NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ

THE REALIZATION OF THE INDIVIDUAL RESEARCH PLAN

Name and surname	Hanno Stinshoff
Project title	Expanding the BoOST massive star models to explain the formation of globular clusters
Scientific disciplines	Astronomy
Supervisor	Dr. hab. Dorottya Szécsi
Foreign scientific supervisor*	Not applicable
Assistant supervisor*	Not applicable

Year of study: .1st. (academic year 2022/2023)

1. Report on the realization of individual research plan (IRP) The precise and documented information about the implementation of the tasks should be described according to the individual points of the individual research plan form:

Project 1: Expanding the BoOST model grids (a and b)

a. Description of methodological assumptions and obtained research results/artistic achievements, including indication and justification of changes in planned research or artistic activities and methodological assumptions:

Massive stars play an essential role in stellar populations. They have strong material and energy outflow called winds and reach the end of their "lifetime" (evolution) quicker than low-mass stars, providing products of nuclear fusion to their surroundings. One specific effect, that may be facilitated by massive stars, is the formation of Globular Clusters from Young Massive Clusters (cf. for example Portegies Zwart et al., 2010) with multiple populations (see also Year II, project 2, also cf. for example Bastian & Lardo, 2018, and for the case of massive stars Szécsi & Wünsch, 2019. For other scenarios regarding this cf. for example Decressin et al., 2007).

Because of that it is essential to create new evolutionary models with a broad range of initial masses, metallicities and rotational velocities, which then can be used in cluster formation to investigate the validity of that aforementioned scenario.

The original Bonn Optimized Stellar Tracks (BoOST) model grids from Szécsi et al. (2022) are stellar evolutionary models, created with the so-called Bonn Code to investigate the evolution of (single) massive stars. They range from 9 up to 500 solar masses, and occupy a broad range of metallicities (cf. Brott et al., 2011), from that of the Milky Way (MW, Z_{MW}=0.0088) down to a scaled fraction (0.02) of the Small Magellanic Cloud (SMC, Z_{SMC}=0.0021). These models were converted into a format that a) filters out unnecessary data, therefore reducing the data load immensely, b) facilitates interpolation of the models to create a fine grid, and c) employs easy-to-use data tables to make application of the models easier.

The goal of this new project is to expand these grids by creating models that also vary in initial rotational velocity (from non-rotating (0 km/s) up to fast-rotating (500 km/s) models), increase the resolution (both time-wise, increasing the number of profiles (states of structural data of the whole star, from core to surface in every grid-point of the 1D spherically symmetric model, for a given time) per evolutionary sequence, and the resolution of the initial parameters chosen, resulting in grids that show in a more resolved way at what parameter thresholds changes in the outputs happen) and bring them, just like their predecessor, into the BoOST format (meaning a filtered format for the data, including interpolation with regards to at

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least the initial mass of the models, to receive fine grids of models) to enable easy application.
The Bonn Code is once again a good choice for this project, as it has access to its large nuclear reaction network, which is needed to eventually analyze the abundances in globular clusters

In the future, these models can then also be used to investigate other things, like Gravitational Wave predictions by implementing the models into binary population synthesis codes like COMBINE (cf. Kruckow et al., 2018), or enabling better comparisons to observations (for example with tools like BONNSAI, cf. Schneider et al., 2014).

b. Status of implementation of organizational undertakings and research/artistic tasks included in the project schedule:

Scientific Goals:

1.) In the beginning of the project I had to design the parameter space that is to be covered by my models: What ranges of initial mass, metallicity and rotational velocity will be employed when creating the models?
→ Successfully achieved.
I opted to create models with initial masses of 10, 20, 40, 80, 150, 300 and 500 solar masses. 10 solar masses is the beginning of the range of stars that are considered massive, 300 and 500 is the absolute extreme (with the most massive observed stars being up to around 200 solar masses, cf. for example Hainich et al., 2014) on the other side of the range. I chose steps similar to those used in Szécsi et al. (2022) to get comparable results in the part of the parameter space that are the same as in that publication, and because it is equidistant in log(M).
The chosen Metallicities were those of the Milky Way (MW), the Large Magellanic Cloud (LMC), the Small Magellanic Cloud (SMC) and multiple fractions of the SMC: 0.5, 0.2, 0.1, 0.05 and 0.02. These were again chosen in part due to the comparability to the Szécsi et al. (2022) paper, which chose these values to have examples of both high metallicity and low metallicity, which can drastically affect the evolution of stars due to for example higher line-driven mass-losses in higher metallicity environments.
The initial rotational velocities covered 0, 100, 200, 300, 400 and 500 km/s, providing no, low and high rotation models, with 500 km/s being chosen as the upper end to cover velocities where for example Szécsi et al. (2022) showed models that evolve differently (chemically homogeneously, see end of b), after goal 4) to models of lower velocities.

2.) The next step was focused on the actual creation of the models of massive stars in said broad parameter space. The Bonn Code was employed with a set of 336 different initial parameter configurations (see goal 1) to ensure a good resolution for the grids to be created. This will later-on be expanded slightly, upon inspecting the models and deciding which sections of the parameter space need better resolution.
→ Partly achieved.
The models were all created properly, showing promising results already. However, some of them show computational problems that prevent the finalization of the models:
At the time, it was not clear to me what caused these crashes. In the second year (see Year II, project 1, b, goal 2) I got to understand that in regions close to the so-called Eddington limit, which is the maximal Luminosity that a star can have theoretically before outputting too much radiation pressure to stay stable under gravity, the models decrease the length of time-steps of the evolution, and the way to solve this is being actively investigated (cf. for example Debnath et al., 2024). However, Szécsi et al. (2022) developed a strategy to achieve this, which includes mass removal from the surface and adjusting for the structural changes (called direct extension method, or DEM). Applying the DEM remained therefore a goal for the second year.

3.) The BoOST format needs to be applied to the models. In this format certain points of equivalent evolution (equivalent evolutionary points, EEPs) are determined in a systematic way, which then are used to get a unified data table with a set number of lines/time points between each of them (see below). They also facilitate interpolation between models of differing initial parameters (see Year II), therefore enabling the creation of dense grids of models.

The EEPs are defined by certain criteria (cf. Szécsi et al., 2022): 7 points in total are dividing the stellar tracks by identifying

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the beginning of the main sequence (A: 0% of the hydrogen in the core burned), a point during (B: "local minimum of the mass-loss rate corresponding to the bi-stability jump", or alternatively just 75% of the hydrogen in the core burned) and a point at the end of the main sequence (C: roughly 100% of the hydrogen in the core burned), then the beginning/bottom of the Red Supergiant Branch (D: Luminosity has a local minimum, or, in the case of blue loops without a base at the Red Supergiant Branch, the "middle of the loop blueward progression"), the middle of the helium burning phase (E: 50% of the helium in the core burned), a point close to the end of the helium burning phase (F: "Small dip in Luminosity" or roughly 90% of the helium in the core burned) and the end of the helium burning phase (G: 100% of the helium in the core burned). These points need to be identified for every model to facilitate the filtering process.
For the filtering the data is reduced to 608 data lines per model, with the EEPs' lines corresponding to lines 1, 151, 252, 403, 429, 505 and 608 (from A to G, cf. Szécsi et al., 2022; Agrawal et al., 2022). The length of each section can be adjusted if necessary.

Preparing the models for the process also includes checking each model for inconsistencies or computational errors. It can happen that the code goes on a tangent to find the solution before eventually getting there, so identifying those moments and deleting and redoing those parts as much as possible is essential for a proper model. This is something I was in the middle of doing when finishing my first year and soon expected to finish, it is the last step before applying the BoOST format.
→ In progress.
As the models have not reached the targeted goal stage of the end of core helium burning, it did not make sense to try to identify the EEPs and/or bring the models into the filtered format. This remained a goal for the second year.

4.) I had to familiarize myself with the WINDCALC code that I will use to investigate the models under the scope of cluster wind research. This includes application to existing models to test out the results and consequences of different inputs. I also had to get a better understanding of how those inputs affected the way the resulting populations behaved.
→ Successfully achieved.
I successfully tested out how the inputs of the WINDCALC code affect the results, creating some test populations and investigating the outputs to get used to the format. I also learned more about what parameters govern the behavior of these populations. The output of the code includes energies ans mass losses of fast and slow winds and how much energy and mass are inserted via winds into the cluster core. The population in the beginning of its evolution is determined by various input factors such as the total mass of the cluster, the kind of initial mass function (IMF, distribution of masses in an initially created cluster) used, which is determined by three function parameters, and the bin length and position (in how many / how big steps are the input ranges divided into) of the stellar masses inserted into the population.

The models created by that point are promising, showing for example two ways of evolution depending on the initial parameters; normal evolution, meaning stars evolving to cooler regions over the duration of the core hydrogen burning phase, occurred in contrast to chemically homogeneously evolving models, exhibiting an evolution to hotter states over time, which is explained by rotationally induced increased mixing of the material of the star being modeled.
This behavior seems to be directly linked to the initial parameters chosen for the models, which indicates that well-resolved grids will show the dependency on mass, metallicity and rotational velocity on these behaviors of the models.

