Comm. in Asteroseismology
Vol. 149, 2008

Kövesligethy's spectroscopic studies

Magda Vargha and Lajos G. Balázs

Konkoly Observatory, Budapest

"Nur allein der Mensch
Vermag das Unmögliche:
Er unterscheidet,
Wählet und richtet;
Er kann dem Augenblick
Dauer verleihen."(Goethe)

"The key of understanding nature is harmony, and harmony is numeric. Nature and all harmony can be understood through numbers: the number is the essence." (Pythagoras)

Curriculum vitae

He was born in Verona in 1862. He completed his PhD theses between 1881-1884 at the University of Vienna.

Starting in 1882 he observed at the private Observatory of Miklós Konkoly Thege regularly. Konkoly founded his observatory in 1871 and recognized already at the beginning the revolutionary change in astronomy by introducing quantitative spevtroscopy. The observatory joined the general spectroscopical research, organized by the Observatory of Potsdam, of stars brighter than 7.5^{mag}. In his PhD thesis he worked out an equation for describing the functional form of continuos radiation, he attemped to estimate the surface theory of celestial bodies and its dependence on the temperature. As a byproduct he discovered Wien's displacement equations. After developing his theory further he attemped to determine the surface temperature of the stars. He was author of a large number of popular papers in astronomy.
He died in Budapest in 1934.

About Kövesligethy's personality

In 1925 the famous Hungarian writer, Dezső Kosztolámyi made a newspaper-report on Radó Kövesligethy. He portrayed him by these words:

"Study-desk covered in red baize, the lamp is on, there's a piece of paper full of a long long list of formulas, formulas that have been written in ink by a hurrying hand, just like we were writing a letter to someone. Kövesligethy is not sitting far from the source of light. Fragile, mercurial person, and cheerful, cheerful. Creators are cheerful. Those who know the weight of obligation, but carry it easily are never as tired as ordinary people, who only carry their own lives' hardship. Extremely loveable, communicative man. A letterbox, in which letters of philosophers from the XIX and XX century rest, is in front of him."

The Kövesligethy Radó's spectral equation

"Oh rainbow, symbol of hope and fascination! Help those who grapple with the fights awaiting for them, and show them the promise of achieving their goal" (Kepler)

Kövesligethy's spectral equation was part of the work that investigated how it is possible to draw conclusions from the radiated spectrum to the physical state inside a celestial body. He believed that thermodynamics was crucial: he thought that in interpreting spectra is just as an important role as the mechanics of Newton to the movement of celestial bodies.

The history of science teaches that it was Max Planck's quantum-hypothesis of 1900 that made it possible to explain the laws of the so called temperature radiation of the celestial bodies. The classic science-history reviews also mention two other important attempts to explain the above cited equation before Planck. One was published by Wien in 1893 and the other one came from Rayleigh and Jeans a few years later. The problem with both of them was that they described only a part of the spectrum correctly: the Wien-solution described the blue part of the spectrum whereas the Rayleigh-Jeans the red one. Therefore for the sum of the radiated energy they prognosticated an infinitely high value.

During his university studies Kövesligethy Radó often turned up at Konkoly Thege's institution in Ógyalla, where he became acquainted with astronomical spectroscopy. He started to believe that there needs to be a general theory which explains the spectrum characteristics of the radiated light of the stars.

In those times it was generally accepted that light is a medium present everywhere and it is the propagation of oscillations of the ether. This was the basis of Kövesligethy's theory as well, and he assumed that this medium, just as matter, consists of interacting particles,the atoms. He also assumed that the atoms of the radiating matter interact with the ether's atoms, and this is

how radiating light develops. He deduced his temperature radiation equation, which was quite similar to Planck's in its format, based on these assumptions. One of its important characteristics is that compared to the later Wien and Rayleigh-Jeans solution the energy radiated by the body is finite.

In 1895 in one of his articles Paschen - whose name was carved in stone by the series of lines that can be observed in hydrogen's spectrum - mentions the laws he found in the spectrum of stars. These were explained theoretically as well by Kövesligethy Radó. Planck did not know of Kövesligethy's results at all. The modern quantum-theory was based on Planck's results.

For deducing his spectral equations Kövesligethy made several assumptions which were quite reasonable on the basis of the accepted views of the contemporary theoretical physics.
He assumed that:

> radiating matter consist of interacting particles
> the form of interaction is an inverse power law
> the light is the propagation of the oscillations of the ether particles

Kövesligethy did not make the same assumptions as Planck. However, it is worth making a comparison that is shown in Fig. 1 below. There is striking similarity between the two curves.

Vienna

Kövesligethy Radó had tight links to this city. His mother, his step-father and his half-sister also lived here. But above all, this is the place which, during his university studies, inspired him to do important theoretical research of spectral analysis.

Bericht des Referenten Oppolzer.

