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IN MEMORY OF EUGENE (JENŐ) VON GOTHARD: A PIONEERING NINETEENTH CENTURY HUNGARIAN ASTROPHYSICIST

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Abstract: Eugene von Gothard was a Hungarian engineer/scientist, instrument-maker and astrophysicist who founded the Herény Astrophysical Observatory in 1881 and carried out pioneering work in astronomical photography and spectroscopy. In this paper we provide biographical material about von Gothard and describe his observatory, before discussing his astronomical observations and the contribution that he made to the early development of astrophysics.

Keywords: Eugene von Gothard, Herény Astrophysical Observatory, astrophysics, astronomical photography, spectroscopy.

1 INTRODUCTION

Eugene von Gothard (Figures 1 and 2) was born on 31 May 1857 in Herény, Hungary, the eldest son of a land-owning family (Harkányi, 1910). He received a degree in mechanical engineering from the Technical University in Vienna in 1879, and just two years later—at the age of 24—founded the Herény Astrophysical Observatory (Figure 3), which was acknowledged in the international scientific literature by the end of the nineteenth century. Von Gothard studied astrophysics, the 'New Astronomy', and he designed and produced instruments that were indispensable for his work.

Von Gothard expressed his philosophy rather beautifully at a party hosted by the Hungarian Scientific Association in 1886:

> … how versatile and mysterious the challenges are, which are still unsolved and the solutions of which are within an inch! And so are the utensils with which the adherents of Urania, sparing no time, no expense, no pains, expecting no appreciation, looking for no sensation, slowly but surely delve deeper and deeper into the sanctuary of nature pursuing the highest goal: the search for the truth. (von Gothard, 1886a: 23; our translation).

Between 1881 and 1895 he made important contributions to astronomical spectroscopy and astronomical photography before being appointed technical manager of the Vas Comitat Electric Works Inc., which was being built on the River Rába, and abandoning his astrophysical studies. In 1899 the first signs of serious heart disease were diagnosed, and von Gothard was forced to retire, but this did allow him to return briefly to his astrophysical studies in 1901. Eugene von Gothard died unexpectedly on 29 May 1909, just two days shy of his 52nd birthday. He was described by Harkányi (1910: 7) as

> … a very kind, reserved man, with great energy, and helpful to everybody who asked aid or advice. He was the recipient of many honors: in 1886 the Voigtländer silver medal from the Vienna photographic society; in 1887 the gold medal of the Vienna photographic exhibition; the highest distinctions of the photographic exhibition of 1889 in Berlin and of 1889 in Moscow. In 1890 he was elected corresponding member of the Hungarian Academy of Sciences in Budapest. He was also a member of the Royal Astronomical Society, of the Astronomische Gesellschaft, and of several other learned societies.

Apart from his valuable contribution to astronomy, Eugene von Gothard also conducting pioneering X-ray experiments (see Vincze and Jankovics, 2010).

Figure 1: Eugene von Gothard, 1857–1909 (courtesy: Gothard Astrophysical Observatory Archives).

Figure 2: The medal struck in 2009 to commemorate von Gothard's contribution to Hungarian astronomy.

2 EDUCATION AND THE FOUNDATION OF VON GOTHARD'S SCIENTIFIC WORK

Eugene von Gothard attended the Premonstratensian Secondary Grammar-School, and the love of nature that he brought from home achieved perfection under the influence of Adolf Kunc, who was his teacher.

