Resume

Wojciech Dimitrow

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1 CV

1.1 Personal data

- Name and surname: Wojciech Dimitrow
- Date of Birth: 24 April 1976
- Place of work: Institute Astronomical Observatory,
  Adam Mickiewicz University, Słoneczna 36, 60-286 Poznań,
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1.2 Education and scientific degrees

- 1990 – 1994 Sofia Mathematical High School
- 1994 – 1999 Studies of physics, specialisation: astronomy,
  Faculty of Physics, Adam Mickiewicz University, Poznań
- 1999 – Master's Degree, thesis *Eclipses of stars by Moon*, supervisor – prof. dr hab. P. A. Dybczyński
- 2006 – Ph.D. in physical sciences, thesis *Observation and modeling of detached binary systems – verification of the distance and evolutionary status*, Faculty of Physics, Adam Mickiewicz University, Poznań, supervisor – prof. Alexander Schwarzenberg-Czerny

1.3 Information about employment

- 21.09.2006 – 30.09.2007 – astronomer, Institute Astronomical Observatory, Adam Mickiewicz University
- 01.10.2007 – 30.09.2017 – adjunct, Institute Astronomical Observatory, Adam Mickiewicz University
- since 01.10.2017 – senior lecturer, Institute Astronomical Observatory, Adam Mickiewicz University

2 Scientific achievement — base of the habilitation procedure

My scientific achievement is a series of publications entitled
„Multiple systems – detection of new components and determination of the absolute parameters".

Wojciech Dimitrow

2.1 List of publications underlying the habilitation procedure

H1 **Dimitrov, W.**, Fagas, M., Kamiński, K., Kolev, D., Kwiatkowski, T., Bąkowska, K., Rożek, A., Bartczak, P., Borczyk, W., Schwarzenberg-Czerny, A.
Spectroscopy of HD 86222 - a quintuple system with an eclipsing component
Astronomy and Astrophysics
2014, Volume 564, id.A26, IF(2014)=4.378,
I discovered the fourth spectroscopic component of HD 86222 system and explained the hierarchy of the whole quintuple system. I took part in the spectroscopic observations and I made 100% of the data reduction and radial velocity measurements. I made the modelling of the eclipsing pair. I wrote the whole text of the publication, own contribution 80%.

H2 **Dimitrov, W.**, Kamiński, K., Lehmann, H., Ligęza, P., Fagas, M., Bagińska, P., Kwiatkowski, T., Bąkowska, K., Kowalczyk, A., Polińska, M., Bartczak, P., Przybyszewska, A., Kruszewski, A., Kurzawa, K., Schwarzenberg-Czerny, A. 2015.
V342 Andromedae B is an eccentric-orbit eclipsing binary.
Astronomy and Astrophysics
2015, Volume 575, id.A101, IF(2014)=4.378,
I organized an international observation campaign, explained the hierarchy of the system. I found that component B is eccentric orbit eclipsing binary, while A is spectroscopic binary. I made part of the observations and data reduction, made the model of the eclipsing binary, wrote 80% of the text, own contribution 75%.

H3 **Dimitrov, W.**, Lehmann, H., Kamiński, K., Kamińska, M. K., Zgórz, M., Gibowski, M. 2017.
The hierarchical triple system DY Lyncis
Monthly Notices of the Royal Astronomical Society
Volume 466, Issue 1, IF(2014)=5.107,
I discovered the third component in the eclipsing system DY Lyn, organized an international observation campaign, prepared data for modeling, made interpretation of the results. I wrote a program, which made the calculation of the radial velocities for both orbits possible. The obtained period of the wide eccentric orbit is 281 d. I wrote 80% of the text, own contribution 70%.

H4 **Dimitrov W.**, Tomov T., Kamiński K., Polińska M., Iliev I., Kamińska M. K. 2018.
GT Ursae Majoris AB – a possible quadruple system.
Acta Astronomica, 2018, Volume 68, No.2, IF(2014)=1.980,
Third component was detected in the system. I organized an international observation campaign. We observed the orbital motion of the third component and the eclipsing pair. I proved that the visual component B is the part of the system. I made part of the observations, data reduction and radial velocity measurements. I calculated the model of the system and wrote 80% of the text, own contribution 75%.

H5 **Dimitrov W.**, Żywucka - Hejzner N., Polińska M., Kamiński K., Kamińska M. K. 2018
Spectroscopy of the eclipsing binary BD-00 2862 – possible multiplicity.
Acta Astronomica, 2018, Volume 68, No.3, IF(2014)=1.980,
All spectroscopic observations of the system were made on PST1 telescope. I participated in observations and calculated the model of the system. I found evidence that the visual companion is a member of the main system. I wrote 80% of the text, own contribution is 75%.

2.2 Description of the scientific achievements of the listed publications and the obtained results

Our knowledge on the formation of the binary and multiple systems is still incomplete. Both observations and simulations of the star formation regions yield that stars born in groups and 100% of zero age stars are binary or multiple (Bate 2004). During the dynamical evolution some of the lighter components are ejected from the systems. Observation of the field stars show that 60–80% are binary or multiple. The multiplicity fraction is close to 100% in the case of the massive stars and lower in case the of lighter stars (Tokovinin 2014). Stars form inside the collapsing molecular clouds. Fragmentation of the cloud is enhanced by rotation and turbulence and braking by the magnetic field (Machida 2008). Observation statistics of the stars enable us to estimate the conditions in molecular clouds in which they form.

The star forming processes are still a field of intense investigations. Latest observations show two main mechanisms of multiple star formation: core fragmentation – separation of the components of about 10^{3-4} AU (Pineda & Offner et al. 2015) and disc fragmentation creating pairs with separation $10^{1.5-2.5}$ AU (Tobin & Crater 2016). One of the basic theories of formation of close binaries separated by 10^{-1} AU state shrinking of orbits in accompany of third body caused by Kozai – Lidov cycles with tidal friction (Eggleton & Kiseleva-Eggleton 2001). The latest results are presented in multiple review papers like Tholine (2002), Zinnecker (2002), Bate (2004) and Moe & Di Stefano (2017).

We know more than 100 multiple stars, which includes an eclipsing pair, most of them are triple systems (Zasche et al. 2009). Only a few of them have more than tree components and are well investigated and we know their absolute parameters with high accuracy. Study of this objects broaden our knowledge of multiple star formation and formation of stars in molecular clouds. In this context, observations of those objects, which supplements statistics and absolute parameters data, are very important. The mentioned papers are devoted to those topic.

