Journal for
Occultation Astronomy

2016–03

Pluto's Sputnik Planum

Explanation: Is there an ocean below Sputnik Planum on Pluto? The unusually smooth 1000-km wide golden expanse, visible in the featured image from New Horizons, appears segmented into convection cells. But how was this region created? One hypothesis now holds the answer to be a great impact that stirred up an underground ocean of salt water roughly 100-kilometers thick. The featured image of Sputnik Planum, part of the larger heart-shaped Tombaugh Regio, was taken last July and shows true details in exaggerated colors. Although the robotic New Horizons spacecraft is off on a new adventure, continued computer-modeling of this surprising surface feature on Pluto is likely to lead to more refined speculations about what lies beneath.

Image Credit: NASA, Johns Hopkins U./APL, Southwest Research Inst.

APOD · 2016 November 22

In this issue:

Journal for Occultation Astronomy

Dear reader,

an e-mail I just received from Dave Herald was referencing an article "Measurement of the Earth's rotation: 720 BC to AD 2015" by British astronomers F. R. Stepenson, L.V. Morrison and C.Y. Hohenkerk.; Proc.R.Soc.A 472:20160404. They reported, that the length of the mean solar day is not increasing by 2.3 msec/century (the value used up to now based on tidal friction), but is increasing only with 1.8 msec/century. The precise timing of eclipse- and lunar occultations of stars are one possibility to derive variations of the earth's rotation over a long period of time. Before 1623 the authors used eclipse observations, thereafter they could rely on lunar occultations that were collected since then.

This article even found an impact in the main media in Germany, it was reported in the FAZ newspaper (Frankfurter Allgemeine Zeitung).

Roughly the past 20 years observers were thinking that there is no use to time occultations of stars by the moon – It's different now, a "new" point of view!

Observers should now use their Video/CCD- and GPS-equipment to record lunar occultation disappearances and in particular reappearances at the highest accuracy that is now pos-sible compared to the stopwatch-method of the sixties. Using the Kaguya-Data too, the reduction will lead to a maximum of quality and accuracy.

Just start again!

Klaus-J. Bode

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In this issue:

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The simplest way to write an article is just use Word as usual and after you have finished writing it, delete all your format-commands by selecting within the push-down-list "STYLE" (in general it's to the left of FONT & FONTSIZE) the command "CLEAR FORMATTING". After having done this you can insert your pictures/graphs or mark the positions of them (marked red: <figure_01>) within the text.

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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 Hanover, 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.

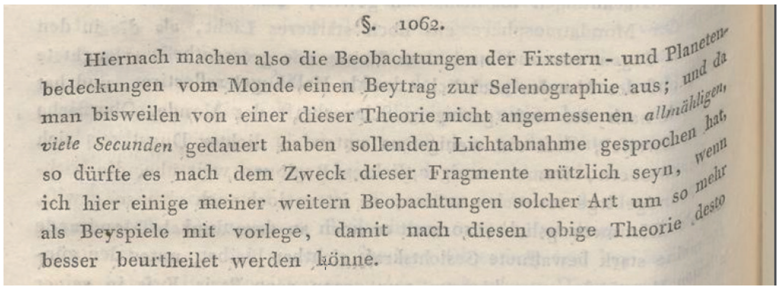
The observational work and published results

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:



§. 1062.

Hiernach machen also die Beobachtungen der Fixstern- und Planeten-bedeckungen 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	δ Tau	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.

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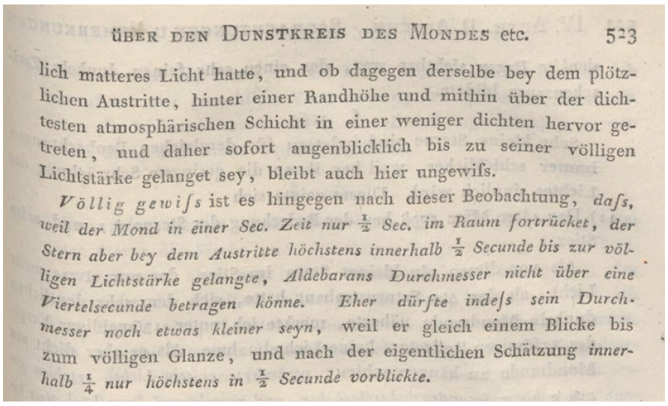
For 23 observations, the comments show no indication for an atmosphere.


