
DODATEK O HOSTOVÁNÍ
KE SMLOUVĚ O ÚČASTI
NA PROGRAMU MERIT

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mezi

Středočeské inovační centrum, spolek

a

Astronomický ústav AV ČR, v. v. i.

Tento DODATEK O HOSTOVÁNÍ KE SMLOUVĚ O ÚČASTI NA PROGRAMU MERIT uzavřené dne 13. dubna 2023 (dále jen „**Dodatek o hostování**“) uzavřely následující smluvní strany:

(1) Středočeské inovační centrum, spolek
se sídlem Zborovská 81/11,150 00 Praha 5
IČO: 042 28 235
zastoupený [redacted]

(dále jen „**Koordinátor**“)

(2) Astronomický ústav AV ČR, v. v. i.
se sídlem Fričova 298, 251 65 Ondřejov
IČO: 67985815
Zastoupená [redacted]
č.ú. (CZK) [redacted],
(EUR) [redacted]

(dále jen „**Partner**“)

(Koordinátor a Partner společně jako „**Strany**“)

PREAMBULE

(A) Strany uzavřely Smlouvu o účasti na programu MERIT (dále jen „Smlouva“), na jejímž základě je realizována jejich spolupráce při realizaci Programu a upraveny podmínky vzniku práva na poskytnutí Podpory.

(B) Realizace Projektu postoupila do další fáze, pročež Koordinátor vyzval Partnera k uzavření tohoto Dodatku o hostování.

(C) Partner v postavení Implementující organizace má zájem nabýt účinností tohoto Dodatku o hostování postavení Hostující organizace, se všemi právy a povinnostmi příslušejícími k tomuto postavení.

Strany v souladu s článkem 9 Smlouvy přistupují k uzavření Dodatku o hostování o následujícím znění:

1. Definice a výkladová pravidla

1.1. Není-li v tomto Dodatku o hostování uvedeno jinak, uplatní se v plném rozsahu definice a výkladová pravidla převzatá Stranami v článku 1 Smlouvy.

2. Předmět a prohlášení stran

2.1. Strany prohlašují, že

2.1.1. Výzkumník předložil Projekt, jehož specifikace tvoří přílohu č. 1 Dodatku o hostování;

2.1.2. Projekt předložený Výzkumníkem splňuje požadavky Programu;

2.1.3. Výzkumník má zájem realizovat Projekt u Partnera;

2.1.4. Výzkumník byl vybrán v rámci výběrového procesu Programu a jeho výběr, včetně přiřazení k Partnerovi, byl oficiálně schválen Řídicím výborem (Steering Committee) – Protokol o výběru Výzkumníka a jeho přiřazení k Partnerovi tvoří přílohu č. 2 Dodatku o hostování.

2.2. Partner se zavazuje nejpozději do 1. října 2024, od uzavření Dodatku o hostování uzavřít s vybraným výzkumníkem, Václavem Pavlíkem, narozeným 18.10.1990, Pracovní smlouvu svým obsahem odpovídající Pokynům k Pracovní smlouvě (viz Příloha č. 3 Smlouvy). Nebude-li Pracovní smlouva dle předchozí věty v daném termínu uzavřena, pozbývá tento Dodatek o hostování účinnosti a Partner ztrácí postavení Hostující organizace.

2.3. Partner se dále zavazuje poskytnout Vybranému výzkumníku Spolufinancování za podmínek a v rozsahu stanoveném Smlouvou.

2.4. Partner bere na vědomí, že účinností tohoto Dodatku o hostování nabývá postavení Hostující organizace s právy a povinnostmi příslušejícími tomuto postavení. Tím nejsou dotčena další práva a povinnosti plynoucí Partnerovi ze Smlouvy.

3. Ostatní a závěrečná ustanovení

3.1. Tento Dodatek o hostování nabývá účinnosti dnem jeho zveřejnění v registru smluv.

3.2. Ve zbytku zůstávají ustanovení Smlouvy nedotčena.

V ______________ dne __________

[redacted]

Datum: 2023.12.19 16:51:11 +01'00'

Koordinátor

[redacted]

V ______________ dne __________

[redacted]

Datum: 2023.12.20 09:39:30 +01'00'

Partner

[redacted]

Příloha č. 1 – Specifikace Projektu

Příloha č. 2 - Protokol o výběru Výzkumníka a jeho přiřazení k Partnerovi (Zápis z jednání Steering Committee)

Obě přílohy jsou součástí Dodatku.