The development of observational methods allows us to broaden our knowledge about multiple systems. Adaptive optics and interferometric methods allow overcoming of the negative impact of the Earth's atmosphere on the images obtained, allowing the detection of components with small angular separation. Space telescopes such as Hubble or Spitzer allow us to view protostellar and protoplanetary disks. The Kepler photometric space telescope dedicated to the detection of planetary transits allowed to observe planets in multiple systems for the first time. The side effect was the light curves for eclipsing and pulsating stars with unprecedented precision, the dispersion in the data is at 10^{-6}.

The presence of an eclipsing pair in a multiple system gives us the unique opportunity to determine absolute parameters with accuracy of 1% or lower. I used the Wilson method - Devinney (1971) to model selected eclipsing systems. Simultaneous analysis of light and radial velocity curves allowed us to determine the full model - masses, radii, orbital inclination etc. The obtained results can be confronted with the theory of stellar evolution, for this purpose I used the results of Yonsei-Yale (Yi et al., 2001, 2003, Kim et al. 2003). Additionally, I used the results from the Hipparcos and GAIA missions that provided information on trigonometric parallax and the proper motions of the examined stars.

The basic research instrument in this observation program was Poznań Spectroscopic Telescope 1/2. I worked on the PST1 project at all stages from design and construction through implementation and modernization as well as data observation and analysis. The second main instrument in the program was PST2 working in Arizona. The telescope proved to be very productive due to the high level of automation and good astroclimate. Both telescopes cooperating in the GATS [1] project (Global Astrophysics Telescope) have already accumulated over 20 000 spectra mainly for pulsating and eclipsing stars. Both telescopes are equipped with high resolution spectrographs ($\sim$ 40,000), which were built in IOA in Poznań. The main goal during their construction was to minimize light losses, including good adjustment to the optical fiber/telescope parameters. In addition, we took care of the thermal stability of spectrographs - the dispersion of the RV measurements during one night is about 40 ms^{-1}. I also used data from 2-m class telescopes - David Dunlap Observatory (Canada), NAO Rozhen (Bulgaria) and Turinger Landessternwarte near Tautenburg (Germany). For the majority of the examined objects, I organized international observation campaigns. I used photometric observations from sky surveys such as ASAS, SAVS or SuperWASP as well as satellite data. Some of the measurements were obtained

[1] `http: //www.astro.amu.edu.pl/GATS`

on a small photometric telescope in Poznań.

For radial velocity measurements the following methods were used: cross-correlation (CCF), broadening function (BF) and spectrum disentangling. For the analysis of line profiles I used the least square deconvolution (LSD) method. I used Monte Carlo and Bootstrap methods to analyze errors of modeling with the Wilson-Devinney method.

For the analysis I chose eclipsing stars belonging to visually double or triple systems, wich were not investigated spectroscopically. Some of them are present in catalogs of visually double stars such as the Washington Double Star Catalog (WDS) or Catalog of Components of Double and Multiple Stars (CCDM). I discovered new spectroscopic components in four of the five objects. In two cases, I was able to observe spectroscopically the motion on a tight and wide orbit in the system.

HD 86222

The first tested object is HD 86222 (publication H1). It is a eclipsing system in a visually triple system, hitherto unexplored spectroscopically. The main components A and B are in the angular distance of 0.5" and the farther component C - 11". Spectroscopic observations were carried out for central A/B system, its components are not separated at short focal lengths or large seeing. The data was collected on the 2-m NAO Rozhen telescope equipped with a Coudé spectrograph (Bulgaria) and a 0.5-m PST1 telescope in Borowiec. Data obtained in Borowiec are comparable to those of the 2-m telescope due to low light losses and fiber fed spectrograph Echellé, which has much wider spectral range, which gives us a large number of lines for cross-correlation. Obtained spectra indicate that we are dealing with a quadruple spectroscopic system. All four peaks on the cross-correlation function move (Figure 1), two of them with a larger amplitude have a period compatible with the eclipse period. So one of the A/B components is an eclipsing pair and the other is a spectroscopically double system. Considering also the further component C, the system is a hierarchical quintuple system. Only a few objects with such multiplicity are known, in which eclipses occur and for which we know the absolute parameters well. Modeling a pair of eclipsing showed that it is a pair of stars on the main sequence with masses of 1.33 ± 0.09 and 1.29 ± 0.09 $M_\odot$. The orbital period is 0.987 d, which is inconvenient when collecting data. The semi-major axis of the orbit is 6 $R_\odot$. I estimated the period and size of the A/B visual orbit for 900 years and 100 AU. A farther visual component C is located at 3000 AU, and I estimated the period of 3×10^3 years.

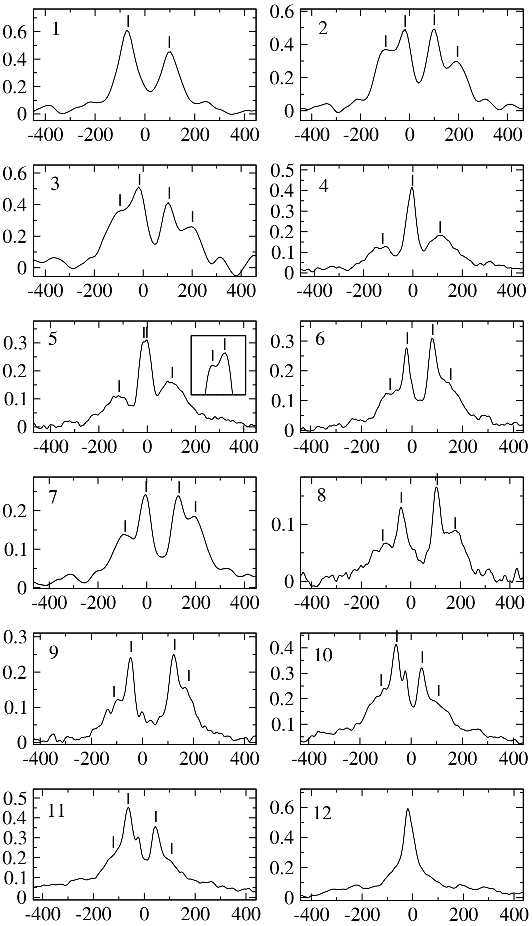

Figure 1: The cross-correlation function for the obtained HD 86222 spectra. The first three graphs concern spectra from NAO Rozhen, and the remaining from Borowiec.