über den Dunstkreis des Mondes etc. 523

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 $\frac{1}{2}$ Sec. im Raum fortrücket, der Stern aber bey dem Austritte höchstens innerhalb $\frac{1}{2}$ 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 $\frac{1}{4}$ nur höchstens in $\frac{1}{2}$ 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 0.36δabove 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.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DAZU GEHÖRIGEN SPECIALCHARTEN UND ZEICHNUNGEN,
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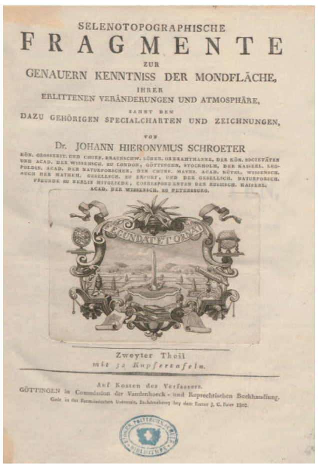
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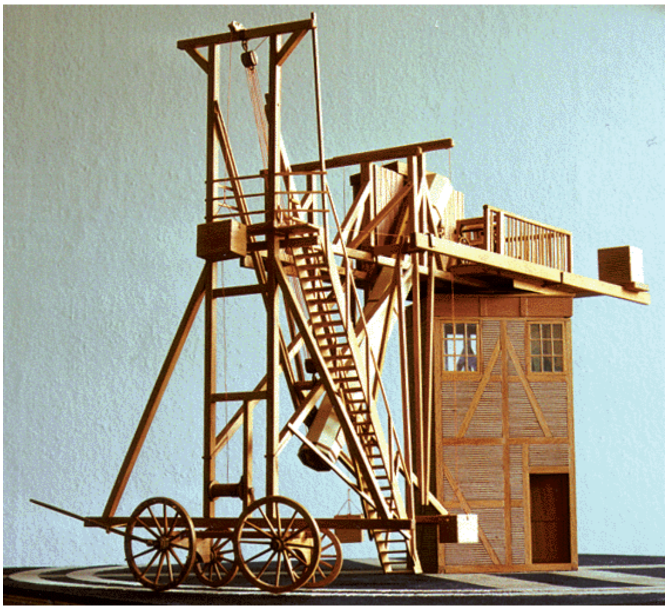
KÖN. GROSSBRIT. UND CHURF. BRAUNSCHW. LÜNEB. OBERAMTMANNE, DER KÖN. SOCIETÄTEN UND ACAD. DER WISSENSCH. ZU LONDON, GÖTTINGEN, STOCKHOLM, DER KAISERL. LEOPOLDIN. ACAD. DER NATURFORSCHER, DER CHURF. MAYNZ. ACAD. NÜTZL. WISSENSCH. AUCH DER MATHEM. GESELLSCH. ZU ERFURT, UND DER GESELLSCH. NATURFORSCH. FREUNDE ZU BERLIN MITGLIEDE, CORRESPONDENTEN DER RUSSISCH. KAISERL. ACAD. DER WISSENSCH. ZU PETERSBURG.
FECUNDAT ET ORNAT
Zweyter Theil
mit 32 Kupfertafeln.
Auf Kosten des Verfassers.
GÖTTINGEN in Commission der Vandenhoeck - und Ruprechtischen Buchhandlung.

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

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Combining Asteroid Lightcurve and Occultation Observations

Mike Kretlow, IOTA/ES, mike@kretlow.de

For many decades the main purpose of asteroidal occultation observations was to get an estimate of the (mean) size of the sky-plane projected shape of an asteroid (by fitting an ellipse to the measured chords, if enough of them were available). Other applications of asteroidal occultations were very limited in the past, probably because the average number of successful observations in total and per event was low compared to the last 10-15 years, where better predictions, planning and observing tools, (amateur) collaborations etc. increased the amount and quality of data significantly. Although even the possibility of satellites or a binary nature of an asteroid was sometimes suggested on base of occultation reports (unfortunately in most cases single reports), the vast majority of such discoveries were made by other techniques like imaging with adaptive optics, radar and lightcurve observations.

In the past years lightcurve observations were successfully combined with other data like occultation timings. This has added a new, important application to asteroidal occultation work.

Some statistics

Currently we know about 715 000 asteroids (numbered and unnumbered). For less than 1% we have a reliable estimate of the rotation period and just for around 900 asteroids we have a global shape model (from lightcurve inversion mainly). And finally just for some ten asteroids detailed informations coming from HST imaging, adaptive optics, radar, space probes etc. are provided. If we consider further physical parameters like asteroid masses (which would give us, together with sizes and shapes, bulk densities and porosities) we can summarize that we know physical parameters only for a tiny fraction of the whole given population of asteroids. Therefore, it is necessary and important to continue collecting data in all these (among others) fields of asteroid research, i.e. astrometry, photometry and occultations.