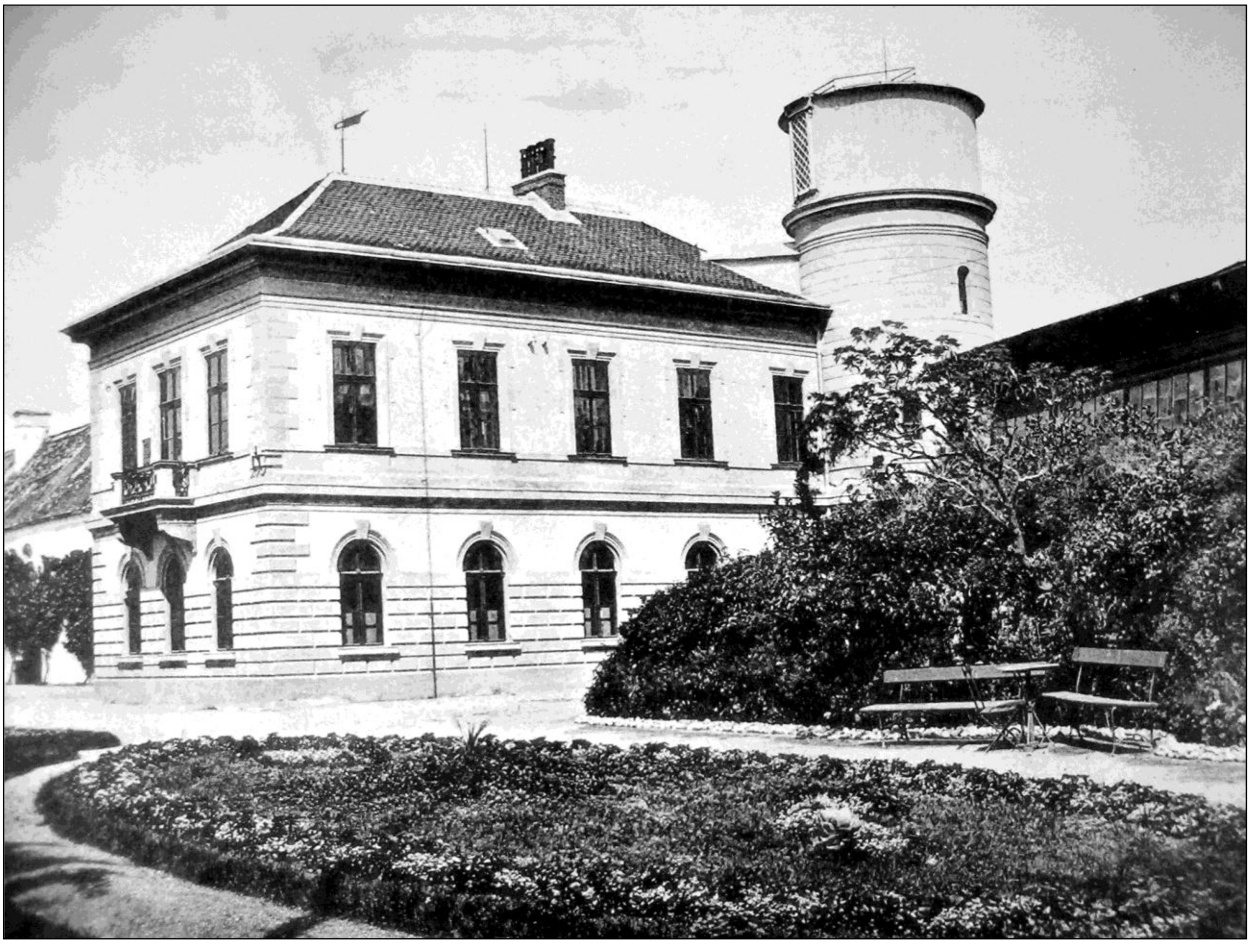


Figure 3: The von Gothard mansion and the Henéry Astrophysical Observatory (courtesy: Gothard Astrophysical Observatory Archives).

When he was still at secondary school von Gothard established physics and chemistry laboratories plus a workshop in a wing of the von Gothard mansion, where he carried out experiments and constructed scientific instruments.

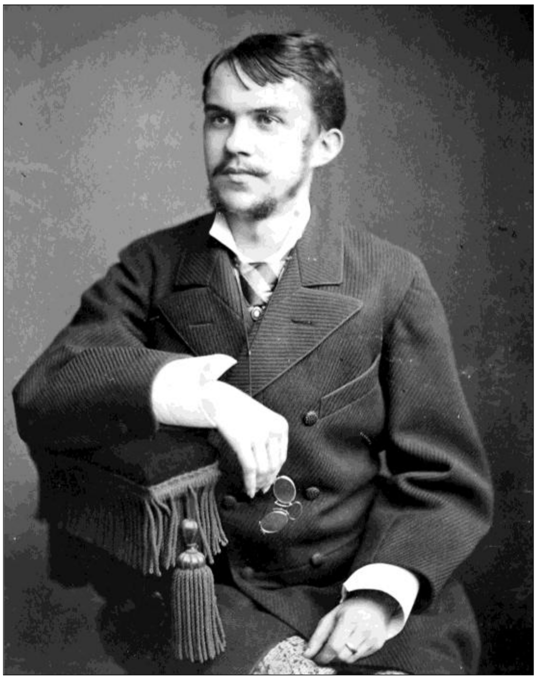


Figure 4: Alexander von Gothard (courtesy: Gothard Astrophysical Observatory Archives).

Von Gothard then carried on with his studies in Vienna at the Technical University (Polytechnische Hochschule), and after completing them he returned home and ran a farm in Herény with his brother, Alexander. This, of course, did not mean that he neglected his laboratory, for he spent his spare time experimenting and studying.

In 1880 von Gothard accepted an invitation from Nicolaus von Konkoly Thege (1842–1916) and visited the Konkoly Observatory at Ógyalla,[1] where his insatiable desire for science flared during his observations of the night sky and long conversations with Konkoly. This visit to Ógyalla not only gave von Gothard direction but it also led to a long and deep friendship.

3 THE FOUNDING OF THE HERÉNY OBSERVATORY

Inspired by Konkoly Thege, Eugene von Gothard and his brother Alexander (1859–1939; see Figure 4) founded the Herény Astrophysical Observatory in 1881 by reconstructing the eastern part of the mansion and at the same time extending the physics laboratory (Figure 5). The 11.22-m high observatory was designed by Professor Alajos Hauszmann from the Technical Universiy in Budapest. It was circular in cross-section, and 4.42 metres in diameter, and was made of stone. However, Eugene von Gothard designed the drum-shaped dome himself (Vincze and Jankovics, 2010), which featured twin shutters. These were each 1 metre wide, and could be moved to the side to ex-

Figure 5: Two views of the refurbished physics laboratory in 1882 (courtesy: Gothard Astrophysical Observatory Archives).

pose a strip of sky. The dome was mounted on wheels and was rotated manually (von Gothard, 1882). Figure 3 shows the von Gothard mansion, and the Observatory after it was completed.

The main instrument in the observatory was an f/7 10.25-in (26-cm) silver-on-glass Newtonian reflector which was made by the British telescope-makers Browning-With[2] in 1874. This was on a solid equatorial mounting with a mechanical drive. There was a 2.25-in Steinheil guide scope and a 2-in Browning finder. Nine eyepieces (see Figure 6) came with the telescope (three Kelners giving 77×, 80× and 140×; three Huygenses giving 240×, 436×, 580×; and three Ramsdens giving 208×, 590×, 840×), along with various filters. When he purchased the telescope from his friend Konkoly Thege in 1881 there was also a Herschel wedge for solar observing, a calcite prism ocular spectroscope and square bar and ring micrometers (von Gothard, 1882). Figure 7 shows the telescope some time after von Gothard acquired it. With the passage of time, von Gothard manufactured various new instruments (e.g. spectroscopes, spectrographs, a spectrocolorimeter, a photometer and astrocameras) which he used with the telescope, and these are discussed below in Section 4.

In order to maintain a local time service the Herény Astrophysical Observatory included a transit annex, which housed a 27-mm Fraunhofer transit telescope that was made in 1879 (Figure 8), and two identical astronomical clocks (see Figure 9) that von Gothard made in 1881.

The Observatory was completed in October 1881, and the first observations, colloquially known as 'first light', were made on the 20th of that month (Vincze, et al., 2003).