V 342 Andromedae

The next studied object is the V342 Andromedae, which is a visually double system (H2 publication). Separation of components A and B, both having comparable brightness, is about 5". My attention to this system was caused by the discovery of eclipses by the Hipparcos satellite. I organized an international observation campaign involving 1.88-m DDO telescope and a 2-m telescope at Tautenburg. We collected spectra and light curve in Poznań. I obtained the first spectra at DDO on a slit spectrograph in the Cassegrain focus. Initially, it was not known which component A or B is eclipsing. The spectrograph was not equipped with a field derotator, but luckily the position angle of the pair allowed me to set both components on the slit and obtain spectra for both of them. It turned out that the eclipsing pair is the visual component B. The first radial velocity curve was obtained with "Broadening function" method applied to data from DDO. The orbit turned out to be elliptical with an eccentricity of $e = 0.08$. We obtained another set of data on the PST1 telescope. The telescope has a much shorter focal length, so both visually components A and B were placed on the optical fiber. I used data from 1.88 DDO and PST1 telescopes for modeling of the eclipsing pair using the Wilson method - Devinney. For spectral analysis we obtained spectra of components A and B on the 2-m TLS telescope in Germany. These results were used, inter alia, to determine the chemical composition of the eclipsing pair components. After analyzing the average profile of the spectral lines in the data from PST1 and TLS it turned out that both an eclipsing pair (B) as well as the component A are spectroscopically double (Figures 2 and 3). I estimated the size of the visual A/B orbit to 460 AU and the period to 2×10^4 years. Using the evolutionary tracks, I estimated the age of the system to 2–3 Gyr.

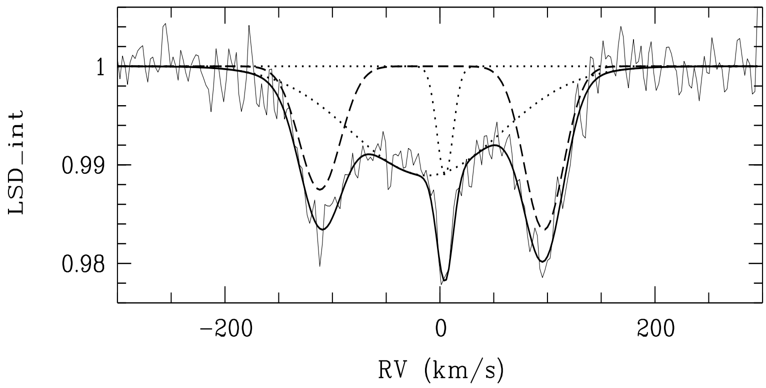

Figure 2: The average profile of the spectral line V342 And A/B for the PST1 telescope - three narrow lines and a wide component are visible. External lines are associated with the eclipsing pair

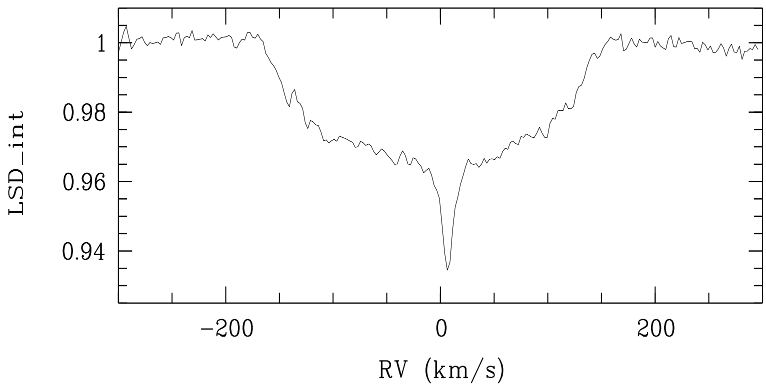

Figure 3: The average line profile for A component (from the TLS telescope) indicates the probable binarity of the component.

DY Lyncis

The object for which I received the most interesting results is DY Lyncis.

In 2009, I discovered third spectroscopic component in the system, together with my graduate student. We announced this result with a short publication in Sękalska & Dimitrov et al. (2010). I also noticed changes in the radial velocity of the third component, which prompted me to organize an observation campaign in the hope that it would be possible to observe the motion around the common center of mass for the large orbit. The results of this campaign were included in the H3 work. Data collection took 6 years. The long campaign paid off, we obtained the parameters of the tight and a wide orbits. The amplitude of the velocity changes on a large orbit is significant (Figure 4). The measured radial velocities for the three components are a sum of velocities on both orbits. I wrote a program to separate the influence of both orbital motions, which determines both radial velocity curves using the iterative method. The wide orbit has a period of 281 days and a significant eccentricity of e = 0.3 (Figure 5). The comparison of spectroscopic results with eclipse timing results was a good confirmation of the obtained results. The deviations with the respect to the ephemeris, eclipse moments, phased with a period of eclipsing pair are shown in Figure 6. We have very good agreement with the synthetic curve calculated from RV curve for the eclipse binary center of mass. So we have the effect of "Light time" in the system, which is associated with a long-term orbit.

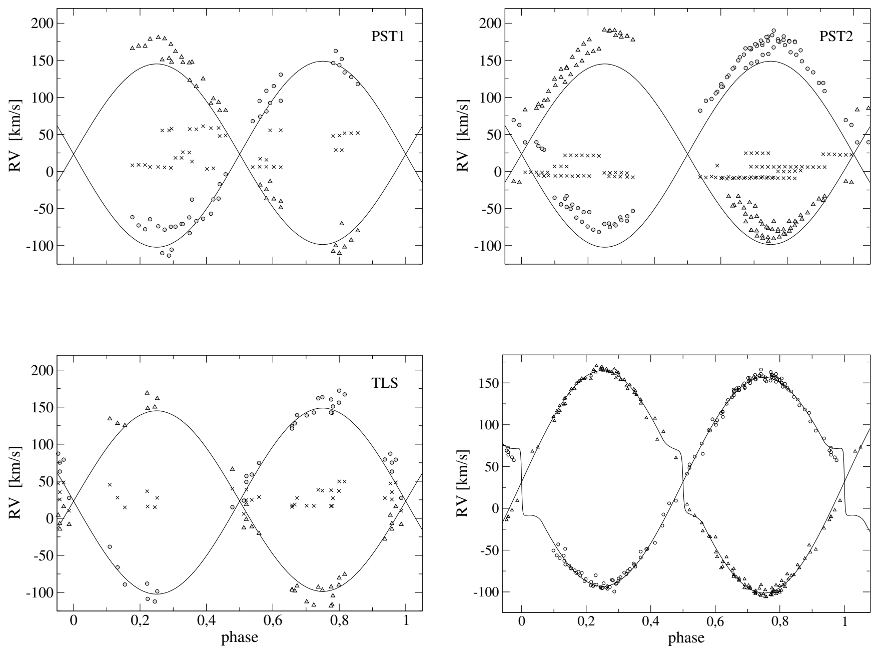

Figure 4: RV measurements from three telescopes before correction for motion around the common center of mass. The last graph shows the measurements after the correction.