Historical outline

About 100 years after the discovery of the first asteroid Ceres in 1801, light variations due to the rotation of the body were detected for the first time on photographic plates (Eros and Iris). In 1906 Russel published a first paper on lightcurve analysis. He attempted to derive the albedo map from the lightcurves observed on the opposition and he found that it was impossible to distinguish between the surface curvature and the spot distribution for a spotted convex surface. This paper contained some important conclusions which were useful for later studies of lightcurves. In 1978 Surdej and Surdej simulated the lightcurves of asteroids assuming tri-axes ellipsoids. And with the definition of a scattering law by Lumme and Bowell in 1981, many analogous methods based on the ellipsoid shape were presented, such as the model introduced by Karttunen (1989) and Karttunen and Bowell (1989). In 1987 Lagerkvist et al. published a first version of the Asteroid Photometric Catalogue, containing more than 2200 lightcurves of 357 asteroids. In 1992 Kaasalainen et al. investigated the lightcurve inversion problem and about 10 years later the group published an optimized and proven inversion algorithm to derive rotation parameters and global (three-dimensional) shape models of asteroids. Based on this, Ďurech et al. (2010) published an online database (DAMIT) which today contains about 1600 shape and rotation models for about 900 asteroids (http://astro.troja.mff.cuni.cz/projects/damit). However, it should be emphasized that several other shape modeling techniques were developed as well (e.g. Bartczak et al., 2013; Lu and Ip, 2015).

While asteroid lightcurve observations were mainly provided by professional astronomers up to the 1980ies, it is meanwhile dominated by amateurs and pro-am collaborations, with the exception of special studies / targets which are outside any amateur instrumentation.

Lightcurves

After removing the distant dependent part of the apparent magnitude of an asteroid (i.e. reducing it to unity distance) the brightness is a function of the shape, the rotation state (spin axis orientation and rotation period) and the surface properties (light scattering behavior, geometric albedo and variations of the latter) of the object. In this consideration we do not take into account any additional variations due to mutual events of binary or multiple asteroid systems. The periodic change of the brightness due to the rotation of the asteroid results into a lightcurve. The rotation period is typically in the order of hours, but values from minutes up to three months are known.

Lightcurve Inversion

In 2001-2002 Kaasalainen et al. provided a robust lightcurve inversion method. From a set of lightcurves, observed over years under different observing aspects we can derive (beside the rotational period and the spin axis orientation) a convex shape model (3D model). Figure 1 shows some examples of shape models compared to images taken by spacecrafts.

Nevertheless the lightcurve inversion scheme has some constraints:

- It is assumed, that the light variation is caused by the shape. The rubble pile model of asteroids implies that in average the surface reflectivity (geometric albedo) is rather homogeneous, therefore it is reasonable to consider most asteroids as uniformly gray (at least in first order). Nevertheless we do know of albedo variations (e.g. the color and albedo heterogeneity of Vesta, but this is a differentiated asteroid).
- The limited observing geometry of an asteroid (orbiting close to the plane of ecliptic), introduces an ambiguity of approximately +/-180°

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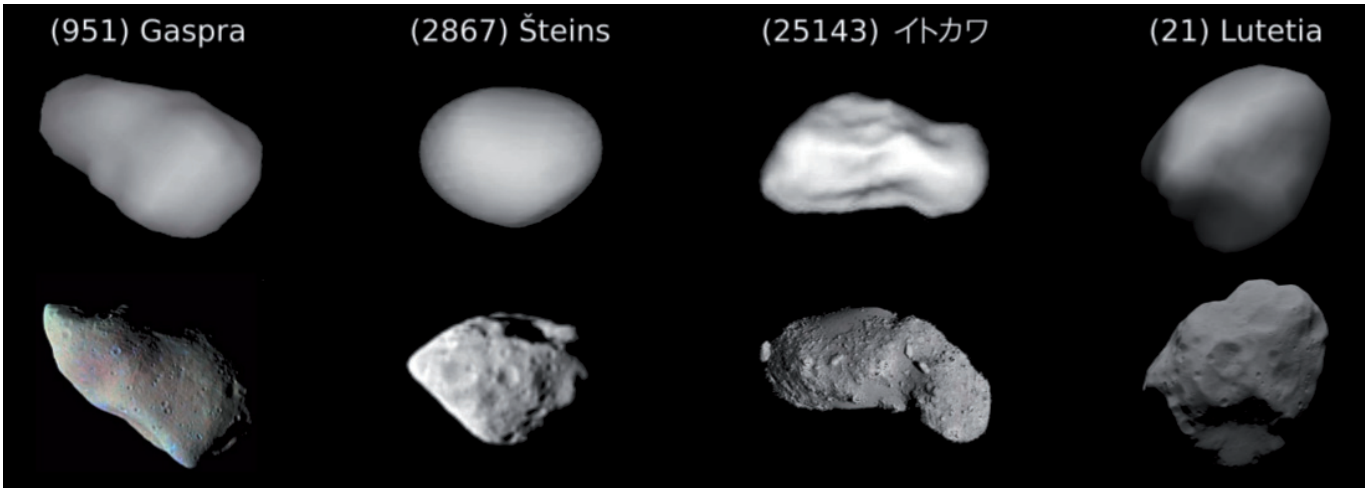