3.1 Infrastructure at the Observatory

From the start, Eugene von Gothard set up a modern infrastructure at the Observatory so that whatever was necessary for his work could be found in every room there: gas, water, a telephone and electric power. Even before the Observatory was finished the mansion had lighting with the help of a Siemens dynamo (von Gothard, 1885a). The telephone and Morse code station were connected to the physics laboratory at the Premonstratensian grammar-school and to Adolf Kunc's private flat by permission of the State Telegraph Office Minister, so that the telephone and the telegraph could be used for scientific and experiment-

Figure 6: Some of the eyepieces that came with the telescope (courtesy: Gothard Astrophysical Observatory Archives).

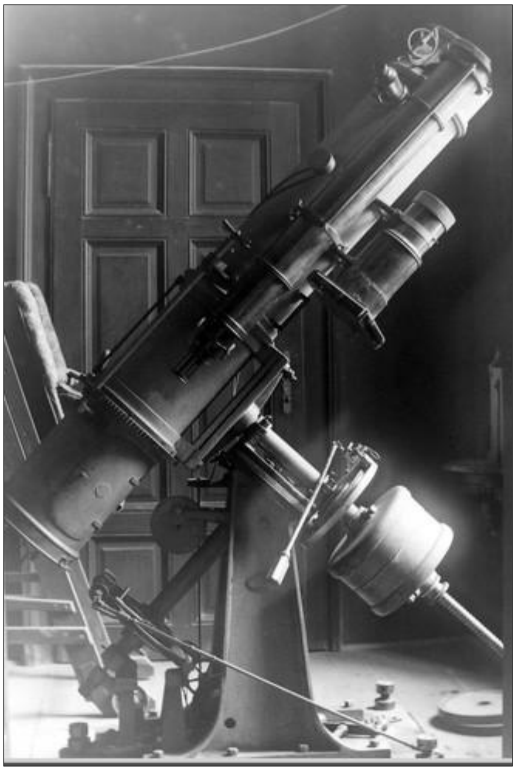


Figure 7: The 10.25-in Browning-With reflecting telescope at the Henéry Observatory (courtesy: Gothard Astrophysical Observatory Archives).

Figure 8: The 27-mm Fraunhofer transit telescope (courtesy: Gothard Astrophysical Observatory Archives).

al purposes (von Gothard, 1882). Meanwhile, von Gothard's well-equipped physics and chemistry laboratories and workshop housed all the latest equipment required for an observatory that was about to embark on a journey of discovery in astrophysics.

At the time he founded the Observatory von Gothard admitted that his library was quite small, but after 1884 he put considerable effort into extending the collection. In order to fill some of the gaps he established close relations with several foreign booksellers. His bills for books and journals reveal a broad-minded European scientist who added contemporary technical literature necessary for his research.

Figure 9: One of the 1881 astronomical clocks (courtesy: Gothard Astrophysical Observatory Archives).

He also acquired several second-hand rarities, including Kepler's *De Stella Nova in Pede Serpentarii* (1606), Scheiner's *Rosa Ursina, sive Sol* (1630), Bayer's *Uranometria* (1661), Ricciolo's *Almagestum Novum* (1651) and his *Astronomia Reformata* (1665), Hevelius' *Selenographia* (1647) and his *Machinae Coelestis* (1673), Brahe's *Historia Coelestis* (1666), and Marinonio's *De Astronomica Specula Domestica* (1745). Most of these can still be found in the von Gothard Collection (see Jankovics, at al., 1995).

4 CONSTRUCTION OF ASTRONOMICAL INSTRUMENTS AT HERÉNY

4.1 Introduction

Initially von Gothard used devices that he obtained, borrowed, exchanged, or purchased from Konkoly Thege, and adapted them for his astronomical observations. Soon, however, he decided to

> ... manufacture his own astrocameras and spectroscopic measuring instruments. He also reconstructed other types of instruments and developed them according to his own research objectives, in the process making them more convenient, more modern and more accurate. In these endeavours von Gothard was assisted by Jozsef Molnar, a technician who worked in the Observatory's workshop. (Vincze and Jankovics, 2010).

In the Herény workshop, von Gothard generally made two or three copies of each new instrument. He retained one copy for his own observatory, generally sent a second copy to Konkoly at Ógyalla, and sometimes supplied yet a third copy to any other observatory that had previously placed an order (Vincze, et al., 2003). In this way, he succeeded in strengthening the specialist astronomical instrumentation at not only his own observatory but at other European observatories and furthering the cause of international astrophysics.

During the manufacturing process, von Gothhard made all of the precision mechanical parts, mounting bases and supporting elements himself, whereas the specialized elements such as the optics were bought from the most famous producers in Europe. It is obvious from von Gothard's publications, and proved by the business letters and bills stored in the archives of the Gothard Astrophysical Observatory, that among the suppliers of the Herény Astrophysical Observatory were companies like Voigtländer & Sohn (Braunschweig), C.A. Steinheil & Söhne (München) and J.H. Dallmeyer (London). It is also notable that from 1881 all of the instruments produced in the Herény workshop were modified by von Gothard on the basis of experience he had gained during earlier observing programs. In this way he was able to improve their accuracy and/or their use.

4.2 Instruments for Spectroscopy

To increase dispersion and to observe the spectra of dimmer objects, von Gothard constructed a spectroscope of his own design, drawing on the advantages and disadvantages of spectroscopes that he had used previously. The Great Comet of September 1882 proved to be the primary incentive for completing this new spectroscope as von Gothard (1883b) wanted to observe its weaker spectral lines. The next astronomer to use the new spectroscope was C.N. Adalbert Krüger (1832–1896), the Director of the Kiel Observatory, who published favourable comments about it (see Krüger, 1884).