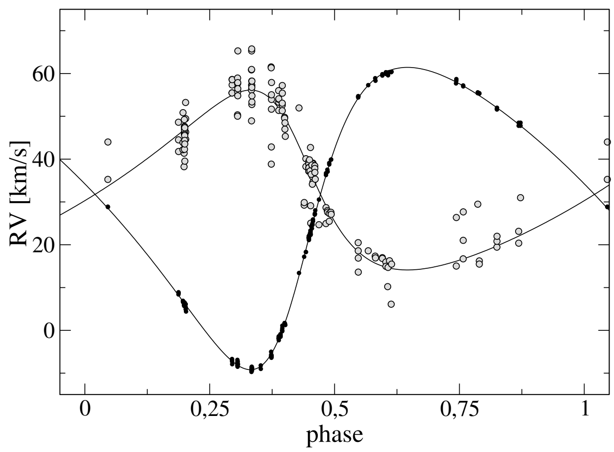

Figure 5: The radial velocity curve for the DY Lyncis wide 281 day orbit. The circles present measurements for the center of mass of the eclipsing binary and the points for the third component.

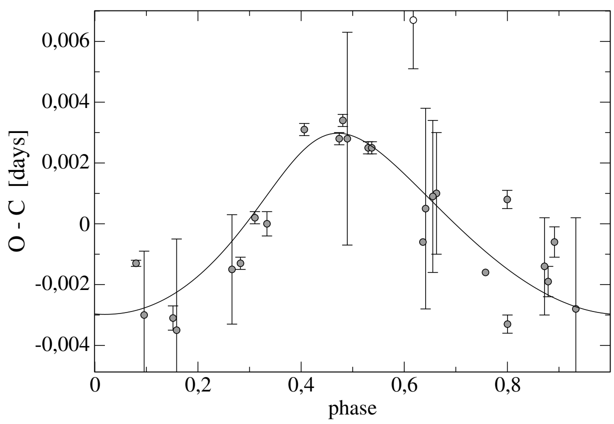

Figure 6: Deviations of the moments of DY Lyncis eclipses with respect to the ephemeris. The data is phased with a period of the wide 281 day orbit. The solid line presents the radial velocity curve for the center of mass of the eclipsing pair converted into time. Results obtained from the timing and spectroscopy show very good agreement confirming correctness of the obtained model.

GT Ursae Majoris

The first observations of the system were made on the 2-m NAO Rozhen telescope on the Coudé spectrograph. A third spectroscopic component was found in the system. However, radial velocity measurements were unsatisfactory. This was caused by too short spectral range and an insufficient number of spectral lines for the measurements. I used an Echellé spectrograph to increase the spectral range. I made a test observation on PST1, radial velocity measurements had much lower dispersion. The main part of the data was collected on PST2 telescope in Arizona. I have observed significant changes in the velocity of the 3rd component. The RV curve for the eclipsing pair also shows typical shifts. So we are dealing with an orbital motion around the common center of the mass of the triple system.

We used the 2-m NAO Rozhen telescope and the new Echellé ESPERO spectrograph to explore the visual companion B. I was involved in the contsruction of this spectrograph (Bonev et al 2017). The measured radial velocity indicates that the component is dynamically bound to the main spectroscopic triple component A. Other arguments that show the visual component B belongs to the system are: similar values of parallax and proper motion of the A and B components. Therefore, we are dealing with a quadruple hierarchical system containing an eclipsing pair.

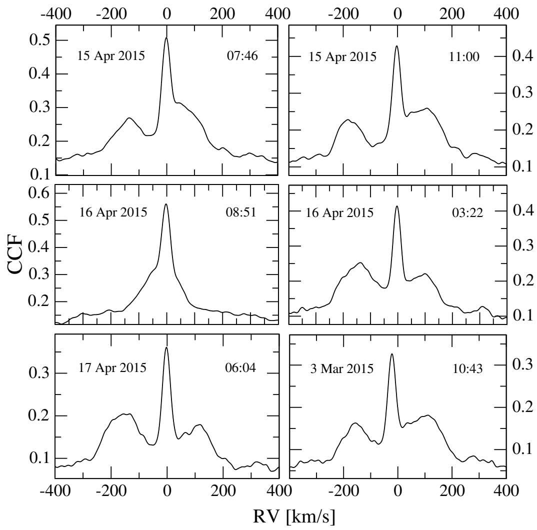

Figure 7: The three moving peaks of the GT UMa cross-correlation function.

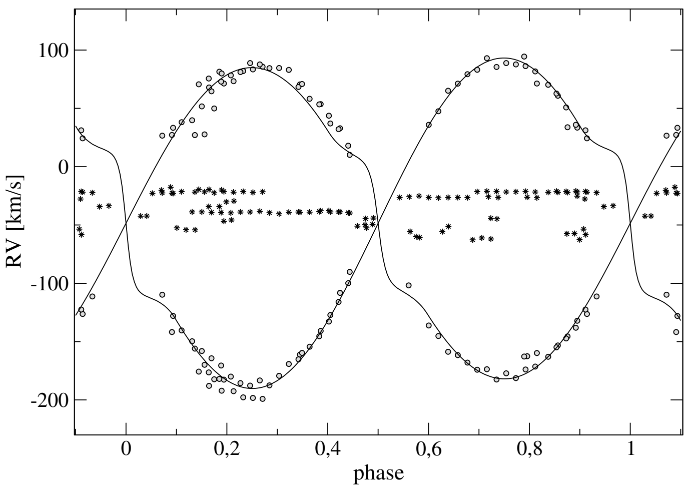

Figure 8: Measured radial velocities of the three spectroscopic components of GT UMa A.

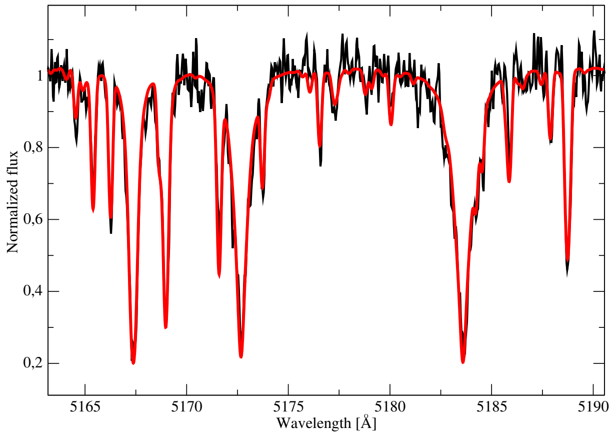

Figure 9: Fitted synthetic spectrum for the magnesium triplet MgIb for the visual companion GT UMa B.