References (in order of appearance):

[1] S. F. Portegies Zwart, S. L.W. McMillan, and M. Gieles, "Young massive star clusters", Annual Review of Astronomy and Astrophysics, vol. 48, pp. 431-493, 2010, doi:10.1146/annurev-astro-081309-130834

[2] N. Bastian, and C. Lardo, "Multiple Stellar Populations in Globular Clusters", *Annual Review of Astronomy and Astrophysics*, vol. 56, pp. 83-136, 2018. doi:10.1146/annurev-astro-081817-051839

[3] D. Szécsi and R. Wünsch, "Role of Supergiants in the Formation of Globular Clusters", *The Astrophysical Journal*, vol. 871, January 2019, p. 20, doi:10.3847/1538-4357/aaf4be

[4] T. Decressin, G. Meynet, C. Charbonnel, N. Prantzos, and S. Ekström, "Fast rotating massive stars and the origin of the

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abundance patterns in galactic globular clusters". *Astronomy & Astrophysics*, vol. 464, 2007, doi:10.1051/0004-6361:20066013

[5] D. Szécsi, P. Agrawal, R. Wünsch, and N. Langer, "Bonn Optimized Stellar Tracks (BoOST) - Simulated populations of massive and very massive stars for astrophysical applications", *Astronomy & Astrophysics*, vol. 658, 2022, doi:10.1051/0004-6361/202141536

[6] I. Brott, S. E. de Mink, M. Cantiello, N. Langer, A. de Koter, C. J. Evans, I. Hunter, C. Trundle, and J. S. Vink, "Rotating massive main-sequence stars: I. Grids of evolutionary models and isochrones", *Astronomy & Astrophysics*, vol. 530, 2011, doi:10.1051/0004-6361/201016113

[7] M. U. Kruckow, T. M. Tauris, N. Langer, M. Kramer, and R. G. Izzard, "Progenitors of gravitational wave mergers: binary evolution with the stellar grid-based code COMBINE", *Monthly Notices of the Royal Astronomical Society*, vol. 481, 2018, doi:10.1093/mnras/sty2190

[8] F. R. N. Schneider, N. Langer, A. de Koter, I. Brott, R. G. Izzard, and H. H. B. Lau, "BONNSAI: a Bayesian tool for comparing stars with stellar evolution models", *Astronomy & Astrophysics*, vol. 570, 2014, doi:10.1051/0004-6361/201424286

[9] R. Hainich, U. Rühling, H. Todt, L. M. Oskinova, A. Liermann, G. Gräfener, C. Foellmi, O. Schnurr, and W.-R. Hamann, "The Wolf-Rayet stars in the Large Magellanic Cloud - A comprehensive analysis of the WN class", *Astronomy & Astrophysics*, vol. 565, 2014, doi:10.1051/0004-6361/201322696

[10] D. Debnath, J. O. Sundqvist, N. Moens, C. Van der Sijpt, O. Verhamme, and L. G. Poniatowski, "2D unified atmosphere and wind simulations of O-type stars", *Astronomy & Astrophysics*, 2024, doi:10.48550/arXiv.2401.08391

[11] P. Agrawal, D. Szécsi, S. Stevenson, J. J. Eldridge, and J. Hurley, "Explaining the differences in massive star models from various simulations", *Monthly Notices of the Royal Astronomical Society*, vol. 512, no. 4, OUP, pp. 5717-5725, 2022. doi:10.1093/mnras/stac930.

c. Information on submitted research applications:

I applied for the prestigious Kavli summer school, which would've offered a great opportunity for further international collaboration. This summer school combines a workshop of a week long collection of lectures with five weeks of teamwork between junior and senior participants to create/progress projects leading to a paper or conference proceeding.
It is a very coveted opportunity, so I sent in an application, which I attached to this document as well.

Reference:

[1] Kavli Summer Program in Astrophysics:
https://kspa.soe.ucsc.edu/

d. Information on participation in scientific conferences, seminars or workshops, including the name, place and date as well as the nature of participation (organizer/participant) and the form of presentation of the results (poster, report, paper):

1. Conference name: VFTS meeting
   Date: 27 - 29 March 2023

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Type of participation: Poster presentation (Title: A new model grid expanding on the BoOST project)
Venue: Max Planck Institute for Astrophysics, MPI, Postfach 1317, D-85741 Garching, Germany
Participant, presenter

2. Conference name: European Astronomical Society Annual Meeting
   Date: 10 - 14 July 2023
   Type of participation: Poster presentation (Title: New stellar evolutionary models of massive stars with rotation: Expanding the BoOST project)
   Venue: ICE Kraków Congress Centre, ICE, Marii Konopnickiej, 17, 30-302 Kraków, Poland
   Participant, presenter

3. Conference Name: European Astronomical Society Annual Meeting (Symposium LS15: Magnetars as central engines across the Universe)
   Date: 10 - 14 July 2023
   Type of participation: Invited Talk (Title: Progenitors of LGRBs: Are single stars enough?) and Poster (same title), both as Co-Author, not Presenter
   Link to Presentation slides:
   https://rafia-s.github.io/R.Sarwar/pdf_files/EAS_2023_(Rafia).pdf
   Link to Poster:
   https://k-poster.kuoni-congress.info/eas-2023/gallery#/poster/f8d2c282-cba6-4fd3-9675-c62c7abd5b18
   Venue: ICE Kraków Congress Centre, ICE, Marii Konopnickiej, 17, 30-302 Kraków, Poland
   Co-Author

4. Workshop title: Public speaking and investor pitching
   Date: 16 - 17 November 2022
   (Type of participation: Workshop participation, improvised presentation)
   Venue: Nicolaus Copernicus University, Toruń, Poland
   Participant

5. Seminar talk: Seminar Talk at Piwnice Astronomical Observatory
   Date: 04 December 2023
   Type of participation: Presentation and Talk (Title: Explaining globular cluster abundance anomalies with expanded BoOST stellar model grids)
   Link to presentation slides:
   https://astro.umk.pl/~hanno/Hanno/presentations/seminars_conferences_workshops_internships/001_doctoralseminar2023_HannoStinshoff.pdf
   Venue: Piwnice Astronomical Observatory, Piwnice, Poland
   Participant, presenter

e. Information on cooperation with domestic or foreign scientific institutions:

Not applicable

f. Information on Apprenticeships:

Not applicable

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g. Information on classes completed as part of the educational plan:

1. Name of the course: Artificial Intelligence and the future of scientific thinking
   Course code on USOS: 7405-AC-AI-2
   Form of classes: Lecture
   Final grade: 4
   Number of hours: 10 hours
   Number of ECTS points: 1 ECTS credits

2. Name of the course: Ethics and intellectual property
   Course code on USOS: 7405-AC-EIP-2
   Form of classes: Lecture
   Final grade: 4
   Number of hours: 10 hours
   Number of ECTS points: 1 ECTS credits

3. Name of the course: Scientific data presentation and copyright II
   Course code on USOS: 7405-AC-SDPC2-2
   Form of classes: Lecture
   Final grade: 4.5
   Number of hours: 10 hours
   Number of ECTS points: 1 ECTS credits

4. Name of the course: History of scientific thinking and inquiry
   Course code on USOS: 7405-AC-HST-2
   Form of classes: Lecture
   Final grade: 5
   Number of hours: 10 hours
   Number of ECTS points: 1 ECTS credits

5. Name of the course: Evolutionary Biology
   Course code on USOS: 7405-AC-EB-2
   Form of classes: Lecture
   Final grade: 4
   Number of hours: 10 hours
   Number of ECTS points: 1 ECTS credits

6. Name of the course: Supervisory mentoring
   Course code on USOS: 7405-AC-SMEN-1
   Form of classes: Supervisor mentoring
   Final grade: 5
   Number of hours: not applicable
   Number of ECTS points: 4 ECTS credits

7. Name of the course: Occupational Safety, Health and Ergonomics (Basic Training)
   Course code on USOS: 9000-eBHP
   Form of classes: Training
   Final grade: ZAL

2. List of scientific papers (included in the list of scientific journals and peer-reviewed materials from international conferences of the Ministry of Higher Education and Science), which were written during the education at the Academia Copernicana Interdisciplinary Doctoral School:

S. Geen et al., „Bringing Stellar Evolution and Feedback Together: Summary of Proposals from the Lorentz Center Workshop", *Publications of the Astronomical Society of the Pacific*, vol. 135, no. 1044, 2023, doi:10.1088/1538-3873/acb6b5

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This paper was written by all participants of the workshop called „Bringing Stellar Evolution and Feedback Together" at the Lorentz Center in Leiden from April 2022. At the time of the workshop I was not yet able to be enrolled at the UMK due to bureaucratic reasons, but by the time of the submission and publication I was already accepted.
I did take active part in the writing process, providing my own thoughts to the discussion. I also had taken notes of a discussion session at the conference, so I was also partially responsible for putting these into words in the paper (particularly on section 5).
I attached a copy of the abstract to this document.

3. A list of research/artistic internships in external scientific centers, especially abroad, in which the doctoral student actively participated, i.e. conducted research or presented its results. The list should be accompanied by appropriate documentation and certificates

Not applicable

4. A list of applications submitted by the doctoral student in competitions of the university or to external entities for funding of foreign travel or research/artistic activities. A copy of the sent applications and relevant decisions should be submitted as documentation

The research of the student in question is covered by the National Science Center (NCN), Poland under grant No. OPUS 2021/41/B/ST9/00757. There is no need for the application for a research grant anymore.

5. A list of classes or workshops carried out outside the compulsory study plan that contributed to the development of the doctoral student's soft skills. The list should be accompanied by relevant documentation

Listed at section (1.d)

6. Opinion of the supervisor(s) on the progress of the doctoral student in preparing the dissertation

See Year II

7. It is possible to submit additional opinions (maximum two) on the PhD student, prepared by scholars from other research centers, especially foreign, involved in the research conducted by the PhD student

See Year II

8. Other scholarly or artistic/conservation achievements and activities not directly related to IRP. Completion of this point is optional

Participated in an unofficial workshop concerning "git" and how to use it. Git is a version control system that can be used both locally for own development and publicly for sharing program code and collaborating on it without hindering each other on the work. Understanding it is very important in our field of work, so even though there wasn't any official credit to be gained, I participated in it to make sure I have sufficient knowledge about it to apply it myself in the future, which helped tremendously in my Year II when visiting Prague and working on the WINDCALC code (see Year II, Project 2). The course was held on 12 and 19 January 2023 by Dr. Áron Szabó, a mathematician who at the time was still working at the UMK. It was held online, to facilitate a Poland-wide participation.