Von Gothard's quest for technical perfection is obvious from the fact that while using his new spectroscope he was already busy designing an improved version. For example, lighting of the 1884 'clarinet spectroscope' was solved not by using an oil lamp but instead a small Edison 4V filament lamp. Von Gothard used his own ideas to design and produce the new instrument, and as an expert in precision mechanics he built the optical parts with practical casings. He also redesigned the electrical components. When observations were to be carried out, the instrument could be inserted in place of the eyepiece of the telescope, whereas in the laboratory it was placed on a laboratory stand. This new spectroscope was made up of five rows of prisms in order to ensure high dispersion, and there was an adjustable reading-telescope at the end, the movement of which could be measured with an extra-fine measuring screw in order to accurately determine the positions of the spectral lines. The lighting of this scale was extremely convenient, lasting only during setting up and when readings were being taken, otherwise the observations were carried out in complete darkness. For comparison spectra, von Gothard transferred light from the Geissler tubes to the slit of the spectroscope, or when comets were observed a gaslight was used to identify the hydro-carbon lines (see von Gothard, 1884b).

In 1882 von Gothard made three identical spectrocolorimeters in the Herény workshop, for Jean-Charles Houzeau (1820–1888) in Brussels, for Konkoly in Ógyalla and for his own observatory The spectrocolorimeter was attached with a bolted joint to the Browning telescope, in place of the eyepiece. Using this innovative instrument the colours of stars could be observed visually using the colorimeter, or the spectral lines could be measured with the spectroscope. Having simultaneous access to these two different functions resulted in a more detailed classification of stars (see Konkoly, 1882).

In order to refine his measurements of stellar spectra von Gothard then began constructing spectrographs, and these supplemented the spectroscopes that he had previously used for visual observations. The challenge was to develop new refracting media, to refine the spectral characteristics of light-resolving devices, to get to know the resolving conditions and to achieve the precision mechanical development necessary for the solution of astrophysical tasks. In the development of von Gothard's spectrographs we can follow the early improvements in astrospectroscopy, from the direct low-resolution prism solutions applied in ocular spectroscopes, through prisms imaging larger ranges of the spectrum. These were developed intensively from the mid-1880s, and used new optical glass or modern gratings. The most important parameters of these devices were: dispersion, spectral purity, resolving power, free spectral range and light intensity. In von Gothard's instruments, these parameters were developing gradually.

In 1886, von Gothard published the technical description of the calcite prism spectrograph that he built which is shown in Figure 10.

Later in 1886 he constructed a Wernicke-prism spectrograph, which was born out of the need to achieve greater dispersion and to extend the ultraviolet range of the spectrum (see Konkoly, 1887).

Figure 10: The calcite prism spectrograph (Gothard No 9) made in 1886 (after von Gothard, 1886b).

Von Gothard also produced two spectrographs equipped with Rowland gratings, one for Josef Maria von Eder (1855–1944), who was a Professor at the Technische Hochschule in Vienna and Director of K.K. Lehr- und Versuchtanstalt für Photographie und Reproductionsverfahren, and another for his own observatory (Eder, 1896).

4.2 An Instrument for Visual Photometry

Besides investigating the spectra of stars von Gothard also was interested in measuring temporal changes in their brightness, and another innovative instrument he developed in the Herény workshop in order to achieve this was a wedge-photometer. This was constructed in 1885 (see Figure 11), and its main part was the gray wedge that could be placed in front of the eye or the eyepiece. It was very important that no extraneous light was cast on it between the two necessary adjustments, so it was not practical to read off the scale using a lamp. Instead, a self-recording machine was

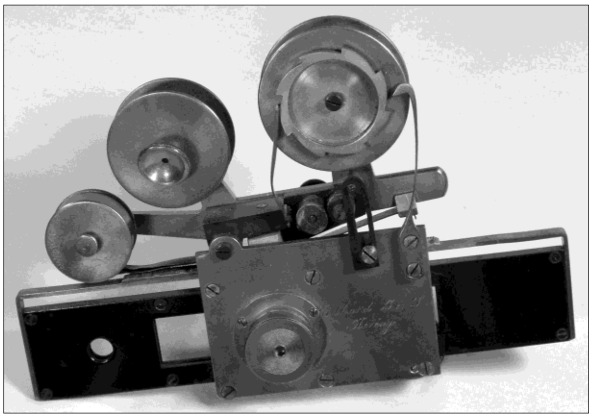
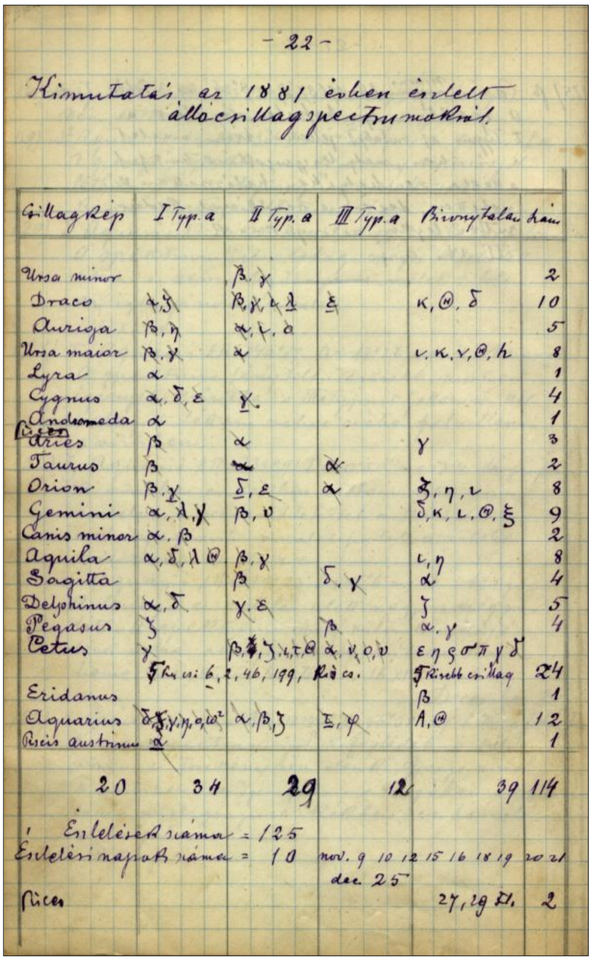


Figure 11: The wedge-photometer constructed at Herény in 1885 (courtesy: Gothard Astrophysical Observatory Archives).