BD-00 2862

The fifth eclipsing object from the cycle is BD-002862 (publication H5). My interest was ignited by the presence of a visual companion and third spectroscopic component, in some obtained spectra. All spectra of the system were collected with the PST1 telescope. Searching for data in catalogs that confirm that the belonging of the visual companion B to the system was successful. The proper motions of components A and B are similar and, in addition, estimated distances of A and B components are equal with in errors. The GAIA (DR2) mission results were used (GAIA collaboration et al 2016, Lindgren et al 2016). Using the obtained with PST1 radial velocity curve and ASAS photometric observations, I calculated a model of the system using the Wilson-Devinney method. The absolute parameters errors are 3% for the masses and 1% for the radii. Based on the eclipsing pair model, I determined the photometric parallax. The agreement of the distance calculated from the model 131 ± 5 pc and from the GAIA astrometric mission 130 ± 4 pc is very good. Comparison of results with evolutionary models shows that the system is very young and located on a short pre main sequence stage (Figure 11).

The studies of these five multiple stars can be continued. An interesting direction of the survey is searching for resonances; for example, in HD 86222 between the two central spectroscopic pairs. Long-term photometric monitoring would allow detection of new components using timing technique. The presence of massive planets could also be detected with this method and it would have a very interesting result. Other direction of future research could be imaging using adaptive optics and interferometric methods.

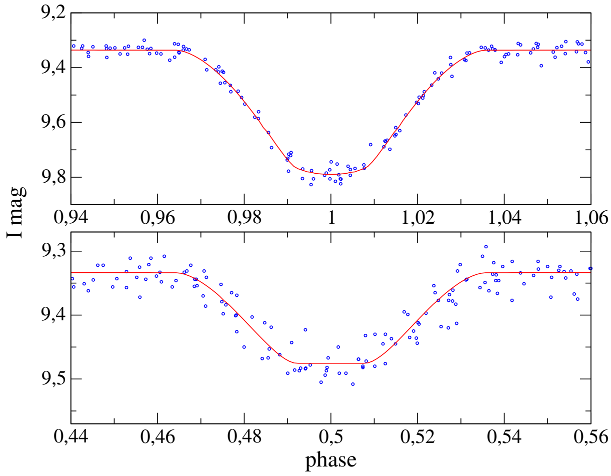

Figure 10: Light curve for BD-002862 A near primary and secondary eclipses.

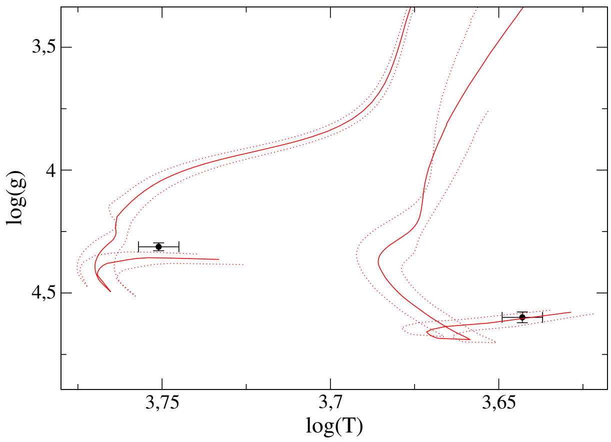

Figure 11: Evolutionary tracks for both components of BD-002862 A i.e. the eclipsing pair. Straight lines present evolutionary tracks; dashed lines – the range of mass determination errors.

2.3 Summary

The publications presented above are devoted to the detection of new components in eclipsing systems and their modeling. The main results of the work are:

- The discovery of new spectroscopic components in the studied systems, including systems with high multiplicity - quadruple and quintuple.
- Explanation of the hierarchy in the examined multiple systems.
- Organizing of international spectroscopic observation campaigns, using 2-m class telescopes in Canada, Bulgaria and Germany.
- Construction of research instruments, telescopes and spectrographs in Poland and abroad, which were used to observe multiple systems.

- Detection of motion around the common center of mass for wide orbits for two spectroscopic triple systems.
- Determination of the exact parameters of the 281 day wide orbit in the DY Lyn system.
- Writing a program that allowed to unravel the motion in a tight and wide orbits in DY Lyn and GT UMa systems.
- Detection of the "Light Time" effect in case of DY Lyn system.
- Determination of absolute parameters for eclipsing pairs (masses, radii, temperature, age and distance) - using Wilson-Devinney method.
- Proving that the visual companions are part of the main systems.

References

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3 Discussion of the other scientific achievements

3.1 Building of scientific instruments

During the last decade, I participated in the construction of three research instruments. I worked at all stages, from design through construction, software development, commissioning, training of observers, servicing and modernization of the Poznań Spectroscopic Telescope 1. I was involved in the construction of two more instruments: PST2 and the Echelle spectrograph for the 2-m telescope NAO Rozhen in Bulgaria. I also took part in modernization and servicing 0.4-m photometric telescope in Borowiec near Poznań.

From October 2018, I am planing to join the construction of the PST3 satellite telescope (Poznań Satellite Telescope). Ultimately, the system will be fully automatic, it will plan and perform astrometric observations of satellites. The construction of the system is planned in Dark Sky Park in Chalin, about 70 km from Poznań. The system will consist of a Planewave 0.7-m CDK 700 telescope and 4 smaller telescopes devoted to searching for space debris.

Poznań Spectroscopic Teleskop 1 – I started scientific and technical work in the PST1 project immediately after completing my PhD in 2006. Together with Eng. R. Baranowski, I was working on the assembly of the telescope and spectrograph as well as on adjusting the optics of both instruments. I participated in the design of some elements.
After completing the telescope, I got the first spectrum. It soon turned out that the telescope meets the expectations placed on it. The limiting magnitude is 11^m for 0.4-m mirrors, which were installed in the initial period. I have developed observation procedures and trained observers. In the first year of the observation, 1800 spectra were collected. The spectrograph is characterized by good stability. In a long period of time, data scatter is about 100 ms^{-1} and during one night only 35 ms^{-1}.