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I created the website for our group, being displayed on:
https://astro.umk.pl/~hanno/massivestars/Group/index.html
Here, among other things, the links to each personal website of the group members and also the Journal Club timeline is posted.

I also created a website for my own, being displayed on:
https://astro.umk.pl/~hanno/Hanno/
This enables me to achieve a more professional demeanor and easily distribute information about my achievements while doing my PhD.

I also participated in the Journal Club of our Group for massive stars, regularly presenting papers for the other members and contributing in the other weeks with questions and discussions about the topics of the week. In the first Year I held seven talks covering various topics like convective core overshooting, primordial very massive stars or magnetism in high-mass stars.
The presentations I held can be viewed on my website on:
https://astro.umk.pl/~hanno/Hanno/03Publications.html

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Year of study: .2nd. (academic year 2023/2024)

1. Report on the realization of individual research plan (IRP) The precise and documented information about the implementation of the tasks should be described according to the individual points of the individual research plan form:

Project 1: Expanding the BoOST model grids (a and b)

a. Description of methodological assumptions and obtained research results/artistic achievements, including indication and justification of changes in planned research or artistic activities and methodological assumptions:

This project is the continuation of the project of last year.
The end goal is still to create comprehensive grids of stellar evolution models of massive single stars, ranging over many initial masses, metallicities and rotational velocities (cf. Year I, Project 1). As Year I showed some problems that held up the progress, this needed to be addressed in Year II. On top of that, the models had to be pushed further and converted into the filtered BoOST format (Szécsi et al., 2022). I managed to progress in these goals by creating the first "boosted" (i.e. EEP-assigned, data-filtered, interpolated, see below) models and advancing the progress of others.

b. Status of implementation of organizational undertakings and research/artistic tasks included in the project schedule:

Scientific Goals:

1.) Handling the vast amounts of data started to become a problem. I created 336 models in total, which in some cases each amount to multiple gigabytes in size. This meant that the saving of backups and the storing of intermediate steps of the process required more space. After the first external hard drive previously used started to spontaneously disconnect and disappear from the system, we bought a second one to ensure a safe deposit.
→ Successfully achieved.
At first, as a temporary measure, an additional backup needed to be made on the computer of our collaborator in Prague to ensure that the data is not lost in case of a complete failure of the drive. Afterwards, the second hard drive was bought, formatted and added to the work station. It is used as additional back up storage and could also be used in the future as the main storage.

2.) Bringing all the models to the end of core helium burning was a goal of the project. Last year already some models were brought to that point, but a lot of them still didn't reach it (see Year I, b, goal 2). This year the goal was to continue this process.
→ Partly achieved.
I managed to progress the models further than before, also employing a manual mass removal method called direct extension method (DEM) to post-process models further in their evolution (cf. Szécsi et al., 2022) that were too close to the so-called Eddington limit (cf. for example Agrawal et al., 2022); stars with luminosity at this value are outputting radiation in such an intensity that the pressure is too high to be counterbalanced by gravity, therefore disrupting the star. For stars that are close to that limit the computation of their evolution can become increasingly difficult, resulting in the code crashing.
In some cases the DEM could already remedy the problem. The rest still need to be converted properly in the beginning of the third year, but after that they should be ready to undergo the rest of the steps (see goals 3-5) as well.

3.) Finally after pushing the models until the end of core helium burning they should be converted into the BoOST format. This among other things (goal 4 and 5) includes the identification of Equivalent Evolutionary Points (EEPs) for all the models.
→ Partly achieved.
Just like in the original work in Szécsi et al. (2022) the EEPs are defined by certain criteria, as was described in Year I, project 1., b., Scientific Goal 3.
Out of the 336 models created, for around 110 the BoOST format was initiated (which will be covered in goal 4.). Still, quite a few of them had the suboptimal EEPs that still need correcting, only around 40 are in a state that seem representative of the actual evolution of the raw data. This is because the process of assigning the EEPs is streamlined for a normal evolution and a chemically homogeneous evolution (cf. Year I, end of b.), but not automatically recognizing each, so at the moment the switch needs to be done by hand. In the future (Year III) it is a goal to assign these processes automatically by

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reading the data output.

4.) For those models that both finished the evolution until the point of core helium exhaustion (see goal 2), the subset of models that also showed the correct choice of EEPs (see goal 3) was ready to be converted into the filtered format. This meant that the EEPs were used to filter unnecessary data in-between these points and converting the output into easy-to-read data tables.
The same length for each section of the evolution between two EEPs was chosen as in Szécsi et al. (2022) (see also Year I, b., 3.).
→ Successfully achieved.
The subset of models with successful identification of all EEPs showed that there are multiple models properly displaying the evolution of the model in the filtered BoOST format. However, at the moment there are not enough models at this point to do continue with the interpolation (see goal 5), so pushing the models further (see also goals 2 and 3) is a necessary step still needed to be completed in Year III.

5.) Finally after converting the models into the filtered format, they can be used for interpolation to create dense grids. With this the changes in the output with respect to the input parameters can be described with a much better resolution.
→ In progress.
At the moment not enough models have been converted to the filtered format to enable a proper interpolation. This remains a goal for next year.

Once the models are fully ready, I plan to use them with WINDCALC (see project 2) to investigate globular cluster abundance anomalies (cf. for example Bastian & Lardo, 2018) in Year III and IV. While the modeling is still in progress, I already started to learn the details of WINDCALC in the collaboration with Dr. Richard Wünsch. This is described in the following section.

Project 2: Investigating the winds of stellar populations with varying wind descriptions:

a. Description of methodological assumptions and obtained research results/artistic achievements, including indication and justification of changes in planned research or artistic activities and methodological assumptions:

As part of my collaboration with Dr. Richard Wünsch (Astronomical Institute of the Czech Academy of Sciences, Boční II 1401/1, 140 00 Prague, Czech Republic) I visited Prague and worked on my international reputation as a researcher.
This internship aimed to provide insight into the WINDCALC code (cf. Wünsch et al., 2017) that will be used later on in my PhD to analyze the cluster winds of synthetic populations based on my own models (from Project 1, as a goal for Year III), similar to the work of Szécsi & Wünsch (2019), as well as improving the code and doing a parameter study to investigate optimal settings for a scenario like the one I will apply in the future, which lead to a full-on second project with the potential for publication.

b. Status of implementation of organizational undertakings and research/artistic tasks included in the project schedule:

Scientific Goals:

1.) I was already familiar with the original BoOST model grids, but I needed to understand how they are integrated into the WINDCALC code. I got the raw models from the Bonn Code (the basis of the published data of Szécsi et al., 2022) and needed to convert them into this BoOST format. For that I needed to identify the EEPs (see Project 1).
→ Successfully achieved.
As the models used in this project are the same as in Szécsi et al. (2022), the choice of EEPs with their criteria is easier than in project 1. This means that there were no models where the EEPs weren't identified correctly. The format conversion happened without any issues.

2.) After identifying the EEPs, they are used to filter the data to get easy-to-use data tables.
→ Successfully achieved.
Identifying the EEPs and filtering the data allowed the creation of data tables with 608 lines for each model (i.e. the BoOST format).

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3.) In the next step, the models are also used to interpolate to achieve fine grids.
→ Successfully achieved.
The interpolation worked without a problem, resulting in fine grids covering all masses from the original models with interpolated ones with steps of roughly 0.02 solar masses.

4.) One of the main goals was to learn more about the WINDCALC code. I not only got a much deeper understanding of how the code works, but was also able to help improve it by adding multiple wind velocity recipes to it to enable a more flexible handling of the data, depending on the requirements of the user.
→ Successfully achieved.
I updated the WINDCALC code with new wind velocity formulas and verified the validity of their results. This included an extensive literature study on the topic and an implementation of 4 entirely new wind formulas for different spectral types (cf. Lamers et al., 1995; Krtička et al., 2021; Sander & Vink, 2022; Howarth & Prinja, 1989; and Prinja et al., 1990) and a rewrite of the old code to facilitate the easy choice of these (and also old) formulas depending on the need.
It also included the addition of a module allowing the free choice of metallicity scaling for separate spectral types, the updating of the parser of the code to improve the help section of the code, and the use of the git structure of the project to create a new main version of the code, integrating my changes in a way that is professional from a software and data management point of view. Especially in this last point the git course from Year I was a big aid to successfully navigate the system.

5.) I am currently using this new and improved code to investigate optimal parameters (like the choice of Wolf-Rayet (WR, a certain type of hot star with high helium abundances at the surface and peculiar winds) star wind prescriptions, cf. Sander & Vink, 2022, or which IMF to choose, cf. for example Kroupa, 2001) to apply in population synthesis, so that I can use them for the population (based on my own models, cf. Project 1 in Year I and II) in the future, and this investigation is publishable and currently prepared for submission to a journal.
→ Successfully achieved.
The internship resulted in the creation of populations based on the original raw models that were the basis of Szécsi et al. (2022), utilizing varying wind velocity formulas for comparison.
Applying the wind prescriptions from Sander & Vink (2022) showed that Wolf-Rayet stars could have a much higher influence on the cluster winds than anticipated, which could result in more mass accumulated for a second generation of stars (cf. Year I, Project description and motivation). The consequences of this on the chemical composition of the forming cluster-stars need to be assessed in Year III and IV.
On top of that it highlighted that a prescription (cf. Howarth & Prinja, 1989) used in another well-known code called starburst99 (cf. Leitherer et al., 1999) only provides results in agreement with the other prescriptions if the top mass of the population is not chosen too high. If one exceeds roughly 100 solar masses as top mass, it results in much more cluster winds than in the case of other comparable prescriptions. More cluster winds could lead to more mass accumulated (although it has to be compared to the critical winds at which point clumps in the cluster start to form), which would lead a researcher using starbust99 to assume that their population results in much more mass for a second generation in the cluster than possibly is physical (based on comparison to other codes).
Since this is a popular code, pointing out its possible limits and how they relate to other codes is useful in the future when creating populations with models from starburst99.