Figure 12: The 10-cm aperture astrograph constructed by von Gothard in 1893 (courtesy: Gothard Astrophysical Observatory Archives).



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Kimutatás az 1881 évben észlelt állócsillagspectrumokról.

Csillagkép	I Typ. a	II Typ. a	III Typ. a	Bizonytalan	hány
Ursa minor		β, γ			2
Draco	α, ζ	β, γ, ι, λ	ξ	κ, θ, δ	10
Auriga	β, η	α, ι, δ			5
Ursa maior	β, γ	α		υ, κ, ν, θ, h	8
Lyra	α				1
Cygnus	α, δ, ε	γ.			4
Andromeda	α				1
Aries	β	α		γ	3
Taurus	β	[illegible]	α		2
Orion	β, γ	δ, ε	α	ζ, η, ι	8
Gemini	α, λ, γ	β, υ		δ, κ, ι, θ, ξ	9
Canis minor	α, β				2
Aquila	α, δ, λ, θ	β, γ		ι, η	8
Sagitta		β	δ, γ	α	4
Delphinus	α, δ	γ, ε		ζ	5
Pegasus	ζ		β	α, γ	4
Cetus	γ	β, ζ, ζ, ι, τ, θ	α, ν, ο, υ	ε η ς σ π γ δ	
	5 kis csill. 6, 2, 46, 199, [illegible]			5 kisebb csillag	24
Eridanus				β	1
Aquarius	δ, ξ, γ, η, ο, ω²	α, β, ζ	ξ, φ	A, θ	12
Piscis austrinus	α				1
	20	34	29	12	39 114

Észlelések száma = 125

Észlelési napok száma = 10 nov. 9 10 12 15 16 18 19 20 21 dec. 25

Pisces 27, 29 [illegible] 2

Figure 13: An example of a page from von Gothard's observing notebook (courtesy: Gothard Astrophysical Observatory Archives).

applied. Also, the eye had to adapt to complete darkness at the beginning of the observations, and after half an hour of observing the astronomers had to change over due to the tiredness of their eyes. However, after long practice, measurements using this visual technique become more and more accurate. Choosing the appropriate natural wedge was very important so that the absorption of the wedge did not depend on wavelength. Knowing all this, von Gothard (1887b) created a perfect instrument for his time.

4.3 Instruments for Astronomical Photography

In order to photograph comets, diffuse nebulae and other objects Eugene von Gothard constructed a wide-angle astrograph which he mounted parallel to the optical axis of his Browning telescope at the Herény Astrophysical Observatory.

In handbooks that he published in 1887 and 1890 Nicolaus von Konkoly Thege described this astrograph and other photographic equipment designed, constructed or modified by von Gothard, and he included more than two dozen relevant figures. He emphasized the applicability, practicality, convenience and accuracy of von Gothard's instruments, and noted that:

> ... [he] is not only an extremely proficient and tireless photographer of the sky, but also a true artist in precision mechanics. (Konkoly, 1890: 163; our English translation).

A 10-cm aperture astrograph manufacted by von Gothard in 1893 is shown in Figure 12.

Eugene von Gothard's activity in developing technical instruments for his astrophyical research is extremely well documented in monographs and papers that he published (e.g. see von Gothard, 1883b; 1886b; 1887b).

5 VON GOTHARD'S ASTROPHYSICAL RESEARCH

5.1 The Early Visual Spectroscopic Observations

When the Herény Astrophysical Observatory was founded, Eugene von Gothard's aim was to carry out spectroscopic observations of stars and comets while his brother, Alexander, focussed on Mars, Jupiter and the Sun (Vincze, et al., 2003). From the beginning they kept a record of the observed phenomena, describing and drawing what they saw (e.g., see Figure 13).

In September 1882, von Gothard observed the spectrum of the Great Comet of 1882 (C/1882R1) and published this observations in the *Astronomische Nachrichten* (von Gothard, 1883a) where he called attention to the strong hydrocarbon lines in the spectra of comets. Later, during its perihelion passage, the nucleus of this comet split into eight discrete fragments (see Sekanina, 1997), but all of von Gothard's observations preceded this spectacular event.

Von Gothard then began observing stars, but only those whose spectra were especially interesting and possibly variable. By 1883 he had observed the spectra of 86 stars, and his examination of the hydrogen emission lines of the variable stars β Lyrae and γ Cassiopeiae was especially revealing:

> It is extremely important to study the spectra of these two stars thoroughly. This is because it points to the significance and precision of spectral analysis, which

> will enable us to examine intensively stars that are billions and billions of miles away. We can not only see their chemical characteristics, but we can also follow their physical changes and their movements. First of all, this reveals the greatness of the human mind in its complexity, for which there is no distance, or magnitude it cannot comprehend and examine ... and secondly, it convinces us that even in the farthest depths of the Universe there is life, movement, change, development and decline, and it gives us a key to the mysteries of variable stars, although it does not reveal all of the answers. (von Gothard, 1884a: 2; our translation).

Then in 1885 he reported on the periodic appearance and disappearance of the hydrogen and helium lines in the spectrum of β Lyrae (von Gothard, 1885a). However, Vincze et al. (2003: 396-397) point out that this discovery "... did not get any attention, as there was insufficient astrophysical background [at that time] for the interpretation of the phenomenon."