During all 11 years of the telescope's work, I was involved in servicing and modernizing the telescope. Additionally, I was working on replacing of the mirrors adjusting and cleaning the optics and repairs of the spectrograph CCD camera. The last major modernization of the telescope was made in 2015. The aim was to enable remote work of the telescope. Currently, the entire observation process can be carried out remotely via the Internet.

Poznań Spectroscopic Telescop 2 – Project GATS
On the basis of the experience from the PST1 telescope, a new PST2 telescope was created. The project manager was dr Krzysztof Kamiński. The telescope was designed for remote operation and has a high level of automation. The system consists of a 0.7-m Planevawe telescope on azimuth mount with direct drive engines and the Echellé spectrograph built in the Poznań Observatory. The telescope has two Nasmith foci, one of them is equipped with a FUI (Fiber Injection Unit) and there is a fast Andor camera for satellite observations in the other one. In GATS project, I worked mainly on the analysis of the obtained data and as a consultant in the construction

of the telescope. I also helped in the construction of some elements of the instrument.

Echellé spectrograph for NAO Rozhen Bulgaria
The cooperation in the construction of a new spectrograph for the 2-m telescope NAO Rozhen began with the interest of the Bulgarian side in spectrographs built at the Poznań Observatory. I was invited to a conference devoted to the 30th anniversary of the telescope's work, on which I presented the results of our work and technical details of the spectrographs. I organized the visit of a group of astronomers and opticians from Bulgaria to acquaint them with the operation and construction of the instrument. This cooperation resulted in the construction of the Echellé spectrograph for the 2-m telescope and is continues today. The first tests and results have been published in the works of Bonev et al. 2017 and Bonev et al. 2014. I am a co-author of those publications.

3.2 Tests of new calibration methods

During the first years of PST1 telescope operation, I performed various tests and experiments on the calibration of wavelength spectra. The spectrograph is well-stabilized thermally, but it does not have pressure stabilization which is too complicated and expensive. Temperature stabilization is passive and active. The thermostat and radiator are responsible for the active stabilization of the temperature in the spectrograph room to 20 ± 1°C. The spectrograph housing is a double aluminum case with a 5 cm layer of styrofoam between. We placed 300 kg granite plate in the interior that provides mechanical stability and acts as a heat accumulator that does not allow for quick temperature fluctuations inside the spectrograph. The whole is based on 4 supports with anti-vibration layers that absorb different frequencies. The spectrograph camera is cooled with a 5-stage Peltier block to a temperature of -100°C and the heat is transported by hoses with coolant at a temperature of 15°C. As standard, the telescope operates in the classic calibration mode, before and after every object spectrum thorium-argon lamp calibration spectra were made. The first tests I carried out were performing long series of object spectra without calibration spectra after every object spectrum. We are using the good spectrograph stability. At the beginning and the end of the three hour series, I made five calibration frames for averaging. The Fig. 12 shows the result of the test – I obtained dispersion of 35 ms^{-1} in data and high sampling frequency. This is the radial velocity curve for the γ Pegassi pulsating star.

During one of the grants I tested iodine cells on the PST1 telescope in Borowiec. These are probably the first observations in Poland stars using an iodine cell. The idea of using a cell to increase the accuracy of radial velocity measurements lies in passing the light of the object through iodine vapors, which gives a large number of narrow absorption lines around 5000-6000 Å. These lines are used as wavelength markers. They are exposed simultaneously with the lines of the object so all shifts caused by pressure

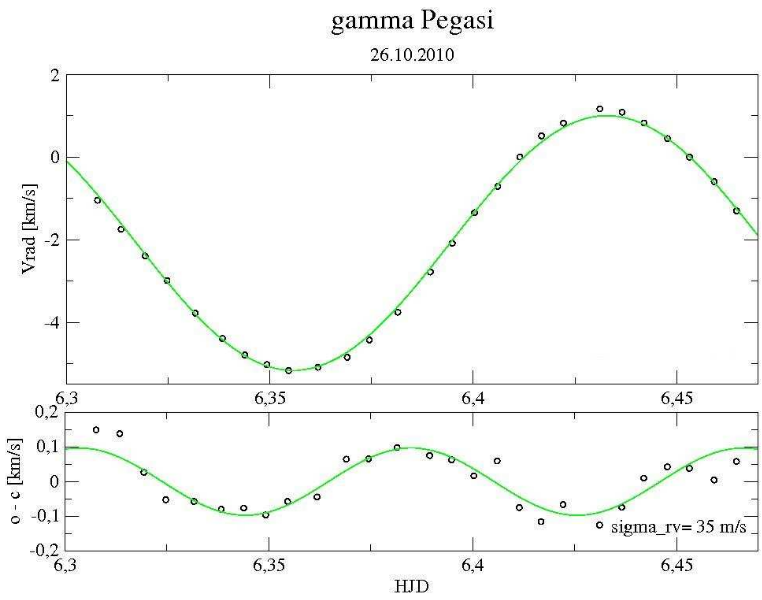

Figure 12: Radial velocity curve for γ Pegassi.

and temperature variations are the same for the object and the calibration spectrum. This technique is used in the cases when accuracy below 10 ms^{-1} is required, mainly for observing the dynamic effects caused by extrasolar planets. The iodine cell was mounted on the entrance of the optical fiber, feeding the spectrograph in the main focus of the telescope. The tests showed that we were able to go down with an accuracy of at least 17 ms^{-1} for PST1 using an iodine cell (Figure 13).

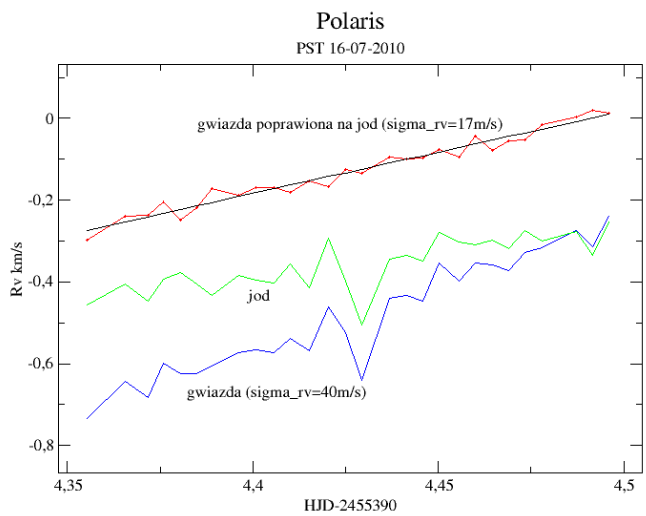

Figure 13: Polaris observation using iodyne cell.