6.) The results of the project need to be formulated and organized in a complete paper draft that can then be submitted to a respectable journal.
→ Initiated.
Although publishable results were already created (cf. goal 5), the organization and formulation is still in initiation.

References (in order of appearance):

[1] D. Szécsi, P. Agrawal, R. Wünsch, and N. Langer, “Bonn Optimized Stellar Tracks (BoOST) - Simulated populations of massive and very massive stars for astrophysical applications”, *Astronomy & Astrophysics*, vol. 658, 2022, doi:10.1051/0004-6361/202141536

[2] P. Agrawal, D. Szécsi, S. Stevenson, J. J. Eldridge, and J. Hurley, “Explaining the differences in massive star models from various simulations”, *Monthly Notices of the Royal Astronomical Society*, vol. 512, no. 4, OUP, pp. 5717-5725, 2022. doi:10.1093/mnras/stac930.

[3] N. Bastian, and C. Lardo, “Multiple Stellar Populations in Globular Clusters”, *Annual Review of Astronomy and*

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Astrophysics, vol. 56, pp. 83-136, 2018. doi:10.1146/annurev-astro-081817-051839

[4] R. Wünsch, J. Palouš, G. Tenorio-Tagle, and S. Ehlerová, "The formation of secondary stellar generations in massive young star clusters from rapidly cooling shocked stellar winds", *The Astrophysical Journal*, vol. 835, no. 1, 2017, doi:10.3847/1538-4357/835/1/60

[5] D. Szécsi and R. Wünsch, "Role of Supergiants in the Formation of Globular Clusters", *The Astrophysical Journal*, vol. 871, January 2019, p. 20, doi:10.3847/1538-4357/aaf4be

[6] H. J. G. L. M. Lamers, T. P. Snow and D. M. Lindholm, "Terminal Velocities and the Bistability of Stellar Winds", *The Astrophysical Journal*, vol. 455, IOP, p. 269, 1995. doi:10.1086/176575.

[7] J. Krtička, J. Kubát, and I. Krtičková, "New mass-loss rates of B supergiants from global wind models", *Astronomy & Astrophysics*, vol. 647, March 2021, doi:10.1051/0004-6361/202039900

[8] A. A. C. Sander and J. S. Vink, "On the nature of massive helium star winds and Wolf-Rayet-type mass-loss", *Monthly Notices of the Royal Astronomical Society*, vol. 499, Issue 1, November 2020, Pages 873-892, https://doi.org/10.1093/mnras/staa2712

[9] I. D. Howarth and R. K. Prinja, "The Stellar Winds of 203 Galactic O Stars: A Quantitative Ultraviolet Survey", *The Astrophysical Journal Supplement Series*, vol. 69, IOP, p. 527, 1989. doi:10.1086/191321.

[10] R. K. Prinja, M. J. Barlow, and I. D. Howarth, "Terminal Velocities for a Large Sample of O Stars, B Supergiants, and Wolf-Rayet Stars", *The Astrophysical Journal*, vol. 361, IOP, p. 607, 1990. doi:10.1086/169224

[11] P. Kroupa, "On the variation of the initial mass function", *Monthly Notices of the Royal Astronomical Society*, vol. 322, pp. 231-246, 2001, doi:10.1046/j.1365-8711.2001.04022.x

[12] C. Leitherer, D. Schaerer, J. D. Goldader, R. M. G. Delgado, C. Robert, D. F. Kune, D. F. de Mello, D. Devost, and T. M. Heckman, "Starburst99: Synthesis Models for Galaxies with Active Star Formation", The Astrophysical Journal Supplement Series, vol. 123, no. 1, IOP, pp. 3-40, 1999, doi:10.1086/313233

c. Information on submitted research applications:

Not applicable

d. Information on participation in scientific conferences, seminars or workshops, including the name, place and date as well as the nature of participation (organizer/participant) and the form of presentation of the results (poster, report, paper):

Conference name: EAS annual meeting 2024 (certification handed in at UMK, but not accounted for in USOS yet)
Date: 01 - 05 July 2024
Type of participation: Poster presentation (Title: Abundance Anomalies in Globular Clusters and their Possible Origin in Multiple Generations Including Massive Stars)
Link to Poster: https://k-poster.kuoni-congress.info/eas-2024/gallery#/poster/3554b366-c514-495e-a8d8-8cb39b8dbe5d
Venue: Padova Congress – Centro Congressi – Fiera di Padova, Via N. Tommaseo 59, 35131 Padova, Italy
Participant, Presenter

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Conference Name: Annual meeting of Astronomische Gesellschaft / German Astronomical Society: Star formation across cosmic time
Date: 13 September 2024 (upcoming)
Type of participation: Invited Talk (Title: Massive stars in low-metallicity environments: A closer look) as Co-Author, not Presenter
Link to Conference Website:
https://ag2024.astronomische-gesellschaft.de/view_abstract.php?id=137
Venue: University of Cologne, Cologne, Germany
Co-Author

Conference Name: International Conference on Gravitation and Cosmology
Date: 30 January 2024
Type of Participation: Invited Talk (Title: Progenitors of LGRBs: Are single stars enough?) as Co-Author, not Presenter
Link to Poster:
https://rafia-s.github.io/R.Sarwar/pdf_files/ICG_Pakistan_rafia_sarwar.pdf
Venue:
Department of Mathematics and Statistics, the University of Lahore, Lahore, Pakistan
Co-Author

e. Information on cooperation with domestic or foreign scientific institutions:

- Visiting the group of Norbert Langer in Bonn, Germany, from 26-30 February, included holding a presentation on my work, discussing possible cooperation for the future with the group members (especially PhD students and postdocs) and proposing usage of my models for their projects.
My presentation slides can be found here (the length of the presentation means it makes more sense to give the link than attach the whole presentation to this report):
https://astro.umk.pl/~hanno/Hanno/presentations/seminars_conferences_workshops_internships/002_Presentation_Workshop_Bonn_HannoStinshoff.pdf

- While being on the internship in Prague (also cf. Project 2 description and also point 3 below), I held a seminar talk there on 8 may with many of the researchers of the institute attending. I described my current projects and how they are linked to my stay in Prague, answering questions like the exact choices of IMF or which version of the code was used.
I also regularly participated in Journal Clubs and Group meetings.
I helped improve the WINDCALC code by adding more wind velocity prescriptions and restructuring the code, and provided insight for my cooperators on the models that I produce, explaining what masses, velocities and metallicities they cover, how they can be applied to the WINDCALC code and why the Bonn Code was used to create the models.
My presentation slides can be found here (the length of the presentation means it makes more sense to give the link than attach the whole presentation to this report):
https://astro.umk.pl/~hanno/Hanno/presentations/seminars_conferences_workshops_internships/003_Presentation_Internship_Prague_HannoStinshoff.pdf

f. Information on Apprenticeships:

Not applicable

g. Information on classes completed as part of the educational plan:

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Name of the course: Applied Data Analysis and Statistics
Course code on USOS: 7405-AC-ADAS-1
Form of classes: Discussion Seminar
Final grade: 5
Number of hours: 50 hours
Number of ECTS points: 2 ECTS credits

Name of the course: Scientific Data Presentation and Copyright I
Course code on USOS: 7405-AC-SDPC1-1
Form of classes: Discussion Seminar
Final grade: 5
Number of hours: 10 hours
Number of ECTS points: 1 ECTS credits

Name of the course: Successful Grant Application
Course code on USOS: 7405-AC-SGA-1
Form of classes: Discussion Seminar
Final grade: 4.5
Number of hours: 10 hours
Number of ECTS points: 1 ECTS credits

Name of the course: Supervisory Mentoring
Course code on USOS: 7405-AC-SMEN-1
Form of classes: Supervisory Mentoring
Final grade: 5
Number of hours: -
Number of ECTS points: 4 ECTS credits

Name of the course: Scientific Methodology
Course code on USOS: 7405-AC-SM-1
Form of classes: Discussion Seminar
Final grade: 5
Number of hours: 30 hours
Number of ECTS points: 3 ECTS credits

Name of the course: Gravitational Waves Progenitors
Course code on USOS: 7404-WA-PFG
Form of classes: Course
Final grade: 5
Number of hours: 30 hours
Number of ECTS points: 3 ECTS credits

Name of the course: Occupational Safety, Health and Ergonomics
Course code on USOS: 9001-BHP-5-SD
Form of classes: Tutorial
Final grade: ZAL
Number of hours: 5 hours

2. List of scientific papers (included in the list of scientific journals and peer-reviewed materials from international conferences of the Ministry of Higher Education and Science), which were written during the education at the Academia Copernicana Interdisciplinary Doctoral School

In preparation.