Figure 1: Comparison of four shape models with corresponding spacecraft images. After Carry et al. (2011).

in the ecliptic longitude (λ) of the pole. The corresponding shapes are mirror images of each other. In fact for about 90% of the asteroids with computed shape models / pole parameters we have more than one solution.

- If the real albedo of the asteroid is not known, the resulting shape model is not scaled to a physical size.

The lightcurve inversion allows to derive also non-convex shape models, but most of the shape models in the DAMIT database are convex, because disk-integrated lightcurves contain very little information about shape non-convexities. That means, that non-convex models based on lightcurves only are not stable and the realness of non-convex details can be questionable. By combining lightcurve inversion with other (high-resolution) data like radar, adaptive optics and occultation timings, we can get better and more trustworthy non-convex models. Despite a more realistic "picture" of the asteroid a non-convex model yields to a better volume estimate and thus we get better densities and porosities if the mass of the asteroid is known.

Occultation observations

As pointed out in the introduction, the scientific outcome of asteroidal occultation timings is often limited to fitting an ellipse (if more than one chord is given) to the sky-plane projection of the shape of the asteroid for the time of occultation. But if we use occultation observations as additional information to lightcurve inversions, these occultations can help to overcome some of the constraints mentioned before.

For convex models from lightcurve inversions we can

- scale the model (i.e. physical body size in kilometers) by fitting the chords (Fig. 2),
- solve the pole ambiguity (Fig. 2),
- predict the orientation of the body in space (as shape, pole and period are known) and therefore compute the sky-plane projection for an occultation (in the past or future). This helps to analyze occultation timings and / or to validate the model itself. It also helps to plan occultation observations as we know in advance the projection geometry and shadow shape.

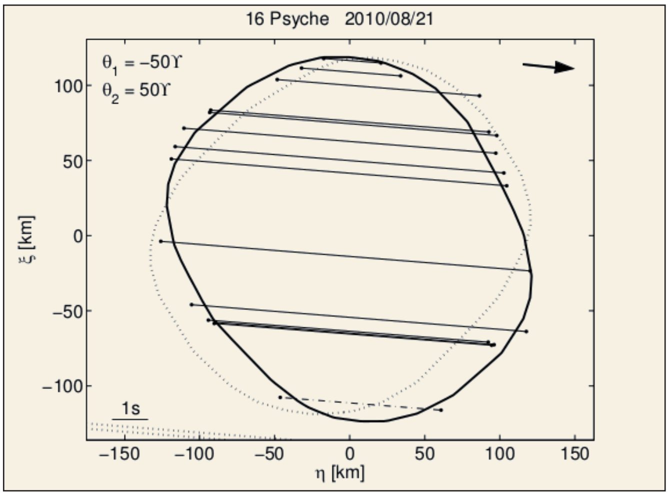

Figure 2: Scaling the model and resolving the pole ambiguity. The solid contour corresponds to the pole (λ,β) = (33°,-7°), the dotted one to (213°,+1°). After Ďurech et al. (2011).

Moreover we can use both occultation and lightcurve data simultaneously to derive a non-convex model (multi-data inversion). Especially non-convex details can be found and verified if enough occultation chords are available, which will in turn improve volume estimations (Figure 3).