In a publication titled *Publikationen des Astropysikalischen Observatoriums zu Herény Eugene von Gothard*, Eugene von Gothard (1885b) summarised the activities of the new Herény Observatory in 1884, and he sent copies to the most renowned astronomical institutes in the world and began to exchange publications with many of them. This scheme brought his work to the attention of the international astronomical community. Meanwhile, in 1881 and 1883 he joined the Astronomische Gesellschaft and the Royal Astronomical Society, respectively, but it was only in 1890 that he was elected a Corresponding Member of the Hungarian Academy of Sciences (Vincze and Jankovics, 2010).

5.2 Pioneering Astronomical Photography and Spectral Photometry

On 16 May 1882 Eugene and Alexander von Gothard launched their 'careers' as pioneering Hungarian astrophotographers by taking a series of photographs of a partial solar eclipse (see Figure 14), and by 1885—after carefully experimentation—they had almost completely abandoned visual observations. They then directed the focus of the Herény Observatory towards the new technologies of spectrography and astrophotography. In that year they photographed a supernova in the Andromeda Galaxy and carried out spectroscopic observations (von Gothard et al., 1885), and on 20 April 1885 Eugene submitted a work titled "Studies in photographing celestial bodies" (our English translation) to the Hungarian Academy of Sciences (von Gothard, 1885c). Then from 1886 Eugene von Gothard was completely engaged in the spectral examination of clusters, comets (e.g. see Figure 15) and gaseous nebulae. He was also the first to record an image of a faint previously undetected comet on photographic emulsion (von Gothard, 1887a), and in 1886 he was the first to photograph the central star of the Ring Nebula in Lyra (M57):

> In the autumn of 1886 I photographed the Ring Nebula in Lyra. In the middle of this ring there is an extremely sharp, intensive star on the picture; after repeating the exposure with the same result, I asked some observatories with large instruments to observe this interesting star. The star could not be seen, so my credibility was already at risk when at last, a year later, with the huge, 27 inch refractor at the Vienna Observatory the small star was sighted, which, with my small 10-inch reflector

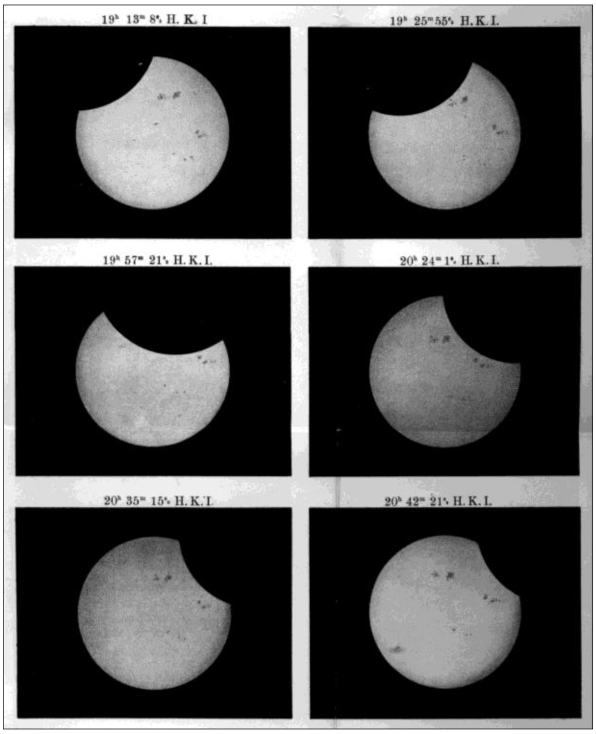

Figure 14: Von Gothard's photographs of the 16 May 1882 partial solar eclipse (after von Gothard, 1890).

> I can photograph easily any time ... [This] example palpably proves the practicability of photography. (von Gothard, 1890: 19; our English translation).

Hermann Carl Vogel (1841–1907), Director of the Potsdam Astrophysical Observatory, wrote about photographs of gaseous nebulae taken with the instruments at Herény:

> Von Gothard's photographs prove that even with a modest instrument photography enables us to achieve scientific results that exceed by far what was attainable using visual observations and the largest instruments. (Vogel, 1888: 338; our English translation).

In 1890, as an experienced researcher in the field of astrophotography, Eugene von Gothard wrote a book on the applications of photography for scientific purposes. Its title, translated into English, was: *Photography. Practice and Applications for Scientific Purposes.*

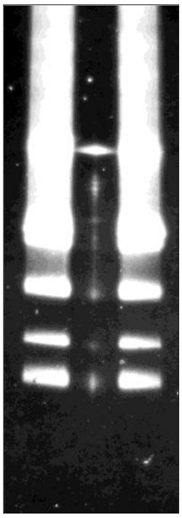

Figure 15 (right): Spectrogram of Comet C/1892 E1 Swift (after von Gothard, 1892c).

In the ten years following the foundation of his Observatory, von Gothard had worked with energy and success in the fields of spectroscopy and astrophotography, and as an acknowledgement of his theoretical, practical and instrumental work he was accepted as a Corresponding Member of the Hungarian Academy of Sciences in 1890. On 20 April 1891 he presented his inaugural address titled "Studies in spectral photography" in which he summarised the results of his activities over the past six

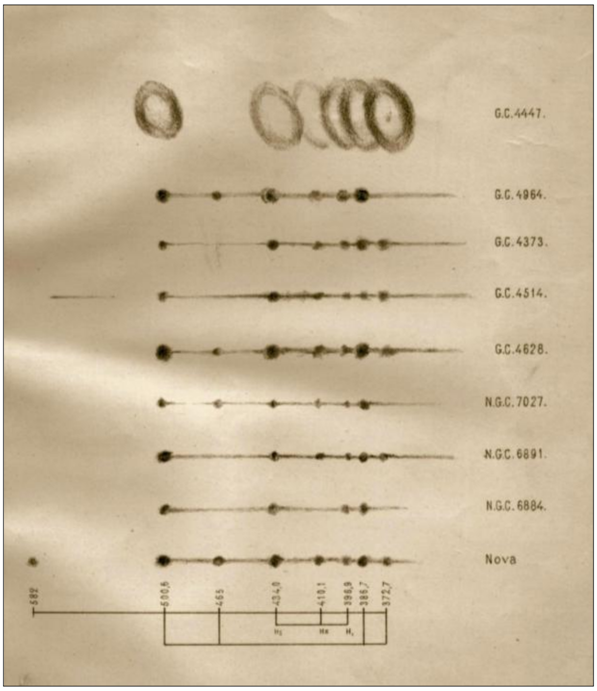

Figure 16: The spectra of Nova Aurigae and a few planetary nebulae (after von Gothard, 1892a).

years (see von Gothard, 1891). This study focussed on the identification of spectrum lines and the accurate determination of their wavelengths.