3. A list of research/artistic internships in external scientific centers, especially abroad, in which the doctoral student actively participated, i.e. conducted research or presented its results. The list should be accompanied by appropriate documentation and certificates

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Name of the internship: „Learning the application of WINDCALC code and investigating the winds of populations with various initial parameters"
Institution, Place: Astronomický ústav AV ČR, Boční II 1401, 141 00 Praha 4, Czech Republic
Date: 15.4. - 15.5.2024
Number of hours: 160 hours (1 month)
Description: I analyzed synthetic populations based on stellar evolutionary models created with the so-called Bonn Code by using the WINDCALC code created by Dr. Richard Wünsch, who was my supervisor during this internship. For more details refer to Project 2 in the description.

4. A list of applications submitted by the doctoral student in competitions of the university or to external entities for funding of foreign travel or research/artistic activities. A copy of the sent applications and relevant decisions should be submitted as documentation

I successfully applied for funding from UMK AC ISD regarding my internship in Prague (see section "e. foreign scientific institutions"). I attached the application and also the mailed confirmation of the funding to this document.

The research of the student in question is covered by the National Science Center (NCN), Poland under grant No. OPUS 2021/41/B/ST9/00757. There is no need for the application for a research grant anymore.

5. A list of classes or workshops carried out outside the compulsory study plan that contributed to the development of the doctoral student's soft skills. The list should be accompanied by relevant documentation

Listed at section (1.d)

6. Opinion of the supervisor(s) on the progress of the doctoral student in preparing the dissertation

Sent by Dr. hab. Dorottya Szécsi, the supervisor of my PhD project, directly to the school.

7. It is possible to submit additional opinions (maximum two) on the PhD student, prepared by scholars from other research centers, especially foreign, involved in the research conducted by the PhD student

Sent by Dr. Richard Wünsch, the supervisor of my internship in Prague, directly to the school.

8. Other scholarly or artistic/conservation achievements and activities not directly related to IRP. Completion of this point is optional.

I taught a lecture in the following course:
Name of the course: Gravitational Waves Progenitors
Course code on USOS: 7404-WA-PFG
Form of classes: Course
Number of hours: 2 hours
Link to presentation: https://astro.umk.pl/~hanno/Hanno/presentations/Lectures/001_GWprog-Class5_HannoStinshoff.odp
Note: As I had already attended the lecture two years prior without being able to do the exam due to not being enlisted in UMK yet, and because the topic of the lecture was exactly what I am working on in my PhD, I not only attended the biggest part of the lecture as a student (cf. The section "g. Information on classes"), but I also took part as a teaching assistant by holding a two-hour lecture for the other students on a subject that I am especially familiar with, and by attending some exams of other students, including asking exam questions I needed to come up with on my own.

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I continued to maintain the website of our group, making sure that it stays presentable, like e.g. keeping track of changes in group membership or continuing to improve the display of the Journal Club Presentation list.

I also continued to participate in the Journal Club of our Group for massive stars, regularly presenting papers for the other members and contributing in the other weeks with questions and discussions about the topics of the week. In Year II I held up till now six presentations, including topics on extended Main Sequences and Main Sequence Turn-Offs and New Mass-loss recipes for B supergiants and also for WR stars (on two separate occasions).
The presentations I held can be viewed on my website on:
https://astro.umk.pl/~hanno/Hanno/03Publications.html

Our group visited Norbert Langer's Group in Bonn, Germany, as part of a collaboration/exchange of ideas, because they also work closely with massive stars. It included presentation of my own work, interacting with other researchers on their and my work and thinking of future ways of collaboration (also mentioned at section "e. foreign scientific institutions").

……..…06.09.2024……
Date

…… ……. ……..
PhD student's signature | Supervisor's signature | Signature of the Head of ISD AC

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HANNO STINSHOFF

Physicist

02 Dec 1992, Marl
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STRENGTHS

Passion | Diligence | Humor | Versatility

ASSETS

Drivers Licence B

Fluent typing | Windows | Windows Office | Beginner in Debian

LANGUAGES

German: Native

English: Advanced / B2-C1

Python, R, LaTeX: Beginner-Intermediate / A2-B1

REFERENCES

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Ref 2
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Supervisor of phd
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Toruń, Poland
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Ref 3
Dr. Dorottya Szécsi
Supervisor of master thesis
Supervisor of phd
MCU
Toruń, Poland
dorottya.szecsi@gmail.com

ABOUT ME

"I am versatile and passionate for many different topics, so if you have my CV on your desk, I am what you're looking for."

EXPERIENCE

Research Assistant: Lab Instructor | University of Cologne

08 2015 – 10 2019 — Cologne, Germany

- Lab Instructor for Mechanics
- Social Skills, leading/instructing
- various physical experiments concerning mechanics

EDUCATION

- | Primary School

08 1999 – 12 1999/01 2000 – 07 2002 — Herten/Recklinghausen, Germany

- GPA: -

GCE | High School

08 2002 – 07 2011 — Recklinghausen, Germany

- GPA: 1.9

Bachelor of Science | University of Cologne

10 2012 – 03 2017 — Cologne, Germany

- GPA: 2.3 topic: *See paragraph **Theses***

Master of Science | University of Cologne

04 2017 – 03 2022 — Cologne, Germany

- GPA: 1.3 topic: *See paragraph **Theses***

phd | Nicolaus Copernicus University

09 2022 – tbd — Toruń, Poland

- GPA: - topic: *Expanding the BoOST massive star models to explain the formation of globular clusters*

THESES

Bachelor

08 2016 – 03 2017

- Gamma-Analysis of the Fusion-Evaporation reaction of ^{12}C on ^{208}Pb near the coulomb-border

Master

09 2020 – 03 2022

- Stellar evolution through cosmic ages: Extending the BoOST stellar model grids

My current research

Massive and very massive stars play important roles in stellar populations. In particular, they may be responsible for the formation of globular clusters, including the notorious multiple population phenomenon.
Anomalous light element ratios have been observed in almost all globular clusters, ratios that can only be synthesized deep inside massive or intermediate-mass stars where the temperature is high enough.
As shown by Szécsi et al. (2018[1],2019[2]), metal-poor massive stars (and especially luminous supergiants) may play a crucial role in this process. These investigations relied on a simple set of evolutionary models now published in the form of the BoOST project [Szécsi et al. (2022)[3]].
To study further details of this scenario, new evolutionary models with a **wide range in metallicities and rotational rates** should be computed and analysed. Expanding the BoOST models and applying them in globular cluster research via the cluster evolution code 'WINDCALC' (presented in Szécsi, Wünsch (2019)[2]) is therefore the goal of this project.

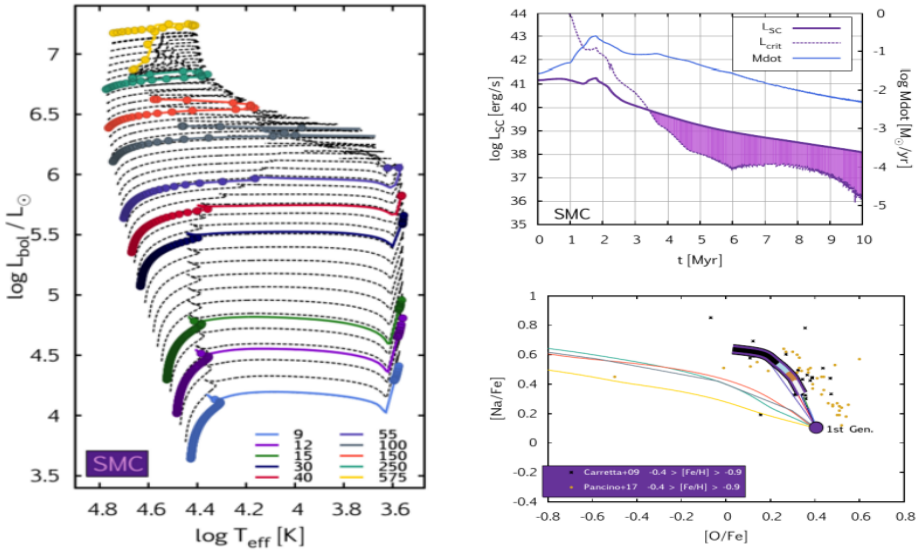

Figure 1: Example figures from the BoOST project [Szécsi et al. (2022)[3]]. I am working on creating those for my models as well. Left: Hertzsprung-Russle diagrams of smc-metallicity population. Color codes indicate the masses, with dots marking time steps of 10^5 yrs and dashed lines interpolated tracks. Top Right: Cluster luminosity evolution over time of the population on the left. Matter accumulation is indicated by the shaded region. Bottom Right: Showcase of the Na-O anticorrelation in the models (lines), WINDCALC predictions (stripes) and observations (dots).

My current research includes the **creation and maintenance of these stellar evolution models** of massive and very massive stars with various initial compositions and rotational velocities. This is done with the Bonn-Code, because it makes use of an extensive nuclear reaction network that is beneficial for the subsequent research planned for these models.

Currently several models reached the end of core-helium burning, while others are still running to finish the main sequence phase due to their closeness to the Eddington limit. I plan to remedy this in the future by means of manually removing mass off the top layers.

Once the models have all reached the end of core-helium burning, I can create **synthetic populations** with them, which can then be used to investigate the metallicity-dependency of the cluster-formation process mentioned in [Szécsi,Wünsch (2019)[2]]. A similar routine was applied there for the original models from the BoOST project [Szécsi et al. (2022)[3], see fig. 1], so the same treatment for my models with extended rotational velocity variation is the logical next step.

The models are implemented in the WINDCALC code to follow the thermodynamical behaviour of the cluster-wind. This then enables for example the investigation of the **origin of lithium in some observed globular clusters**.