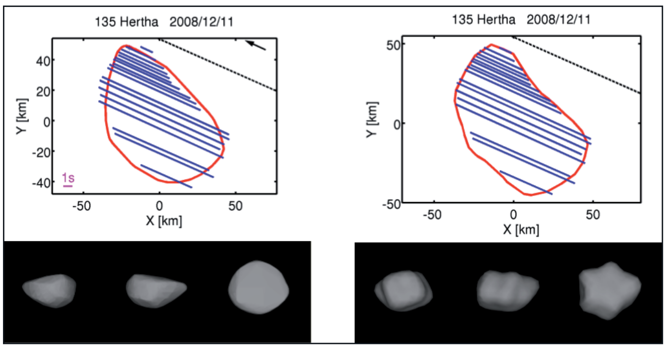

Figure 3: Left: Convex shape model, scaled to fit occultation chords.
Right: Non-convex model derived from simultaneous inversion of lightcurves and occultation timings. After Ďurech (2014).

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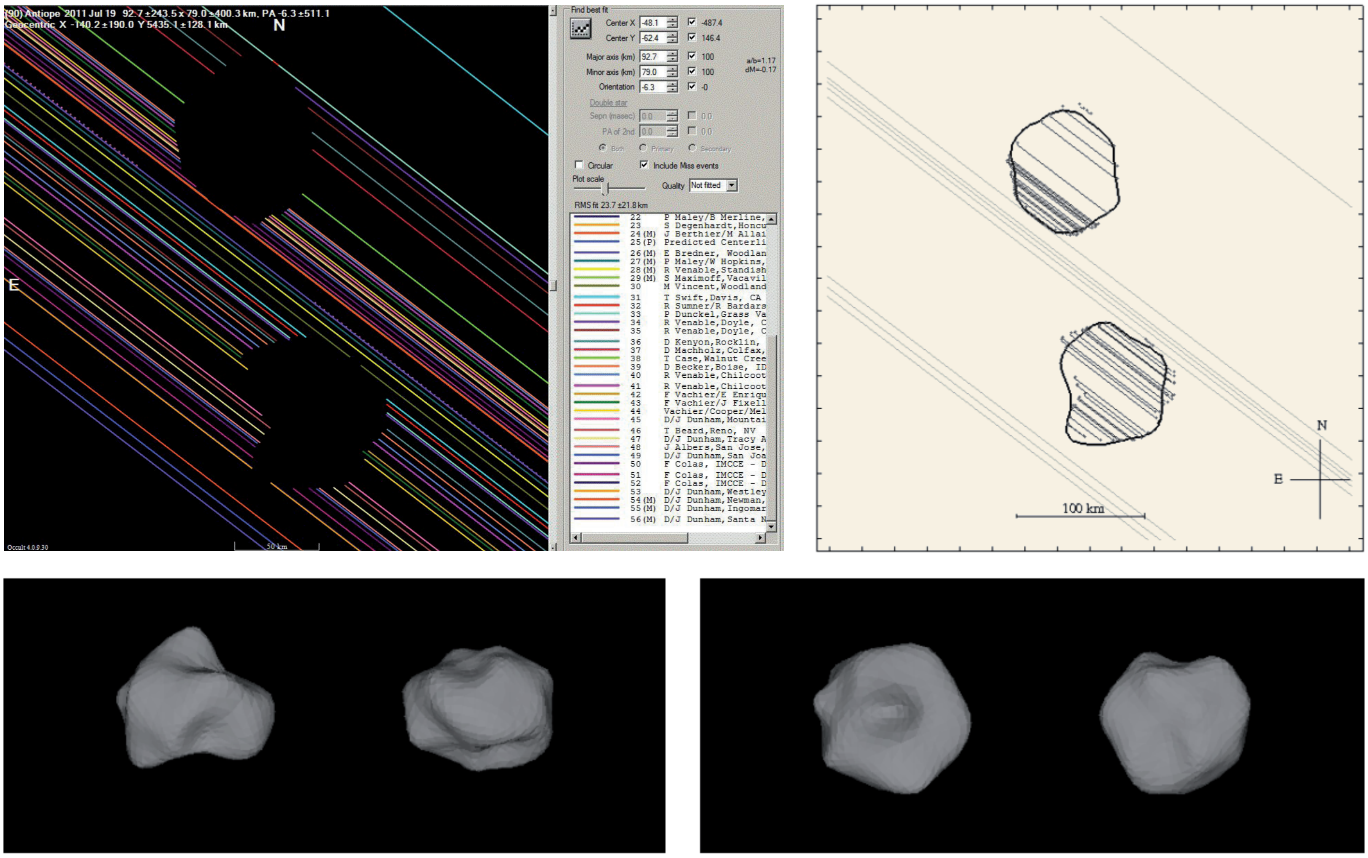

Figure 4: Occultation by 90 Antiope on 2011 July 19. Top left: Occultation chords plotted with Occult. Top right: Best fit of the stellar occultation chords obtained during the 2011 occultation to the solution found for the non-convex shape model of 90 Antiope (Bartczak et al., 2014). Bottom: Two different spatial views of the non-convex model for 90 Antiope shown at equatorial viewing on the left, and the pole-onview on the right.