1. EXCELLENCE

1.1 Quality and pertinence of the project's research and innovation objectives (and the extent to which they are ambitious, and go beyond the state-of-the-art).

Introduction: The visible universe is hierarchical – a complex structure organised on a vast range of scales, from aggregates of galaxies to individual stars. But the fundamental building blocks of it all are star clusters (SCs), providing us with essential information on the formation and evolution of stars and the dynamical development of their host Galaxy. However, because of their distance and size, measuring precise information about their internal structure and composition is challenging. Their stellar components age and evolve on nuclear timescales, Myr to Gyr, and the global dynamical evolution of SCs or the Galaxy is similarly slow. Therefore, it is crucial to study SCs through a multidimensional approach – combining robust theories and their implementations in numerical simulations with state-of-the-art observational data, and eventually also incorporate machine-learning techniques.

Traditionally, the dynamical evolution of SCs was considered tractable using a thermodynamics-based framework or through two-body relaxation, assuming only two-body encounters and averaging over the whole cluster.[1] However, recent observations have shown that these methods are inadequate, and a more realistic dynamical paradigm is required. For instance, high precision *HST* and *Gaia* observations of SCs have revealed that SCs exhibit internal rotation or anisotropy in the stellar velocity distribution.[2] This motivated theoretical and numerical efforts to explain the different kinematic properties of these systems.[3] In particular, when it comes to energy redistribution and the evolution towards energy equipartition, *my recent numerical study* pointed out vastly different evolution of SCs with an isotropic stellar velocity distribution and a radially anisotropic one[4] (see Fig. 1). This spurred more observational research and theoretical efforts, including my own,[5] and also became a useful way of characterising the "multiple stellar population" conundrum, which remains a focus of current research.[6]

My work further showed that mass segregation, which is a direct consequence of two-body relaxation, proceeds at different rates in SCs with isotropic and radially anisotropic velocity distributions. Another our result is linked to the formation, exchange, and disruption rates of binary stars, especially those with a high mass ratio or the low-mass ones. This has a impact on the observed populations of low-mass X-ray binaries[7] and – with the knowledge obtained from this programme – will allow us to uncover how those mixed binary systems with stellar remnants, which are now under a lot of attention, form and evolve.[8]

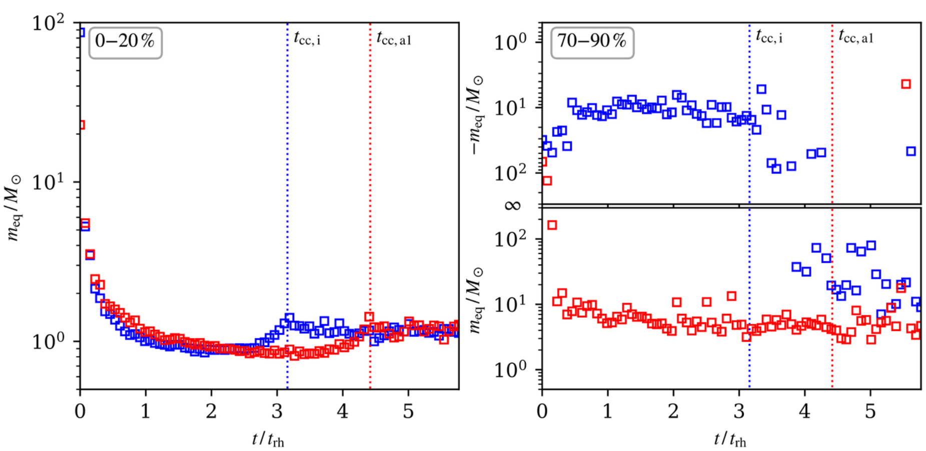

Fig. 1: Time evolution of the equipartition mass – defined by $\sigma \sim \exp[-m/(2m_{eq})]$, where σ is the velocity dispersion and m is stellar mass – in models with initial isotropic (blue) and radially anisotropic (red) velocity distribution. Panels display two radial shells, defined by the given total mass percentage (i.e., Lagrangian radii). The outer shell is split into $m_{eq} < 0$; the top axis is inverted to show the reciprocal relation correctly. Notice the similarity between the SCs in the left-hand plot, and the major difference in the right-hand plot – the anisotropic model is evolving towards energy equipartition (to lower positive m_{eq}), but the isotropic model away from it (to $m_{eq} < 0$). From Pavlík & Vesperini (2021).

