the bright limb |
| 14/03/1796 | Small star similar Dione***** | 2 to 5 sec reduction of brightness, disappear in 1/2 sec |
| 14/03/1796 | δ1 Tau | Without light reduction |
| 14/03/1796 | δ2 Tau | Instantaneous disappearance |
| 14/03/1796 | Small star****** | Became dark, came back for 1 to 1,5 sec and disappear fast than lightning |
| 14/03/1796 | 1Tau | Reappearance fast without growing |
| 20/08/1796 | 30Psc | Disappear on bright limb no reduction of light |
| 20/08/1796 | 33Psc | Quick reappearance |
| 21/08/1796 | Saturn | Contacts measured, no reduction of brightness |
| 21/08/1796 | Saturn | Reappearance, no reduction of brightness on limb |
| 26/09/1797 | Small star******* | Reduced brightness for 7 to 8 sec. |
| 31/07/1798 | Graze of Mars | No reduction of brightness |

Table 1

** identified as PPM 144653 = 96Psc, $6.5^m$
*** identified as PPM 120922, $5.0^m$
**** reported as observation through small clouds
***** identified as PPM 119831 $8.8^m$
******identified as PPM 119860 $9.5^m$
*******identified as PPM267044, height above horizon 7°

As one of the first astronomers, he planned to use occultation observations as proof for a scientific theory. Between 1793 and 1798, he observed occultations of stars, Mars, Jupiter and Saturn at the observatory Lilienthal (Germany). Additionally, he analysed eclipses and the view of the moon in the syzygy days.

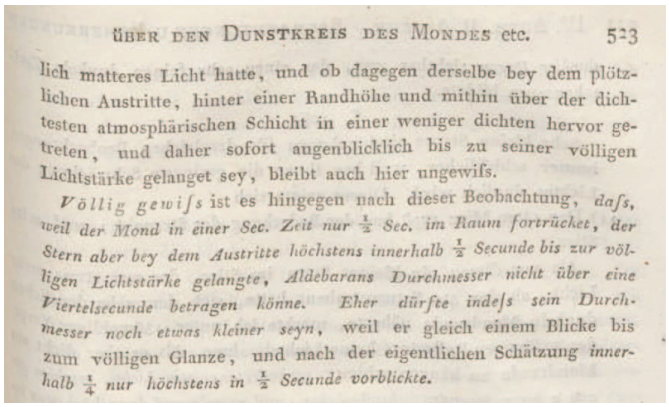
His observations, along with his own comments, were published in 1802 in the second part of the "Selenotopografischen Fragmente. In detail they are:

The occultation of Aldebaran was also used to calculate the diameter of the star:

Due to the fact that the reappearance took less than ½ sec, Aldebaran must have a diameter less than ¼ arcsec.

Thus, J.H. SCHROETER made 25 observations from 1793 till 1798 including a solar eclipse, occultations of Jupiter, Saturn and Mars (graze) also Aldebaran.

For 23 observations, the comments show no indication for an atmosphere.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lich matteres Licht hatte, und ob dagegen derselbe bey dem plötzlichen Austritte, hinter einer Randhöhe und mithin über der dichtesten atmosphärischen Schicht in einer weniger dichten hervor getreten, und daher sofort augenblicklich bis zu seiner völligen Lichtstärke gelanget sey, bleibt auch hier ungewiſs.

*Völlig gewiſs* ist es hingegen nach dieser Beobachtung, *daſs, weil der Mond in einer Sec. Zeit nur ½ Sec. im Raum fortrücket, der Stern aber bey dem Austritte höchstens innerhalb ½ Secunde bis zur völligen Lichtstärke gelangte, Aldebarans Durchmesser nicht über eine Viertelsecunde betragen könne. Eher dürfte indeſs sein Durchmesser noch etwas kleiner seyn*, weil er gleich einem Blicke bis zum völligen Glanze, und nach der eigentlichen Schätzung *innerhalb ¼ nur höchstens in ½ Secunde vorblickte.*

Only the eclipse „light of twilight" and the occultation of PPM 267044 is commented as proof for a lunar atmosphere. This strange relation of positive and negative observations was explained by SCHROETER in this way:

The lunar atmosphere exist only 0.36  above the moon's limb. Therefore, in valley areas only, the atmosphere can influence the light of a star. In mountain areas or for big objects like planets, no influence is visible. Small stars only are influenced.