In 1892 von Gothard carried out a photographic examination of the spectra of planetary nebulae using a 250-mm objective-prism with the Browning-With reflector (von Gothard, 1892a). Then, while studying the spectrum of Nova Aurigae, he proposed a connection between novae and planetary nebulae:

> … the spectrum of the nova is identical to the spectrum of planetary nebulae [see Figure 16]. By working hard with photographic plates I succeeded in determining the wavelengths of the lines we had detected. I managed to identify several of them with terrestrial materials, and in this way extend our knowledge about these extremely dim celestial bodies, which has been fairly inaccurate thus far. I regard it as very important that I was able to find a closer relationship between nebulae, the new star and some other interesting stars and though I find it too early to draw conclusions, I can point to the direction which may lead to understanding the nature of nebulae and new stars. (von Gothard, 1892b; our English translation).

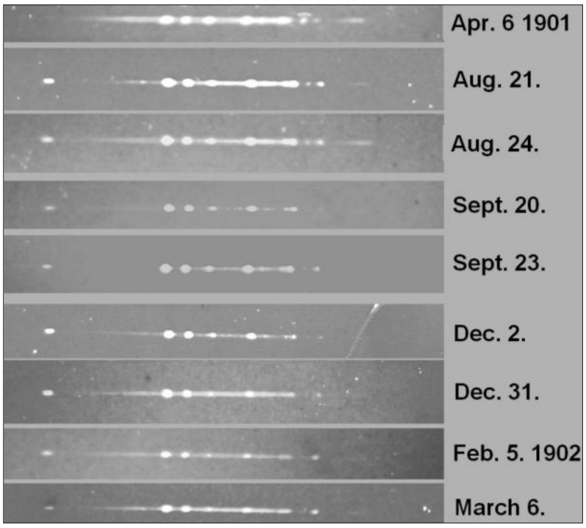

Figure 17: Spectroscopic observations of Nova Persei made in 1901 and 1902 (courtesy: Gothard Astrophysical Observatory Archives).

In our opinion, this discovery was the most outstanding achievement of von Gothard's work. His result is regarded by experts worldwide as one of the predecessors of theories of the later stages of stellar evolution (e.g. see Hearnshaw, 1986).

On 9 April 1892, von Gothard took a four-hour exposure photograph of the spectrum of Comet Swift in the spectral range between 3873 and 5673 Å (see Figure 15), and identified a number of hydrocarbon bands (von Gothard, 1892c).

Eugene von Gothard's astronomical activities were aborted in 1895 when he took on responsibilities at the Vas Comitat Electric Works Inc. which was being built on the River Rába, and it was only many years later, in 1901, that he was able to return briefly to astronomy. In this year he took a high quality and high resolution spectrogram of Nova Persei (von Gothard, 1901), and he then followed up by analysing the changes in the spectrum of this nova as it dimmed over the course of the following year (see Figure 17).

7 CONCLUDING REMARKS

Eugene von Gothard was a pioneering nineteenth century Hungarian astrophysicist who over a fifteen-year period built his own instruments and conducted astronomical research with them. He published his results in *Astronomische Nachrichten* and *Zeitschrift für Instrumentenkunde*, which brought him to the attention of the international professional astronomical community. Some of his papers on the spectra of comets, planetary nebulae and novae made useful contributions to astrophysics, and his successful application of photography and spectroscopy to astronomy brought him renown throughout Hungary.

Many of the scientific instruments constructed and used by von Gothard and astronomical records that he kept have been preserved by the Gothard Astrophysical Observatory at the Loránd Eötvös University in Hungary, and

> … a valuable part of this material is the astronomical plate collection of 455 pieces taken between 1882 and 1900, containing unique images of comets, star clusters, nebulae, galaxies and stellar spectra … (Vincze, et al., 2003: 394).

These same authors (2003: 397-398) stress that it is

> ... very important to preserve and to publish this unique and early collection in digital format and, in so doing, turn the attention of the astronomical community once again toward the scientific achievements of Gothard. Gothard Observatory.

Some of von Gothard's astronomical instruments mentioned in this paper are currrently on display at the Gothard Astrophysical Observatory of Eötvös University in Herény, Hungary (see Figure 18).

8 NOTES

1. At the time Konkoly was Hungary's foremost astronomer (see Sterken and Hearnshaw, 2001).
2. During the second half of the nineteenth century George With (1827–1904) of Hereford (England)

Figure 18: Von Gothard instruments and records on display at the Gothard Astrophysical Observatory.

and John Browning (1835–1925) of London combined their respective talents to make reflecting telescopes that were popular with amateur astronomers and professional observatories. With produced the optics, with primary mirrors up to 18 inches (45.7-cm) in aperture (King, 1979), while Browning manufactured the telescopes and mountings that accommodated these optics (ibid.).

3. In the literature, Eugene von Gothard's published papers written in German are listed under 'E. Von Gothard', while in the case of those written in Hungarian his name is given as 'J. Von Gothard' (with the J standing for Jenő).

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10 REFERENCES[3]

Eder, J.M., 1896. Spectrumphotographie. *Jahrbuch für Photographie und Reproductionstechnik*, 10, 453-455 (in German).

Harkányi, B., 1910. Eugene v. Gothard. *The Astrophysical Journal*, 31, 1-7.