1 Chandrasekhar & von Neumann, 1942, ApJ, 95, 489; Chandrasekhar & von Neumann, 1943, ApJ, 97, 1; Chandrasekhar, 1943, ApJ, 97, 255; Lynden-Bell & Wood, 1968, MNRAS, 138, 495

2 Bellini et al., 2014, ApJ, 797, 115; Bellini et al., 2017, ApJ, 844, 167; Bellini et al., 2018, ApJ, 853, 86; Libralato et al., 2018, ApJ, 861, 99; Bianchini et al., 2018, MNRAS, 481, 2125; Sollima et al., 2019, MNRAS, 485, 1460; Cohen et al., 2021, AJ, 161, 41

3 Kim et al., 2002, MNRAS, 334, 310; Bianchini et al., 2017, MNRAS, 471, 1181; Breen et al., 2017, MNRAS, 471, 2778; Tiongco et al., 2016, MNRAS, 455, 3693; Tiongco et al., 2017, MNRAS, 469, 683; Tiongco et al., 2019, MNRAS, 487, 5535; Fleming et al., 2023, MNRAS, 523, 5306

4 **Pavlík** & Vesperini, 2021, MNRAS, 504, L12

5 Watkins et al., 2022, ApJ, 936, 154; **Pavlík** & Vesperini, 2022a, MNRAS, 509, 3815; **Pavlík** & Vesperini, 2022b, MNRAS, 515, 1830; Livernois, Vesperini & **Pavlík,** 2023, MNRAS, 521, 3, 4395

6 Bellini et al., 2015, ApJ, 810, L13; Amorisco, 2019, MNRAS, 482, 2978; Libralato et al., 2019, ApJ, 873, 109; Cordoni et al., 2020, ApJ, 889, 18; Vesperini et al., 2021, MNRAS, 502, 4290

7 Cohn et al., 2010, ApJ, 722, 20; Lugger et al., 2017, ApJ, 841, 53; Zhao et al., 2020, MNRAS, 499, 3338; Cohn et al., 2022, ApJ, 930, 96

8 El-Badry et al., 2023, MNRAS, 521, 4323; Chen et al., 2023, ApJ, 948, 84; and references therein

Objective: The limitations of our current theories are apparent on all scales, from young SCs and star-forming regions to the very old globular clusters. We have only been able to follow the relevant evolutionary processes by performing lengthy and costly numerical simulations. But even with the state-of-the-art numerical models, we remain a long way from capturing the richness of these complex systems. The latest advancements in astronomy prove that we urgently need a comprehensive description of the long-term evolution of stellar systems composed of stars and their compact remnants – white dwarfs (WDs), neutron stars (NSs) and black holes (BHs). This is *our primary objective* in the programme "**ECLIPSE**: **E**xploring **C**ompact ste**l**lar remnants and their **I**m**p**act on **S**tar **C**lusters **E**volution".

Examples: The following *three examples* strengthen the foundation for this programme. They provide more evidence of the complexity of SCs' evolution, place the objective within contemporary astrophysics, and showcase my research expertise in stellar dynamics.

Ex.1 – Effects of the initial conditions: In 2018, observational results from the Serpent South star-forming region showed that massive stars are preferentially born in the centres of SCs and that the stellar mass decreases (almost strictly) towards the outskirts of the molecular cloud,[9] consistently with other studies.[10] According to the traditional theory of SCs' evolution, we expect that even SCs with randomly distributed stars should evolve towards mass segregation on the relaxation time scale.[11] My study, therefore, utilised *N*-body models to tackle the questions whether we can identify the birth properties of young but evolved SCs and when we should expect the relaxation processes to match the effects of primordial mass segregation.[12] The answer is that we can reliably distinguish between the initial conditions for up to about 3 relaxation times. Note, that there is a *discrepancy with the conventional theory* of two-body relaxation which predicts that a system should "forget its initial conditions" already after *one* relaxation time.