In Figure 4 the occultation of LQ Aquarii by the double asteroid 90 Antiope in 2011 is shown. Bartczak et al. (2014) derived a non-convex shape model from disk-integrated photometry (using their so-called SAGE technique). The occultation observations were used to scale the shape model and some of the orbital parameters (distance between the two components). Ďurech presented a very similar solution (2014).

Conclusion

The lightcurve inversion method is a powerful tool to derive rotational parameters and global shape models of asteroids. Adding asteroidal occultations measurements helps to overcome some limitations of that method and to gain further scientific informations.

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15th to 19th September
2017

We are pleased to invite all interested parties to Freiberg, Germany for the 36th installment of the European Symposium on Occultation Projects. IOTA-ES's annual conference will, as always, include talks and lectures as well as interesting excursions. Hosting town this time is Freiberg (German for: free mountain), Germany's oldest mining town. Founded in the 12th century in order to exploit silver deposits, the town is closely associated with mining and minerals. Not only is the largest mineral collection on display at the castle in the heart of the historic old town, Freiberg is also home to the technical university Bergakademie, where two elements of the periodic table were discovered (indium and germanium). The Bergakademie is the oldest university of mining and metallurgy in the world, and educated polymaths such as M. Lomonossow and A. Humboldt. In keeping with ESOP tradition, post conference excursions will be offered.

Getting to Freiberg: The nearest airports are Prague (Czech Republic) and Dresden (Germany). The train from Berlin takes about 3 hrs; Freiberg is part of the local public transport system of Dresden (32 mins to main station). Autobahn junctions for Freiberg are Siebenlehn (A4) and Nossen-Ost (A14). Junction Dresden-Gorbitz (A17) for participants travelling from Prague is not advised, as roadworks will disrupt traffic here.

Please note: in the past, people have accidentally made their way to Freiberg am Neckar, a town founded in 1972 close to Stuttgart, southern Germany. Freiburg, also in southern Germany, is spelled differently, so are Freyburg (central Germany) and Freiburg (Switzerland). Freiberg, the first of several mountain towns, is located close to Dresden.

Beyond Jupiter

The world of distant minor planets

Since the degradation of Pluto in 2006 by the IAU, the planet Neptune marks the end of the zone of planets. Beyond Neptune, the world of icy large and small bodies, with and without an atmosphere (called Trans Neptunian Objects or TNOs) starts. This zone between Jupiter and Neptune is also host to mysterious objects, namely the Centaurs and the Neptune Trojans. All of these groups are summarized as "distant minor planets". Occultation observers investigate these members of our solar system, without ever using a spacecraft. The sheer number of these minor planets is huge. As of November 2016, the Minor Planet Center listed 689 Centaurs and 1788 TNOs.

In the coming years, JOA wants to portray a member of this world in every issue; needless to say not all of them will get an article here (KG).

In this issue:

(8405) Asbolus – A Two-Faced Centaur?

Oliver Klös (IOTA/ES):

Discovery:

One of the first discovered Centaurs got the designation 1995 GO. It was discovered by James Scotti and Robert Jedicke of "Spacewatch" at Kitt Peak Observatory in Arizona, U.S.A. on April 5th 1995. [1] Later the Centaur got his official name (8405) Asbolus. At Greek mythology the centaur Asbolus was capable to read forecasts in the flight formations of birds. He caused a battle between the Centaurs and Heracles and thus was indirectly responsible for the deaths of Pholus and Chiron. [2]