To the author, this explanation seems to be inconsistent. Perhaps SCHROETER fell in his own trap:

He "discovered moon's atmosphere in part 1 of the "Selenotopografischen Fragmente" in 1791 and started a proof at the same time. So the result, presented in part 2 of the "Selenotopografischen Fragmente ", must be positive to have no contradictoriness in the total work.

The great tragedy of SCHROETERS scientific work is the fact that he began the proof after postulating the theory. He never had a scientific education which could have taught him to be doubtful and so he followed his own idea and looked for evidence supporting his theory. He saw what he wanted to see. Still, he remains the first astronomer who systematically used the "Swiss army knife" to collect observational data in order to support a theory.

SELENOTOPOGRAPHISCHE
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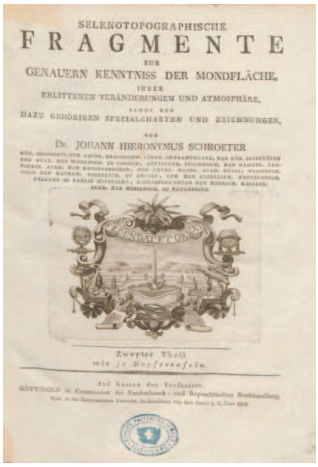
SELENOTOPOGRAPHISCHE
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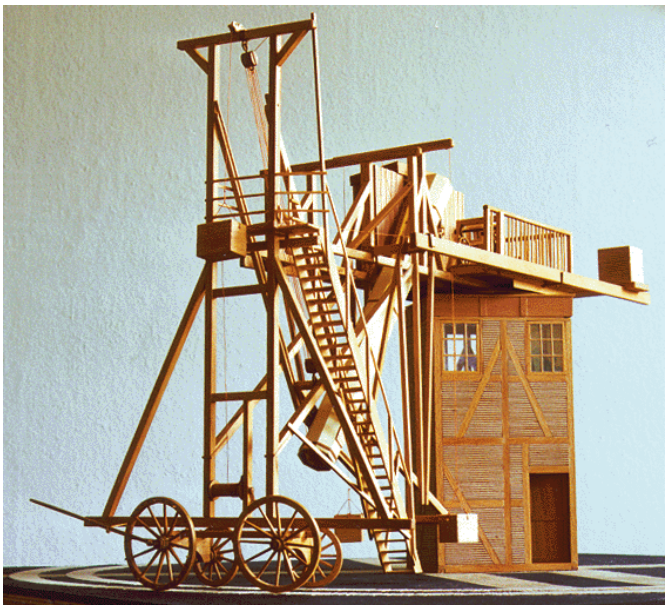
DAZU GEHÖRIGEN SPECIALCHARTEN UND ZEICHNUNGEN,
Dr. JOHANN HIERONYMUS SCHROETER
Zweyter Theil

## Pictures:



pic. 1 a model of the Riesenteleskop, Giant Telescope

pic 2 Duke of Cambridge visits Lilienthal in 1800

Left: Pic 3 front page of part one of the "Selenotopografischen Fragmente" 1791

Pic 4 front page of part two of the "Selenotopografischen Fragmente" 1802

## Sources:

/1/ J.H.Schroeter: Selenotopographische Fragmente I, Lilienthal 1791

/2/ J.H.Schroeter: Selenotopographische Fragmente II, Göttingen 1802

/3/ D. Gerdes: Die Lilenthaler Sternwarte 1781 bis 1818, Lilienthal 1981