Simultaneous exposition of the object and calibration spectrum allows to increase the calibration accuracy. I conducted tests mixing the calibration light with the object one. For this purpose, a calibration lamp with an optical system that provides a parallel beam was mounted on the telescope entrance and directed to the main mirror parallel to the optical axis. Figure 14 shows the spectrum of the star with the emission lines of the calibration lamp that are our wavelength markers.

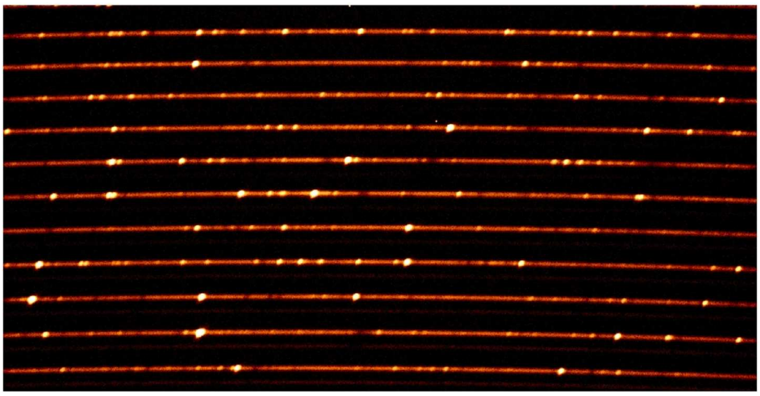

Figure 14: Mixing of the object and callibration lamp light.

The PST1 spectrograph has thermal stabilization, however, pressure stabilization is too expensive and only the world's best spectrographs have these. I started tests to check the possibility of introducing corrections to RV measurements based on pressure and temperature measurements. These studies were continued by dr K. Kamiński on the PST2 telescope after purchasing high-class pressure and temperature meters.

Tests and experiments carried out on PST1 served and will serve in the future in the development of Poznań Spectroscopic Telescopes. In near future, I am planning to introduce simultaneous exposure of the ThAr spectrum and the object as two parallel spectra using two optical fibers. This technique is used, among others, in HARPS spectrographs.

3.3 Observation and modeling of extrasolar planets

Another direction in my work are the extrasolar planets. I was involved in spectroscopic observations and the use of the Wilson-Devinney method for modeling of the planet-star pairs. I took care of two Master's theses in extrasolar planet research. The PST1 telescope and spectrograph proved stable enough to observe bright systems with a large amplitude of radial velocity variations of the host star. Such an object is τ Bootis A, which has a planet with a mass of about 7 M_{jup}. The amplitude of the radial velocity variations is about 500 ms^{-1} and the period of 3.3 days. A radial velosity curve was obtained (Figure 15) as part of one of the Master's theses. The plot present a long-term stability of the spectrograph, in case of this object the data scatter is 83 ms^{-1}.

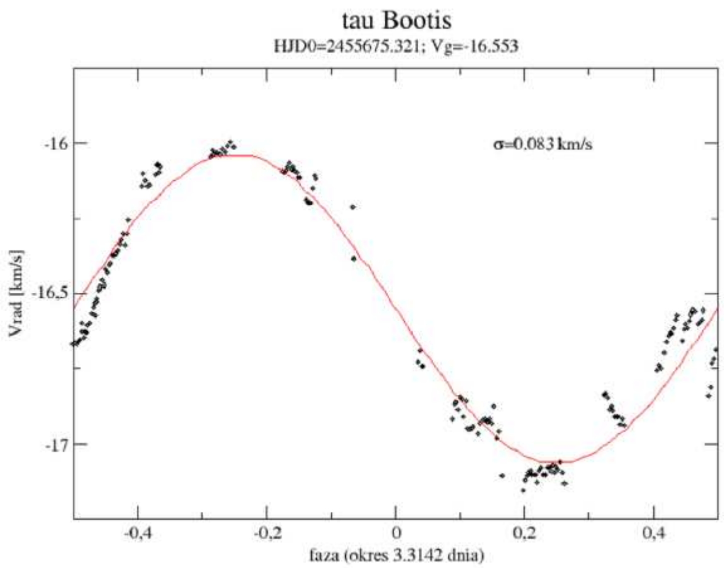

Figure 15: Radial velocity curve of the host star τ Bootis A.

References

Bonev, T. et al., 2014, The Astronomer's Telegram, No. 5829, 1B

Bonev, T. et al., 2017, Bulgarian Astronomical Journal, Vol. 26, p. 67

3.4 Authorship and co-authorship of scientific publications

In total, I am a co-author of 16 publications from the Journal Citation Reports (JCR), part A, of which 14 appeared after obtaining of my doctoral degree. I am also the author or co-author of 19 other publications. Total number of citations by SAO/NASA Astrophysic Data System (ADS) is 144. Based on the Web of Knowledge it is 87.
My Hirsch index is 6.
A detailed list of publications attached.

In most of my works, I took the name "Dimitrov", which is originally written in Cyrillic. However, in a few works, the spelling "Dymitrov" or "Dimitrow" was used. A full list of my publications could be found on the website http://pallas.astro.amu.edu.pl/~voyager/ link PUBLICATIONS

3.5 Participation in research projects

Contractor in the ESA grant *"Space Surveillence and Tracking in Observational Network with Event-based Sensors"*, Main contractors: 6ROADS, OA

UAM, ITTI, UZH Zurich, 12 months, 2018/2019 r.

Contractor in the grant *"Optical system of robotic satellite sensors"*, Grant manager: dr Krzysztof Kamiński,
instrumental grant MNiSW 6725/IA/SP/2017.1, 2017-2019.

Contractor in the grant *"Global Astrophysical Telescope System"*, Grant manager: dr Krzysztof Kamiński, 2011/01/D/ST9/00427, 2011–2016.

Contractor in the grant *„Cepheid study using radial velocities"*, Grant manager: dr hab. T. Kwiatkowski, 1P03D 025 29, grant finished in Nov. 2008

Contractor in the grant *„Spectroscopy and photometry of eclipsing binaries for their calibration as cosmological distance markers"*,
Grant manager: dr hab. T. Kwiatkowski, 5P03 D002 20, 2001–2003.

Contractor in the grant KBN, CAMK, *"SHAPE: Cepheid distances from the shape of their light curves"*, Grant manager: prof. Aleksander Szchwarzenberg-Czerny, KBN 2P03 D018 18, 2000–2002.

3.6 Prizes and awards

- Rector's II degree Team Award for scientific achievements, 2016.
- Application for the II degree Rector's Team Award for scientific achievements in 2018. The application was supported by the Faculty Council.