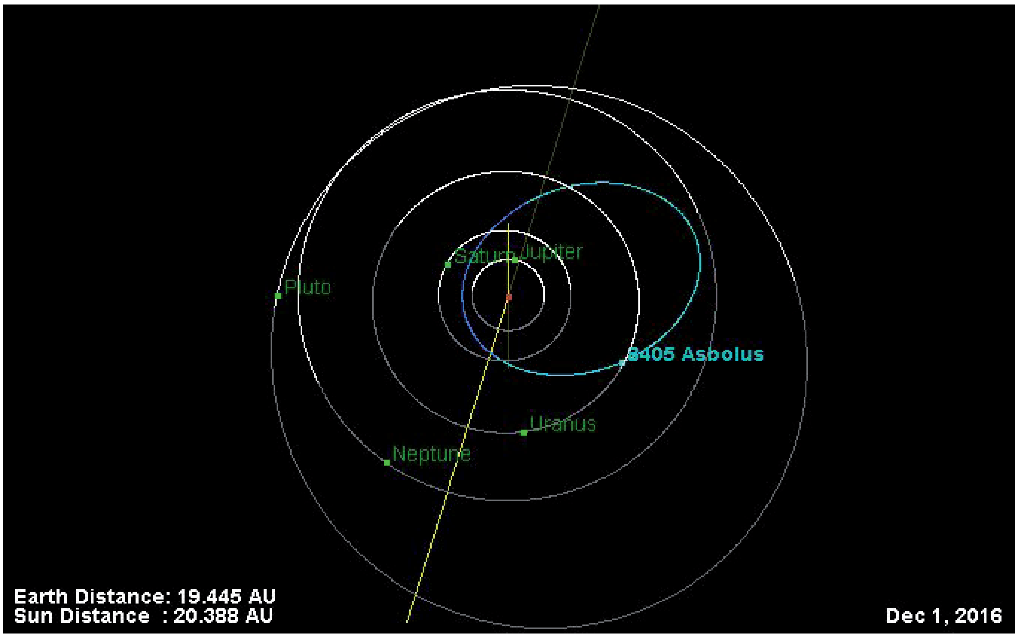

Fig. 1

The orbit of (8045) Asbolus at December 2016. The Centaur has passed the orbit of Uranus. Orbit diagram: JPL Small-Body Databse

The Class

A Centaur is a mixture of horse and human in the Greek mythology. The group of small bodies of the same name are orbiting the sun between Jupiter and Neptune. Some of them are classified as asteroids and as comets because they show both characteristics. Centaurs have very unstable orbits that crossed or will cross the orbit of one or more of the giant planets.

The Orbit

The orbital parameters of (8405) Asbolus are very interesting. At aphelion the centaur reaches out in the solar system as far as 29.12 AU, slightly inside Neptun's orbit. Moving inward the solar system it passes the orbit of Saturn to reach perihelion at 6.8 AU. [Fig. 1] Currently Asbolus is classified as a SN Centaur because Saturn controls the perihelion and Neptun the aphelion. The orbit has an eccentricity of 0.62, a semi-major axis of 17.97 AU and a period of 76.4 years. Predicting the orbit beyond a few thousand years is difficult. Perturbations of the giant planets are amplifying the errors of the known orbit. After an encounter with Jupiter in 2700 years the orbit becomes unpredictable. [Fig. 2]

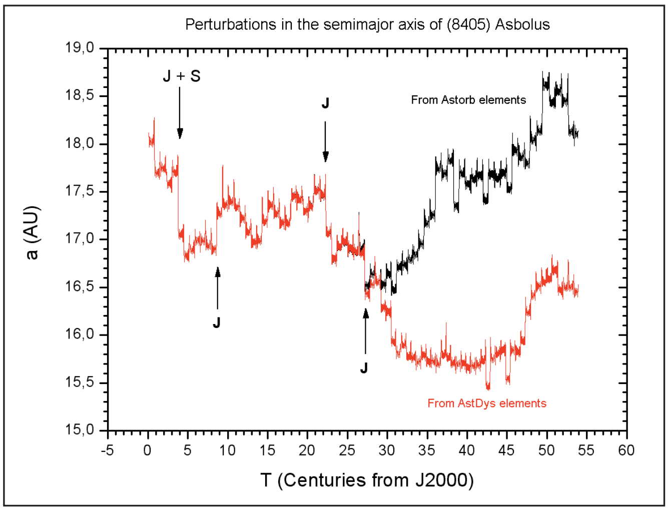

Fig. 2

Changes in Asbolus' semi-major axis by orbital perturbation during the next 5500 years. After the encounter with Jupiter in 2700 years, the orbit becomes unpredictable. (Aldo Vitagliano, SOLEX)

The Two Faces of Asbolus

A near-infrared spectral analysis with the Hubble Space Telescope was made in June 1998 as part of a survey of Centaurs. Generally Centaurs are dark in colour because the icy surfaces are getting darker and darker due to exposure by solar radiation, solar wind and cosmic rays. The infrared spectrum of Asbolus showed the featureless spectrum of a dark Centaur. But for a time span of more than 1.7 hours the more complex absorption spectrum of a fresh, reflective type of ice with other unidentified surface constituents faded in and out in the measurements.