[1] D. Szécsi, J. Mackey, and N. Langer. A&A, 612:A55, April 2018.
[2] D. Szécsi and R. Wünsch. ApJ, Vol. 871, nr. 1, 2019.
[3] Dorottya Szécsi, Poojan Agrawal, Richard Wünsch, and Norbert Langer. A&A, 658:A125, February 2022

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87-100 Torun
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https://wwwold.astro.umk.pl/~hanno/Hanno/

February 13, 2023

To whom it may concern,

I'm writing you today to express my interest in the Kavli Summer School Program in Astrophysics 2023. I am a first-year PhD student at the Nicolaus Copernicus University in Toruń, Poland, working under the supervision of **Dr. Dorottya Szécsi**.

I am interested in the school because it deeply intersects with my field of research. When working on my master's thesis (Find it here on my webpage), I had started to create grids of models for massive stars with various initial compositions and rotational velocities to **extend the BoOST stellar model grids** (cf. [Szécsi, Agrawal, Wünsch, Langer (2022) A&A]) using the Bonn code. Whereas the original work had established grids for multiple metallicities, I expanded on it by adding a variation in rotational velocities, which resulted in the current grids with roughly 330 models.

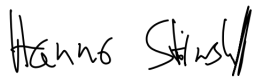
Even though they are now still undergoing development as they are progressing through the main sequence and the beginning of helium burning, I could already show that the phenomenon of chemically homogeneous evolution is clearly visible in some of my models and that a dependency on my input parameters can be established.
The models also show cool, core-hydrogen-burning supergiants similarly to what was already shown for low rotational velocities in the original BoOST paper.

Once they have reached core-helium-burning, I am applying those models in the investigation of **abundance anomalies in globular clusters**, using the scenario established in [Szécsi, Wünsch (2019) ApJ], but there are other applications as well: They provide a great basis for investigation on other feedback processes and can also be used to research **gravitational waves** or **gamma ray bursts** with population synthesis.
Apart from gaining and sharing knowledge, I hope to meet a lot of people from this area of research to make connections. Having specialization-specific contacts is important for a young researcher like myself, and this summer school will bring together the very people I need in my network to further possible opportunities of future collaboration.

I am an attractive choice for participation in this school, both because of my close connection to the topic itself and because of my passion for learning and discussing new things. I am always eager to broaden my horizon and to seize any opportunity for improvement. I am also looking forward to work on the ensuing project after the initial conference phase. Not only do I as a relatively new researcher need more publications, which I am positive the project would lead to, but I also really like the prospect of working with different people and getting new ideas in the research field to broaden my perspective on it.

I hope you will consider my application. I look forward to your answer.

Yours Sincerely



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Max Planck Institute for Astrophysics

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MAX-PLANCK-INSTITUT
FÜR ASTROPHYSIK

To whom it may concern

We hereby confirm that **Hanno Stinshoff** participated in the VFTS meeting which took place from 27-29 March 2023 in Garching, Germany.

Garching, March 27, 2023

The LOC

Max-Planck-Institut für Astrophysik
Garching

CERTIFICATE OF ATTENDANCE

THIS IS TO CERTIFY THAT

Mr Hanno Nicolas Stinshoff

ATTENDED THE

**EUROPEAN ASTRONOMICAL SOCIETY ANNUAL MEETING
HELD IN ICE KRAKOW CONFERENCE CENTRE, POLAND,
FROM JULY 10TH TO 14TH, 2023**

Chair of the
Hosting Committee

Dorota Kozieł-Wierzbowska

Co-Chair of the
Scientific Organising Committee

Agnieszka Pollo

Co-Chair of the
Scientific Organising Committee

Stanisław Zoła

CERTIFICATE OF CONTRIBUTION

THIS IS TO CERTIFY THAT

Mr Hanno Nicolas Stinshoff

PRESENTED A/AN

ePoster

ENTITLED

New stellar evolutionary models of massive stars with rotation: Expanding the BoOST project

AT THE

EUROPEAN ASTRONOMICAL SOCIETY ANNUAL MEETING
HELD IN ICE KRAKOW CONFERENCE CENTRE, POLAND,
FROM JULY 10TH TO 14TH, 2023

Co-Chair of the Scientific Organising Committee
Agnieszka Pollo

Co-Chair of the Scientific Organising Committee
Stanisław Zoła

PPNT

Poznan Science
and Technology Park

CERTIFICATE

of participation in the workshop

for

Mr. Hanno Stinshoff

Public speaking and investor pitching
16.-17.11.2022 (12 teaching hours)

Niedzielski

Roman Niedzielski
Coach

Wujewski

Michał Wujewski
Coach

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UNIVERSITY
IN TORUŃ

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TOPICAL REVIEW • OPEN ACCESS

Bringing Stellar Evolution and Feedback Together: Summary of Proposals from the Lorentz Center Workshop

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Abstract

Stars strongly impact their environment, and shape structures on all scales throughout the universe, in a process known as "feedback." Due to the complexity of both stellar evolution and the physics of larger astrophysical structures, there remain many unanswered questions about how feedback operates and what we can learn about stars by studying their imprint on the wider universe. In this white paper, we summarize discussions from the Lorentz Center meeting "Bringing Stellar Evolution and Feedback Together" in 2022 April and identify key areas where further dialog can bring about radical changes in how we view the relationship between stars and the universe they live in.

EUROPEAN ASTRONOMICAL SOCIETY

ANNUAL MEETING

PADOVA CONGRESS, ITALY

JULY 1ST - 5TH

eas 2024 Padova

CERTIFICATE OF ATTENDANCE

THIS IS TO CERTIFY THAT

Mr Hanno Stinshoff

ATTENDED THE

**EUROPEAN ASTRONOMICAL SOCIETY ANNUAL MEETING
HELD IN PADOVA CONGRESS, ITALY,
FROM JULY 1ST TO 5TH, 2024**

Co-Chair of the Hosting Committee	Co-Chair of the Hosting Committee	Co-Chair of the Hosting Committee	Co-Chair of the Scientific Organising Committee	Co-Chair of the Scientific Organising Committee
Simone Zaggia	Alessia Morretti	Marco Gullieuszik	Bianca Poggianti	Giuseppina Micela

EUROPEAN ASTRONOMICAL SOCIETY
ANNUAL MEETING

PADOVA CONGRESS
ITALY
JULY 1ST - 5TH

eas 2024 Padova

CERTIFICATE OF CONTRIBUTION

THIS IS TO CERTIFY THAT

Mr Hanno Stinshoff

PRESENTED A/AN

ePoster

ENTITLED

Abundance anomalies in globular clusters and their possible origin in multiple generations including massive stars

AT THE

EUROPEAN ASTRONOMICAL SOCIETY ANNUAL MEETING
HELD AT PADOVA CONGRESS, ITALY,
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DOHODA O PODMÍNKÁCH KRÁTKODOBÉ NÁVŠTĚVY ZAHRANIČNÍHO HOSTA A ÚHRADĚ SOUVISEJÍCÍCH NÁKLADŮ

(dále jen „**Dohoda**")

uzavřená ve smyslu ustanovení § 1746 odst. 2 zákona č. 89/2012 Sb., občanský zákoník, ve znění pozdějších předpisů (dále jen „**Občanský zákoník**") mezi stranami této Dohody, kterými jsou

Astronomický ústav AV ČR, v. v. i.,
Se sídlem Fričova 298, 251 65 Ondřejov,
IČO: 67985815,
Zapsaný do rejstříku veřejných výzkumných institucí dne 1. 1. 2007,
Zastoupený ředitelem Mgr. Michal Bursa, Ph.D.
(dále jen „**ASU**")

a

Host / Guest [jméno a příjmení / name and surname]:

bytem / residing at [trvalá adresa / permanent address]:

datum narození / born on [datum / date]:

státní občanství / citizenship: [•]:

(dále jen „**Host**")
(ASU a Host dále společně též jen „**Smluvní strany**")

AGREEMENT ON CONDITIONS OF SHORT-TERM VISIT OF FOREIGN GUEST AND RELATED EXPENSES REIMBURSEMENT

(hereinafter as the "**Agreement**")

Entered into in compliance with Section 1746, subsection 2 of the Act no. 89/2012 Coll., the Civil Code, as amended, (hereinafter as the "**Civil Code**") by and between the following parties

Astronomický ústav AV ČR, v. v. i.,
With its registered office at Fričova 298, 251 65 Ondřejov,
Id. No.: 67985815,
Inscribed in the register of public research institutions on 1 January 2007,
Represented by the director Mgr. Michal Bursa, Ph.D.
(hereinafter as the "**Institute**")

and

Hanno Stinshoff

Adama Mickiewicza 6/8, 87-100 Toruń, Poland

02.12.1992

German

(hereinafter as the "**Guest**")

(The Institute and the Guest together also referred to as the "**Contractual Parties**")

Čl. 1
Úvodní ustanovení

1.1. Předmětem této Dohody je úprava podmínek krátkodobé návštěvy Hosta na pracovišti ASU a úhrady souvisejících nákladů.

1.2. Návštěva hosta dle této Dohody je realizována na základě (označte variantu):

- ☒ dvoustranné vědecké spolupráce ústavu /
- ☐ meziakademické dohody AV ČR /
- ☐ jiné formy mezinárodní spolupráce /

1.3. Návštěva Hosta na pracovišti ASU bude probíhat v termínu

od / from 15 / 4 / 2024 do / to 15 / 5 / 2024

1.4. Základní parametry návštěvy Hosta jsou stanoveny v Návrhovém listu ASU (formuláři nazvaný „Přijetí hosta ze zahraničí"). ASU v okamžiku podpisu formuláře (Návrhového listu) příslušnými osobami ustanoví průvodce Hosta z řad zaměstnanců, který zodpovídá za celkový průběh pobytu Hosta v prostorách ASU.