3.7 Participation in international conferences

- „Wrocław HELAS Workshop – Interpretation of astroseismic data" (23 - 27 June 2008), Wrocław, Poland
  Speech: Radial-velocity observations of pulsating stars with a new Poznań Spectroscopic Telescope

- „Binaries – Key to Comprehension of the Universe" (8 - 12 June 2009), Masaryk University, Brno, Czech Republic.
  Poster: FM Leonis - the tale of twins, (coautor)

- „Rozhen National Astronomical Observatory: Thirty Years Eyes on the Sky" (26 - 29 September 2011), Bulgarian Academy of Science
  Invited speech:
  Fiber Fed Echellé Spectroscopy in Poznań

- „Second National Congress on Physical Sciences, Bulgaria”
  25–29 September 2013, Sofia
  Union of Physicists in Bulgaria, Bulgarian Academy of Sciences, Sofia University St. Kliment Ohridski, Ministry of Education, Youth and Science

- „KOLOS Slovakia - variable stars”
  3 – 5 December 2015, Vihorlat Observatory in Humenné
  Speech:
  Spectroscopy of multiple stars with eclipsing component

- „International meeting on variable stars research”
  1 - 3 December 2016, Slovakia, Vihorlat Observatory in Humenné
  Speech: Echelle spectroscopy in Poznań

3.8 National conferences

- „GATS Workshop”, (20-21 May 2017)
  Astronomical Observatory Institute UAM, Poznań
  main organizer
  Speech: Telescope in Borowiec (PST1)
  Speech: Modernisation of the PST1 telescope

- „Use of small telescopes II” (16 - 17 June 2011) Physics Institute of Opole University
  Speech: Poznań Spectroscopic Telescope (main autor)
  Poster co-autor

- „XXXV Polish Astronomical Society meeting” (11 - 15 Sept. 2011) Physics Institute of Opole University
  Speech: Poznań Spectroscopic Telescope (main autor)
  Poster co-autor

- „50 years of eclipses of U Geminorum” (5 Dec. 2011) Nicolaus Copernicus Astronomical Centre, Polish Academy of Science

- „Use of small telescopes” (Kraków-Koninki 10-12 Maja 2013) Astronomy Department of Pedagogical University of Cracow,
  SOC member,
  Speech: Global Astrophysical Telescope System (coauthor Krzysztof Kamiński)

- „Software Systems for Astronomy” 7-18 July 2014, Poznań Astronomical Observatory Institute, Faculty of Physics, Adam Mickiewicz University **Invited speech: Spectroscopy with PST1**

- „Poland in Space” 26-27 Nov. 2015,
  Warsaw, Institute of Aviation

- „Poland's participation in the European SSA program" (Space Situational Awareness), 6 April 2016, Poznań Polish Space Agency - POLSA and Astronomical Observatory Institute, Faculty of Physics, Adam Mickiewicz University

- „ESO Practical Workshop" 7 Feb. 2017, Warsaw Ministry of Science and Higher Education, Astronomical Center Nicholas Copernicus PAS (CAMK PAN) and Astronomical Observatory of the University of Warsaw

- „Meeting with NASA representative Artur Chmielewski and representatives of Polish companies from the space industry" 4 June 2018, Poznań Astronomical Observatory Institute, Faculty of Physics, Adam Mickiewicz University

3.9 Membership in international and national organizations and scientific societies

- I am a member of the International Astronomical Union

3.10 Internships in foreign scientific or academic centers

- Bulgaria, multiple trips to the NAO Rozhen observatory – spectroscopic observations on the 2-m Ritchey-Cretien Coudé telescope.

- Canada, a monthly trip to David Dunlap Observatory – spectroscopic observations on the 1.88-m telescope.

3.11 Training in observations with PST1 spectroscopic telescope and data reduction

Apart from the annual internships for Polish students. I also conducted trainings, in the reduction of Echellé spectrograph data and radial velocity measurements, for PhD students and adjuncts in the PST1 telescope service.

- Tomasz Zdravkov - observations of pulsating stars
  - PhD student, CAMK Warsaw

- Sebastian Kurowski - observations of eclipsing systems
  - PhD student, Cracow

- dr Waldemar Ogłoza - observations of eclipsing systems
  - adjunct, UP Cracow

3.12 Management and care of master's theses

During the last 10 years I was either an advisor or, was involved in supervising of 8 master's theses. Four of my students continued their education in astronomy at doctoral studies in Poland or abroad.

Determination of parameters of the eclipsing binaries
FM Leo and FK Leo
Milena Ratajczak (Poznań 2008)
currently: she completed her doctorate at CAMK Warsaw
– MSc thesis advisor

Modeling of eclipsing systems BD-002862 and HD 67894
Rafał Szudera (Poznań 2009)
– MSc thesis advisor (informal supervisor)

Study of extrasolar planet - application of Wilson-Devinney method
Elżbieta Andrzejewska (Poznań 2010)
– MSc thesis advisor (informal supervisor)

Spectroscopic observations and modeling of the HD system 65498
Justyna Sękalska (Poznań 2010)
– MSc thesis advisor (informal supervisor)

Spectroscopic observations of semi-dethached eclipsing systems
Patrycja Bagińska (Poznań 2011)
currently: PhD student, UAM Poznań
– supervisor

Spectroscopic observations of an extrasolar planet τ Bootis
- spectrograph stability tests
Tomasz Kowalczyk (Poznań 2011)
– supervisor

Spectroscopic observations and modeling of HT Vir and RR Lyn
Katarzyna Bensch (Poznań 2012)
currently: PhD student, IAA Spain
– MSc thesis advisor (informal supervisor)

Analiza obserwacji spektroskopowych gwiazd zaćmieniowych i pulsujących
Natalia Żywucka (Poznań 2013)
currently: PhD student, UJ Cracow
– supervisor

Modeling of the symbiotic star SY Muc based on photometric and spectroscopic observations
Aleksandra Leśniewska (Poznań 2018)
currently: PhD student, UAM Poznań
– I helped in data analysis but formally I was not involved in supervising of this master thesis

3.13 Help with doctoral dissertations

Hybrid oscilations of B type main sequence stars
Tomasz Zdrawkow, CAMK, Warsaw 2013
– I helped in observations and data reduction

Spectroscopy of binary stars
Patrycja Bagińska, UAM, Poznań
– I helped in observations, data analysis and in preparation of the publication
– after opening the doctoral procedure I will be a promoter or an auxiliary promoter

Spectroscopy of pulsating stars
Ewa Kosturkiewicz, UAM, Poznań
– I helped in data reduction and in preparations to the conference