The scientists stated at the Hubblesite News Release:

"The ice we detect does have some strong similarities to water ice, but in places it really doesn't match," adds lead investigator Susan D. Kern of UA. "This could be a new mixture of things we've seen before, but not in this combination." If this ice is new, McCarthy says, "one interpretation is you're suddenly looking at a different part of the early solar nebula" a big gas cloud that condensed into our solar system. [3]

This indicates an impact crater which revealed more ice from below of an inhomogeneous surface on one of the hemispheres. It is estimated that the crater is less than 10 million years old and it's even possible

Fig. 3

Artist's impression of (8405) Asbolus with its suspected impact crater. Illustration by Greg Bacon (STScI/AVL)

that this impact caused a "Knock-out" for Asbolus out of the Kuiper belt into its eccentric orbit. [Fig. 3]

This observation led to a new interpretation of the light curves of the Centaur. While the accepted rotation period 8.94 hr is based on a shape-dominated light curve, Kern et al. suggested a rotation period of 4.47 hr only dominated by the bright spot. [4]

A ground-based infrared spectroscopy in the J, H and K bands with ISAAC spectrometer at the ESO-Very Large Telescope in May 1999 presented no obvious features in the spectra which could be attributed to water ice. The measurements were compared with different models for the composition of the surface of the Centaur. One of the models showed that a few percent only of the surface may be covered by pure water ice. In this case the band at the K-level could be lost in the noise of the measurement. But it is possible that the spectra were recorded while the water ice was out of reach for the instruments due to the inhomogeneous surface of (8405) Asbolus. [5]

To measure the profile of Asbolus would be important for further interpretations of the spectra and the rotation period - and that's a job for occultation observers!

Observing Asbolus

Asbolus is dark and small and reached its last perihelion in July 2002. Since then the Centaur moves to the outer regions of our solar system again. It is now at a distance of 20.4 AU from the sun and has just passed the orbit of Uranus. Its current apparent magnitude is fainter than 22 mag. For the next years Asbolus will move through the constellations Auriga and Perseus. Fortunately these areas of sky cover the "star-rich" Milky Way.

Gerhard Dangl, Austria, observed an occultation by (8045) Asbolus of a 14.4 mag star on October 19th, 2007. His video observation was disturbed by moving clouds and was reported "negative". [6] Another negative observation of the same occultation was recorded by Malcolm Jennings, U.K. He reported: "Videorecording, no obvious occultation longer than 2-3 Seconds." [7] [8]

I made a run of predictions by OCCULT with Gaia14 catalogue, the UCAC4 and latest Astorb data for the upcoming five years. The mag limit of the target star was set to 15 mag.

Only occultations of faint stars (< 12 mag) were found with durations of ~2 sec up to ~9 sec. The predicted paths have very large uncertainties. So many observing stations are needed for a successful observation attempt. If we would be able to measure several chords of Asbolus it would be improving our knowledge of the diameter and the shape of this unusual body. A successful observation would be the first occultation by the interesting icy object recorded ever. Let's wait and hope for improved predictions available in the upcoming years.

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[3] Kern, Susan D. et al. Centaur's Bright Surface Spot Could be Crater of Fresh Ice, Hubbelsite.org, News Release Number STScI-2000-31

[4] Kern, Susan D. et al. Compositional Variation on the Surface of Centaur 8405 Asbolus, The Astrophysical Journal, 542:L155-L159, 2000 October 20

[5] Barucci,M.A. et al. Infrared spectroscopy of the Centaur 8405Asbolus: first observations at ESO-VLT, Astronomy and Astrophysics, v.357, p.L53-L56 (2000)

[6] Dangl, Gerhard, Observation Report of Occultation by (8045) Asbolus

[7] EAON-Info N° 59, 2007, October to December

[8] http://www.euraster.net/results/2007/index.html#1019-8405

Further reading:

Orbital elements at the JPL Small-Body Database

Johnston, W. R. TNO/Centaur diameters, albedos, and densities, Johnstonarchive.net

Duffard, R. et al. TNOs are Cool: A Survey of the Transneptunian Region XI: A Herschel-PACS view of 16 Centaurs, Icarus. 250: 482–491.

Our new flyer is now available in the download area of our website. In addition there is a printed version which we will send on request. The flyer also contains an Applicationform for membership.

Journal for Occultation Astronomy

IOTA's Mission

The International Occultation Timing Association, Inc. was established to encourage and facilitate the observation of occultations and eclipses. It provides predictions for grazing occultations of stars by the Moon and predictions for occultations of stars by asteroids and planets, information on observing equipment and techniques, and reports to the members of observations made.

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