(Fragments)

"Herr R. v. Kövesligethy hat seine Arbeit betitelt "Prinzipien einer theoretischen Astrophysik auf Grund mathematischer Spectralanalyse" als Inauguraldissertation eingereicht. Wie man sieht lässt sich der Titel dieser Arbeit wohl richtiger lauten: "Theoretischen Grundlagen der Spectralanalyse". Der Referent ist nicht in der Lage mit den ihm vorliegenden Behelfen in Spectralanalyse in kurzer Zeit sich ein definierend Urtheil über die Arbeit zu finden und hat sich deshalb ein Besitz einer ... an Hofrath Stefan gewandt, der von der Arbeit in manchen Puncten erstaunliche ... Zielsetzung der Arbeit als Inauguraldissertation als gerechtfertigt betrachtet sofern

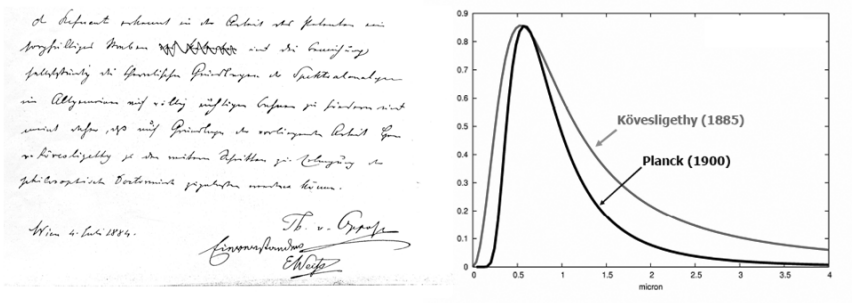

Fig.1: A fragment of Oppolzer's referee report on Köveligethy's PhD theses (left). Comparison of the Köüveslifthy's spectral equation with that of Planck (right). Note the striking similarities between the two curves

dieselbe nicht vor ... publiciert wird. Der Referent erkannte in der Arbeit des Probanden ein sorgfältiges Streben (des Probanden) und die Erreichung selbstständig die theoretischen Grundlagen der Spectralanalyse im Allgemeinen mit völlig richtigem Einsehen zu finden und meint daher das auf Grundlagen der vorliegenden Arbeit. Rad. v. Kövesligethy zu den weiteren Schritten zur Erlangung der Philosophischen Doctorwürde zugelassen werden könne."
Einverstanden Th. v. Oppolzer, E. Weiss
Wien 4. Juli 1884.

Köveligethy acquired his theoretical knowledge first of all from Joseph Stephan. He must also have gained thorough education from the few-months-work with H.C. Vogel in Vienna. He described the final aim of his spectroscopy studies in the following way:

"The spectral-theory described, and later revised in several points, in my work entitled 'Grundzüge einer theoretischen Spectralanalyse' has evolved with the explicit aim to set astrophysics, which had mostly had a descriptive character that far, on mathematical grounds. Provided that we do not regard celestial bodies and their systems as pure points anymore, the mathematics describing their state and movement will also be complemented with their thermo-theoretical details. This would only be possible in case, (as proved among others by the Ritter Ágoston theses published in Wiedemann Annalen), we were really able to measure the temperature and the density of the celestial bodies and can assume that they are (eszményi gázállapotú) bodies.

We can be successful only, in case we define the state of a body as known, if its spectrum is known. ... It is clear that in this way the whole of astrophysics becomes a science that can be discussed theoretically, and it represents the

Cosmic application of thermo-theory just as astronomy does with mechanics."

Kövesligethy's spectroscopic theses
1883 - Konkoly introduced Kövesligethy's thesis entitled *The mathematical spectral analysis as the basis of astrophysics*
1885 Febr 15 - Konkoly spoke of the Ógyalla spectroscopic catalogue edited by Kövesligethy at the meeting of the III Class of the Hungarian Acaemy of Sciences
1885 Oct 19 - Konkoly introduced Kövesligethy's thesis entitled: 'The theory of continuous spectra' at the meeting of the III Class. In this work he was the first who published a spectral equation which predicts a finite energy for the black body radiation (15 years before Planck!). This spectral equation has a characteristic that was discovered by Wien in only in 1893.
1887 May - Konkoly presented Kövesligethy's spectroscopical theory . He applied his theory also on the line spectra and successfully interpreted the Balmer formula of the Hydrogen spectrum.
1890 - Kövesligethy published a popular article on spectrum analysis in the *Natural Science Bulletin*
1890 - Kövesligethy's book entitled *'Grundzüge einer theoretischen Spektralanalyse'* was published in Halle. In this book he summarized his theoretical results on the stellar spectra supplemented by a comprehensive theory of astronomical instruments (e.g. photometers and spectrographs).
1898 - He presented his spectroscopic studies in detail at the meeting of *Astronomischen Gesellschaft* in Budapest. In his talk he made a comprehensive overview on his theory but seemingly nobody responded.