1.5. Pokud je Hostovi poskytnuto finanční plnění ASU, je Host povinen během svého pobytu vyplnit a před ukončením své návštěvy předložit ASU formulář nazvaný „Vyúčtování pobytu zahraničního hosta".

Art. 1
Introductory Provisions

1.1. This Agreement regulates the conditions of short-term visit of the Guest at the Institute´s workplace and reimbursement of expenses related therewith.

1.2. The visit of the Guest pursuant to this Agreement is carried out based on (indicate the choice):

bilateral scientific cooperation of the Institute,

Inter-Academy cooperation of the Czech Academy of Sciences,

another form of international cooperation:

_____

1.3. The visit of the Guest at the Institute shall take place in a period

do / to _____ 15 / 5 / 2024 _____

1.4. The basic parameters of the Guest´s visit are set down in a Proposal list (a form called "Acceptance of foreign guest"). The Institute shall appoint a guide from among the employees while signing the form (Proposal list) by the respective persons. The guide is responsible for a course of entire stay of the Guest in the premises of the Institute.

1.5. If the Institutes financially contributes to the The Guest, the Guest is obliged to fill in and before the end of his/her visit submit a form called "Settlement of foreign guest stay".

Čl. 2
Úhrada nákladů

2.1. Smluvní strany se dohodly, že ASU uhradí Hostovi náklady uvedené v čl. 2. odst. 3 této Dohody na základě podpisu této Dohody. Cestovné, náklady na ubytování a případné další náklady ASU hradí na základě podpisu formuláře „Vyúčtování pobytu zahraničního hosta" během jeho pobytu na ASU poté, kdy Host předloží potřebné doklady prokazující výši skutečně realizovaných a odůvodněných nákladů.

2.2. Náklady ASU k pokrytí výdajů souvisejících s přijetím hosta jsou finančně zajištěny ze zdroje uvedeného v Návrhovém listu v souladu s čl. 1.6. směrnice ASU o přijímání zahraničních hostů.

2.3. Smluvní strany se dohodly, že ASU Hostovi uhradí následující náklady (označte variantu):

- ❑ Cestovné do České republiky a zpět v prokázané výši, v maximální částce dle Návrhového listu ASU.
- ❑ Stravné ve výši a za podmínek uvedených v tabulce Akademie věd České republiky obsahující výši stravného a kapesného pro zahraniční hosty v závislosti na délce jejich pobytu, která je k dispozici k nahlédnutí u referentky zahraničních styků ASU.

Art. 2
Expenses Reimbursement

2.1. The Contractual Parties have agreed that the Institute shall reimburse the expenses stated in Art. 2 sec. 3 hereof to the Guest based on this Agreement. Travel expenses, accommodation expenses and other possible expenses are reimbursed based on signing the form called "Settlement of foreign guest stay" during his/her stay at the Institute and upon submission of relevant documents proving the amount of truly and reasonably incurred expenses by the Guest.

2.2. The expenses of the Institute incurred in order to cover the expenses related to receiving the Guest are financially covered from a source stated in the Proposal list in compliance with Art. 1.6. of direction of the Institute on receiving the foreign guests.

2.3. The Contractual Parties agree that the Institute shall reimburse the following expenses to the Guest: (indicate the choice):

- ❑ Travel expenses to the Czech Republic and back in the proven maximum amount stated in the Proposal list of the Institute.
- ❑ Food allowance in the amount and under conditions stated in a table of the Czech Academy of Sciences containing the amount of food allowance and pocket money for foreign guests depending on the period of their stay, which is accessible at the office of the Institute´s foreign affairs officer.

❑ Ubytování v dohodnuté lokalitě a v prokázané výši v maximální částce dle Návrhového listu.

❑ Další níže uvedené náklady ve výši prokázané dle čl. 2.1. této Dohody dle Návrhového listu.

Poznámky a upřesnění:

_____

_____.

❑ Accommodation in the agreed locality and in the proven maximum amount stated in the Proposal list.

❑ Another below-mentioned expenses in the amount proven in compliance with the Art. 2.1. hereof and pursuant to the Proposal list.

Notes and specifications:

_____

_____.

Čl. 3
Prohlášení smluvních stran

3.1. Smluvní strany tímto prohlašují, že v průběhu návštěvy a provádění činnosti Hosta na pracovišti ASU nedochází k výkonu závislé činnosti ani ke vzniku pracovního poměru mezi ASU a Hostem. Činnost Hosta je vykonávána bez nároku na odměnu.

3.2. Host tímto prohlašuje, že odpovídá za splnění svých vízových a dalších případných povinností spojených s jeho pobytem na území České republiky a za uzavření cestovního pojištění.

3.3. Host tímto čestně prohlašuje, že je daňovým rezidentem:

Polska

a odpovídá za splnění svých daňových povinností vyplývajících z této Dohody.

Art. 3
Declarations of Contractual Parties

3.1. The Contractual Parties hereby declare that neither dependent work nor the employment relationship is created between the Institute and the Guest during the visit and performing the activity by the Guest. The Guest performs the activity without a right to remuneration.

3.2. The Guest hereby declares that he/she is responsible for fulfilment of his/her visa obligations and other possible obligations related to the stay in the Czech Republic and that he/she is responsible for conclusion of travel insurance.

3.3. The Guest hereby declares that he/she is a tax resident of

and is responsible for fulfilment of his/her tax obligations arising from this Agreement.

3.4. ASU prohlašuje, že Host bude po jeho příjezdu na pracoviště ASU seznámen s pravidly bezpečnosti a ochrany zdraví při práci.

3.5. Pro vyloučení pochybností Host prohlašuje, že v průběhu svého pobytu odpovídá za veškeré věci ve vlastnictví Hosta a rovněž za případnou škodu způsobenou Hostem na věcech a zařízeních, které ASU Hostovi po dobu jeho pobytu na pracovišti ASU svěřil.

Čl. 4
Elektronická komunikace

4.1. Host bere na vědomí, že je při výkonu činnosti a ve vztahu k informacím a datům ASU oprávněn využívat pouze zabezpečené internetové připojení. Hostovi bude umožněn přístup k internetovému připojení ASU z jeho vlastního zařízení. Host je povinen bránit úniku e-mailů, informací a dat, s nimiž přijde v průběhu své návštěvy do styku, k neoprávněným osobám a chránit je před zveřejněním nebo neoprávněným přístupem. Host je povinen činit vše pro to, aby byla zachována důvěrnost komunikace a žádné informace nebyly zpřístupněny třetí osobě.

Čl. 5
Závěrečná ustanovení

5.1. Tato Dohoda je sepsána ve dvou vyhotoveních, z nichž každá ze Smluvních stran Dohody obdrží po jednom vyhotovení.

3.4. The Institute hereby declares that the Guest will be acquainted with the rules on occupational health and safety protection after his/her arrival at the workplace of the Institute.

3.5. In order to avoid any doubt, the Guest declares that he/she is responsible for all the items in his/her possession during the stay and he/she is also responsible for any damage caused by the Guest to any items and equipment he/she has been provided with by the Institute during the stay.

Art. 4
Electronical Communication

4.1. The Guest acknowledges, that he/she is obliged to use only secured internet connection in order to carry out the activity and also in connection with the data and information of the Institute. The access to the internet connection of the Institute will be provided to the Guest from his/her own equipment. The Guest is obliged to prevent the leakage of e-mails, information and data he/she come into contact with during the stay to the unauthorized persons and protect them against disclosure or unauthorized entry. The Guest is obliged to take all necessary measures in order to ensure a confidentiality of communication and prevent a disclosure of any information to a third person.

Art. 5
Final Provisions

5.1. This Agreement is concluded in two counterparts of which each Contractual Party shall obtain one.

5.2. Tato Dohoda se řídí obecně závaznými právními předpisy České republiky.

5.3. Tato Dohoda může být měněna pouze na základě vzestupně číslovaných písemných dodatků podepsaných oběma Smluvními stranami.

5.4. Tato Dohoda je sepsána v českém a anglickém jazyce. V případě rozporů mezi oběma jazykovými verzemi, platí verze v českém jazyce.

5.5. Smluvní strany tímto prohlašují, že si tuto Dohodu před jejím podpisem přečetly, že byla uzavřena po vzájemném projednání podle jejich pravé a svobodné vůle, určitě, vážně, srozumitelně, a nikoliv v tísni a na důkaz toho připojují své podpisy.

V / In Praze dne / on 15.4.2024

[Místo a datum / Place and date]

5.2. This Agreement is governed by the Czech law.

5.3. All changes and amendments to this Agreement shall be made only in the form of written and numbered amendments agreed upon and signed by both Contractual Parties.

5.4. This Agreement is drawn up in Czech and English language. Should there be any discrepancy between both language versions, the Czech version shall prevail.

5.5. The Contractual Parties hereby declare, that they have duly read this Agreement prior to its execution, the Agreement expresses their true and free will, it has been concluded seriously and comprehensibly, not in distress and in witness thereof, the Contractual Parties affix their signatures.

Hanno Stinka

[Host / Guest – podpis / signature]

M Bures

[Director of Institute or person authorized – podpis / signature]

NICOLAUS COPERNICUS
UNIVERSITY
IN TORUŃ

Academia Copernicana Interdisciplinary Doctoral School
1 Lwowska Street, 87-100 Toruń, Poland

……02.04.2004……..
date

ACADEMIA COPERNICANA FUNDING APPLICATION

Full name of a doctoral student ……Hanno Nicolas Stinshoff……

Year of study……..…second year……

E-mail ……..……hstinshoff@doktorant.umk.pl……

Name of supervisor(s)……Dr. Dorottya Szécsi, Prof. Michał Hanasz……

Scientific discipline……Astronomy……..