Hearnshaw, J., 1986. *The Analysis of Starlight. One Hundred and Fifty Years of Astronomical Spectroscopy*. Cambridge, Cambridge University Press.

Jankovics, I., Horváth, J., Vincze, I.J., 1995. Astronomical databases in the XVII-XVIII centuries: old astronomical books in the Library of Gothard Observatory. *Vistas in Astronomy*, 39, 270.

King, H.C., 1979. *The History of the Telescope*. New York, Dover.

Konkoly, N., 1882. Sternspektralapparat in Verbindung mit einem Kolorimeter. *Central-Zeitung für Optik und Mechanik*, 3(1), 1-2 (in German).

Konkoly, N., 1887. *Praktische Anleitung zur Himmelsphotographie nebst einer kurzgefassten Anleitung zur modernen photographischen Operationen und der Spectralphotographie im Cabinet*. Halle (in German).

Konkoly, N., 1890. *Handbuch für Spectroskopiker im Cabinet und am Fernrohr*. Halle (in German).

Krüger, A., 1884. Kiel. *Vierteljahrschrift der Astronomischen Gesellschaft*, 19, 109-110 (in German).

Sekanina, Z., 1997. The problem of split comets revisited. *Astronomy and Astrophysics*, 318, L5-L8.

Sterken, C., and Hearnshaw, J. (eds.). 2001. *One Hundred Years of Observational Astronomy and Astrophysics. Homage to Miklós Konkoly Thege (1842-1916)*. Brussels, Vrije Universiteit Brussel.

Vincze, I.J., and Jankovics, I., 2010. Eugen von Gothard and his X-ray experiments. *Physics in Perspective*, 12, 25-35.

Vincze, I.J., Jankovics, I., and Kovács, J., 2003. Gothard Astrophotographic Plate Library: digitization and archiving of the original plates taken by Eugen von Gothard at the end of the XIX century. In Corbin, B., Bryson, E., and Wolf, M. (eds.). *Library and Information Services in Astronomy IV... Emerging and Preserving: Providing Astronomical Infomaton in the Digital Age* ... Washington, US Naval Observatory. Pp. 394-398.

Vogel, H.C, 1888. Über die Bedeutung der Photographie zur Beobachtung von Nebelflecken. *Astronomische Nachrichten*, 119, 337-342 (in German).

von Gothard, J., 1882. A herényi astrophysikai observatorium leírása és az abban tett megfigyelések 1881-ben. *Értekezések a természettudományok Köréb*, l9(3), 1-35 (in Hungarian).

von Gothard, E., 1883a. Spectroscopische Beobachtungen des grossen September-Cometen 1882 II auf dem astrophysicalischen Observatorium in Herény (Ungarn). *Astronomische Nachrichten*, 105, 311-314 (in German).

von Gothard, E., 1883b. Ein Spektroskop für Kometen- und Fixstern-Beobachtungen. *Central-Zeitung für Optik und Mechanik*, 4(11), 121-124 (in German).

von Gothard, J., 1884a. Megfigyelések a herényi astrophysikai observatoriumon 1883. évben. *Értekezések a mathematikai tudományok Körébõl*, 11(5), 1-34 (in Hungarian).

von Gothard, E., 1884b. Spectroskopische Beobachtungen des Cometen 1884 I (Pons 1812). *Astronomische Nachrichten*, 109, 99-106 (in German).

von Gothard, E., 1885a. Die periodische Veränderlichkeit des Spektrums von β Lyrae. *Astronomische Nachrichten*, 111, 161-164 (in German).

von Gothard, E., 1885b *Publikationen des Astropysikalischen Observatoriums zu Herény Eugene von Gothard*. Herény, published by the author (in German).

von Gothard, J., 1885c. Tanulmányok az égitestek photographálása terén. *Értekezések a mathematikai tudományok Körébõl*, 12(8), 1-18 (in Hungarian).

von Gothard, J., 1886a. *Az ujabbkori csillagászat módszerei és megfigyelési-módjai*. Budapest (in Hungarian).

von Gothard, E., 1886b. Apparate für Aufnahmen himmlischer Objecte. *Zeitschrift für Instrumentenkunde*, 6, 5-14 (in German).

von Gothard, E., 1887a. Cometen-Beobachtungen im Jahre 1886. *Astronomische Nachrichten*, 116, 121-124 (in German).

von Gothard, E., 1887b. Keilphotometer mit Typendruck-Apparat. *Zeitschrift für Instrumentenkunde*, 7, 347-349 (in German).

von Gothard, J., 1890. *A fotografia. Gyakorlata és alkalmazása tudományos czélokra*. Budapest (in Hungarian).

von Gothard, J., 1891. Spektrálfotografiai tanulmányok. (Székfoglalóul felolvasta a III. osztály ülésén 1891. ápr. 20.) *Értekezések a természettudományok Körébõl*, 21(2), 1-31 (in Hungarian).

von Gothard, E., 1892a. Studien über das photographysche Spectrum der planetarischen Nebel und des neuen Sterns. *Memorie Della Società Degli Spettroscopisti Italiani*, 21, 169-173 (in German).

von Gothard, J., 1892b. A Nova Aurigae spektruma

összehasonlítva néhány bolygószerû köd spektrumával. *Értekezések a mathematikai Tudományok Körébõl*, 15(2), 1-36 (in Hungarian).
von Gothard, E., 1892c. Spectrographische Beobachtung des Cometen 1892 … (Swift März 6) auf dem Astrophysikalischen Observatorium zu Herény. *Astronomische Nachrichten*, 129, 405-408 (in German).
von Gothard, E., 1901. Periodische Veränderungen im Spectrum der Nova Persei. *Astronomische Nachrichten*, 155, 269-272 (in German).
von Gothard, E. et al., 1885. Über den neuen Stern im grossen Andromeda-Nebel Mittheilungen aus Herény. *Astronomische Nachrichten*, 112, 390-391 (in German).

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