Konkoly Thege Miklós, and his observatory in Ógyalla

Kövesligethy wrote to Miklós Konkoly Thege in his letter in 1895 *"I spent the most beautiful days of my youth there and among your loving family, and I spent truly useful years there, as here in Ógyalla is where I learnt most of what I consider as my own"*

Miklós Konkoly Thege had an outstanding role in Kövesligethy's life.

He was a generous and helpful supervisor, a strenuous patron and a fatherly good friend. This is what he mostly needed as a person who attained majority formally at the age of 19 from his step-father as well.

In 1884 when Kobold left Ógyalla, Kövesligethy, continuing his Vienna studies on his own, worked in Ógyalla for a year. He also needed money. During the year spent in Ógyalla, as a supplement to his theoretical work that far, he did some spectroscopic observations. These resulted in the Spectrum Catalogue of Ógyalla.

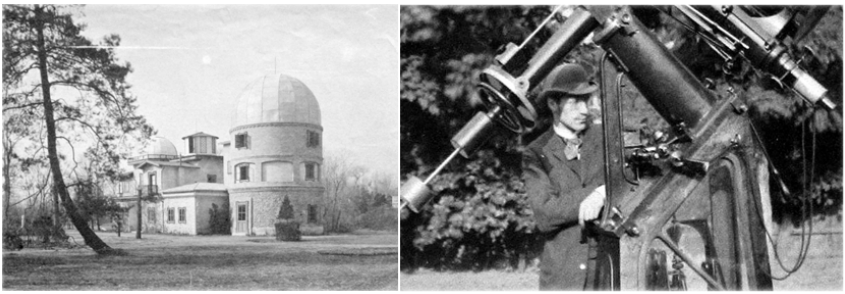

Fig.2: Konkoly's Observatory at Ógyalla (left) Radó von Kövesligethy (right) made the bulk of the spectroscopic observations in the period of 1883–85

Kobold's speech about Ógyalla Observartory

"Die wissenschaftliche Tätigkeit des Observatoriums hatte bis zu meinem Eintritt fast ausschliesslich auf dem Gebiet der Astrophysik gelegen, entschprechend den Neigungen des Herrn v. Konkoly und der Ausrüstung des Observatoriums, die eine grosse Anzahl von vorzüglichen Instrumenten für spektrometrische, photometrische and kolorimetrische Beobachtungen und Messungen umfasste. Ausser Beobachtungen dieser Art waren noch Zeichungen der Oberflächen der Planeten ausgeführt, die Tätigkeit der Sonne verfolgt durch Zählung und Ortsbestimmung der Sonnenflecken und im Zusammenwirken mit diesem gestellt."

Is his career a success-story?

His theses on spectroscopic research are mentioned in only one article and even then just briefly.

The spectrum catalogue put together by him has never become a tool of astronomers.

In 1915 he had to resign from his position as the secretary-general of the Seismologic Society owing to the war. A decree was issued in Brussels that all scientists living in Entente countries who maintain a relationship with their counterparts from the countries of the Central Powers need to be pilloried.

His priceless library and the letters from the box mentioned by Kosztolányi are in an unknown place. We have managed to find only a few copies of his George Darwin letters.

What could be the reason for not receiving the acknowledgment of his fellow astronomers from abroad for his strokes of genius?
We cannot answer this question. It is inexplicable as the language of his articles

The most important dates of Kövesligethy's scientific career

Fig.3: Kövesligethy as dean of the University Budapest

1895 – He becomes a corresponding member of the Hungarian Science Academy
1897 – He is a public university professor of Cosmography at the University of Pest.
1905 – He is elected as the secretary-general of the International Seismologic Society
1906 – He founds the Seismologic Observatory in Budapest
1909 – He is elected as a full member of the Hungarian Science Academy

The academic year of 1916/17 - He becomes the dean of the University Budapest

could not be an obstacle either, as it was in the case of so many other Hungarian scientists. Kövesligethy published his scientific results in Hungary and abroad at the same time and sometimes they even appeared first in foreign magazines.

Researching his work it occurred to us that the obstacle to acknowledging his theses may lie in him being a genius, he was always one little step ahead of his time.

His fellow academicians admitted too that they did not understand his mathematical solutions.

To give a proper answer to this question we need to go on a spiritual trip that no one has done before: going through the immensity of his formulas, to get a clear picture of his scientific image and define the exact place among the scientists of his time.

Epilogue

Finally, it is worth mentioning a few of his students, who achieved a successful career: Alfréd Rényi, László Turán, Jenő Egervári, Károly Jordán Hungarian academics who were all well-known mathematicians around the whole world. Among astronomers baron Béla Harkányi, correspondence member of the Academy and university professor, Károly Lassovszky, the director of the Observatory of Svábhegy, and Mátyás Tibor, the contributor to the Observatory of the Vatican are all proud to have had Kövesligethy as their master.