Requested amount[1]: ……1353 EUR……..

Purpose and justification[2] including the influence of a given activity/purchase (e.g. conference participation, publication, etc.) on the development of a PhD student and/or the implemented doctoral project

……I am taking part in an international internship in Prague, as I am supposed to do as part of the PhD programme. This will help me with my studies, as the internship will prepare me for the use of the tools necessary to analyze my results of the first step of my project. I am creating models of stars that will then be analyzed under the aspect of cluster winds, and the Program that I use for that (WINDCALC) is created by one of the supervisors of the internship. ……

During the one month-long stay in Prague from April 15 to May 15, I am planning to stay partly in an institute guest house offered by the host, and partly in an AirBnB. Additionally, my flixbus trip to Prague and back to Poland will be covered from the requested amount. ……

If the requested funding does not cover the full cost of the activity, please indicate the source which will complement the remaining amount

……NCN OPUS
2021/41/B/ST9/00757……
……
……

Supervisor's opinion and signature……
…I fully support Mr Stinshoff's internship plans. My opinion is that Prague is the best choice for this internship, as the supervisor, Dr. Richard Wünsch, is an internationally recognized expert in cluster wind dynamics, a topic Mr. Stinshoff needs to study and understand for his doctoral project. Additionally, he will learn useful coding skills and get more practice with how to apply the stellar models he has created with his simulations in the first year of his PhD. To summarize, this internship is crucial for Mr. Stinshoff to write a successful doctoral thesis. *Dr. Dorottya Szécsi*

Dorottya Szécsi
……
supervisor's signature

[1] If the requested amount is larger than 500,00 PLN, please attach your CV/resume.
[2] The information on the purpose and justification of funding **must be described in detail.**

Attachments:

1. …CV of the applicant……

2. ……

FreeMail

Re: IMPORTANT - Financial support of Academia Copernicana Doctoral Students in 2024

Von: "Justyna Trawicka" <trawicka@umk.pl>

An: hstinshoff@doktorant.umk.pl

Datum: 24.04.2024 13:26:55

Dear Hanno,

everything is fine, just some information needed to be added. Anyway the funding in the amount of 2300 PLN was granted.
I have passed that information to the Research Department, so they will include that in the final settlement of your travel.

Best
Justyna Trawicka
Cytowanie hstinshoff@doktorant.umk.pl:

> Good evening,
>
> I am a bit confused, I thought I answered these two criteria in the
> application form itself? Did I do something wrong in these
> categories, or is there something else that is lacking which I am
> missing at the moment? Is it just too little, should I have written
> more? I thought I would fill the space the form provides, so I wrote
> about as much for the categories.
>
> I attached the application form to this mail here again, and
> additionally a reworded document I just wrote to paraphrase what I
> also wrote in the application form (both just in case there was some
> misunderstanding and the content of either of them is enough). If
> there is something specific I am still lacking, could you tell me
> what it is so that I can expand on it? I just don't know what is
> required that I didn't provide, I am very sorry for the hassle.
>
> Thank you in advance,
> Yours Sincerely,
> Hanno Stinshoff
>
>
> Quoting Justyna Trawicka <trawicka@umk.pl>:
>
>> Dear Hanno,
>>
>> your funding application came back from prof. Hrynkieiwcz - it has
>> been requested to add to the application the following information:
>>
>> - give a thorough breakdown of expenditures - what the funds will
>> be spent on.
>> - give a detailed justification of the purpouse of your internship
>> and how it is related to the implementation of your PhD project.
>>
>>
>> After that, the application will be reconsidered.
>>
>> Thank you!
>> Justyna Trawicka
>> Cytowanie hstinshoff@doktorant.umk.pl:
>>
>>> Good afternoon,
>>>
>>> Thank you for your help.
>>> I attached the application form and my CV (as requested in the
>>> form) to this mail, I hope everything is in order.
>>>
>>> Also thank you for the information about the internship and the
>>> midterm evaluation, I will just wait for any new development then.
>>>
>>> Wishing you a good day,
>>> Yours Sincerely,
>>> Hanno Stinshoff
>>>
>>>
>>> Quoting Justyna Trawicka <trawicka@umk.pl>:

>>>
>>>> Dear Hanno,
>>>>
>>>> Yes, I've seen your correspondence with Anna and the application.
>>>> All I will need now is the funding application – please send it
>>>> directly to me. I will pass it along to prof. Hrynkiewicz.
>>>> As far as your questions are concerned –
>>>> 1) Well, technically you are no longer obliged to conduct
>>>> internships, but if you do, they will be considered and ECTS
>>>> points granted. For an International internship – 4 ECTS / 1 week.
>>>> 2) Your midterm evaluation should be in September – we have not
>>>> established the exact date yet. As soon as I know more, I will
>>>> let you know.
>>>>
>>>> Best
>>>> Justyna Trawicka
>>>> Cytowanie hstinshoff@doktorant.umk.pl:
>>>>
>>>>> Quoting Justyna Trawicka <trawicka@umk.pl>:
>>>>>
>>>>>> Good afternoon,
>>>>>>
>>>>>> well you could submit the application for funding - I will pass
>>>>>> it along to prof. Hrynkiewicz, however, I cannot promise it
>>>>>> will be reviewed sonner than the 25th of April, as it has been
>>>>>> already mentioned in the email.
>>>>>>
>>>>>> Perhaps the reimbursement of expenses incurred is possible, but
>>>>>> since this a foreign travel it is handled by the Department of
>>>>>> Research. Thus, there is a certain procedure to follow ->
>>>>>> https://www.umk.pl/en/research/travel/
>>>>>>
>>>>>> So at this point, it would be advisable to direct the question to them.
>>>>>>
>>>>>> If you do, please add me in CC.
>>>>>>
>>>>>> You could contact Anna Niemcewicz, e-mail: anna.niemcewicz@umk.pl
>>>>>>
>>>>>>
>>>>>> Have you already filled in a travel abroad application form?
>>>>>>
>>>>>> Regards
>>>>>> Justyna Trawicka
>>>>>>
>>>>>>
>>>>>> Cytowanie hstinshoff@doktorant.umk.pl:
>>>>>>
>>>>>>> Good afternoon,
>>>>>>>
>>>>>>> As you can (hopefully) see I sent in the travel abroad
>>>>>>> application form regarding my internship in Prague as you asked
>>>>>>> me to do (see the mail from the past below).
>>>>>>> Is that all I have to do for now?
>>>>>>> I am also working on the application form for the funding, but I
>>>>>>> am not sure whether I am supposed to send it to you or Prof
>>>>>>> Hrynkiewicz or to someone else.
>>>>>>>
>>>>>>> Apart from that, I have three questions, two of them also
>>>>>>> related to this topic:
>>>>>>> - We are supposed to undertake an international internship of
>>>>>>> (at least) a month as part of our PhD, as is outlined by the
>>>>>>> obligatory courses instruction. Is this internship of 30 days in
>>>>>>> Prague sufficient to fulfill this requirement?
>>>>>>> - How many ECTS points will I get for this internship?
>>>>>>>
>>>>>>> - Off-topic: I started my PhD around October 2022, so I assumed
>>>>>>> that I'd have to do my midterm evaluation around that time this
>>>>>>> year. But I didn't yet get any official note of date or
>>>>>>> procedure about this up till now. Do you have any information
>>>>>>> about that? Should I just wait for a notice and it is just not
>>>>>>> arrived yet or am I supposed to contact someone about it?
>>>>>>>
>>>>>>> Thank you for your help,
>>>>>>> Yours Sincerely,
>>>>>>> Hanno Stinshoff
>>>>>>>
>>>>>>>
>>>>>>>
>>>>>>>> Good afternoon,
>>>>>>>>
>>>>>>>> (I hope I direct this mail to the correct person, if not I
>>>>>>>> deeply apologize. In that case I'd ask you to point me in the
>>>>>>>> direction of who to contact)
>>>>>>>>
>>>>>>>> I received the forwarded mail from AC a few days ago, and I
>>>>>>>> have a question regarding the third point (internship):
>>>>>>>>

>>>>>>> I am going to go on an internship (as part of my PhD) for a
>>>>>>> month in april, but I will already have arrived there by the
>>>>>>> 15th of april, so before the next deadline for submission (and
>>>>>>> also for the decision deadline).
>>>>>>> Can I apply for fundings or partial fundings for that
>>>>>>> internship or does that not work if I am already there?
>>>>>>> I ask because usually when going on conference trips for
>>>>>>> example I have to pay ahead of time either way and only get
>>>>>>> reimbursed afterwards, so if it is working like that, then it
>>>>>>> wouldn't be a problem for me to apply, right?
>>>>>>> I just wanted to make sure that I am not wasting everyone's
>>>>>>> time if I apply for it.
>>>>>>>
>>>>>>> Thank you in advance for your help,
>>>>>>> Yours Sincerely,
>>>>>>> Hanno Stinshoff
>>>>>>
>>>>>>
>>>>>>
>>>>>> --
>>>>>> Justyna Trawicka
>>>>>> Academia Copernicana Interdisciplinary Doctoral School
>>>>>> Collegium Humanisticum
>>>>>> Room: C.0 32
>>>>>> Bojarskiego 1, 87-100 Toruń
>>>>>> Nicolaus Copernicus University in Toruń
>>>>>> Phone: +48-56-611-26-79
>>>>>> Email: trawicka@umk.pl
>>>>>> https://www.ac.umk.pl/
>>>>
>>>>
>>>>
>>>> --
>>>> Justyna Trawicka
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