We also tested these results on a real system, for which I compiled *the most complete multi-wavelength catalogue*[13] of the Orion Nebula Cluster (Messier 42). We concluded that this representative SC, which is only about 2 Myr old, was likely formed mass-segregated. I later extended this research in *two solo-authored papers* by including a primordial population of binary stars which put further constraints on our perception of SCs' formation.[14] Testing theories on real systems is vital for our understanding of SCs' formation as real young clusters are complex, e.g., often embedded in larger molecular clouds where the coupling of gas and stars can speed up their evolution[15] (as was also shown in an MSc thesis which I co-supervised,[16] where we combined *N*-body and hydrodynamical models).

Ex.2 – Natal kicks and the population of stellar remnants: Remnants of massive stars (NSs and BHs) often receive a natal velocity kick with magnitudes of hundreds of km/s caused by the asymmetries in the core-collapse supernova (SN) explosion.[17] Such large kicks can make the remnants unbound and allow them to escape from their host SC. Nonetheless, a substantial number of BHs are reportedly still retained in the present-day Galactic globular clusters.[18] In an *extensive study* motivated by this conundrum, I performed a series of numerical models with various initial conditions for the kick distributions, and the sizes and densities of the SCs.[19] Our results constrained the magnitude of the BH kicks in different environments and provided an *independent evidence* that in order to satisfy the observations, BHs should either be in binary systems, or need another mechanism to reduce the kick speeds, such as the fallback of mass. One very recent work now confirmed similar conclusions from the observations of the Hyades cluster.[20]

Note that stellar remnants in binaries are particularly interesting; mass transfer can recycle WDs and NSs to produce exotic objects bright in gamma and X-ray, or rejuvenate them to cause a delayed SN explosion and increase the number of more massive remnants.[21] Since these processes are linked to the amount of time the stars spend with their companions, it depends on their ability to withstand external perturbations by other stars – analysing this is one of the aims of our programme ECLIPSE. Furthermore, few years ago, *Fermi-LAT* measured a gamma-ray excess in the

9 Plunkett et al., 2018, A&A, 615, A9
10 Vázquez-Semadeni et al., 2019, MNRAS, 490, 3061
11 Aarseth, 1966, MNRAS, 132, 35; Spitzer, Jr. & Hart, 1971a, ApJ, 164, 399; Spitzer, Jr. & Hart, 1971b, ApJ, 166, 483; Scaria & Bappu, 1981, Journal of Astrophysics and Astronomy, 2, 215; Stodolkiewicz, 1982, Acta Astron., 32, 63
12 **Pavlík**, Kroupa & Šubr, 2019a, A&A, 626, A79
13 **Pavlík**, Kroupa & Šubr, 2019b, VizieR Online Data Catalog, J/A+A/626/A79
14 **Pavlík**, 2020a, CAOSP, 50, 456; **Pavlík**, 2020b, A&A, 638, A155
15 e.g., Gieles et al., 2006, MNRAS, 371, 793; Karam & Sills, 2023, MNRAS, 521, 5557
16 Suin, 2022, MSc thesis, Pisa, https://etd.adm.unipi.it/t/etd-01062022-202945/; Suin, Shore & **Pavlík**, 2022, A&A, 667, A69
17 Lyne & Lorimer, 1994, Nature, 369, 127; Hansen & Phinney, 1997, MNRAS, 291, 569; Jonker & Nelemans, 2004, MNRAS, 354, 355; Repetto, Davies & Sigurdsson, 2012, MNRAS, 425, 2799; O'Doherty et al., 2023, MNRAS, 521, 2504
18 Peuten et al., 2016, MNRAS, 462, 2333; Baumgardt & Sollima, 2017, MNRAS, 472, 744
19 **Pavlík**, Jeřábková, Kroupa & Baumgardt, 2018, A&A, 617, A69
20 Torniamenti et al., 2023, MNRAS.tmp. doi:10.1093/mnras/stad1925
21 Podsiadlowski, Joss & Hsu, 1992, ApJ, 391, 246; De Donder & Vanbeveren, 2003, New A, 8, 817; Belczynski et al., 2010, ApJ, 714, 1217; Zapartas et al., 2017, A&A, 601, A29; Belczynski et al., 2016b, ApJ, 819, 108; Agrawal et al., 2023, arXiv:2303.10187

Galactic centre and a similar one was also found in the Andromeda galaxy.[22] Several explanations were proposed, however, the most plausible seems to be that this excess is the combined emission of thousands millisecond pulsars (MSPs), i.e., spun-up rejuvenated binary NSs, that were transported to the Galactic centre by inspiralling SCs over the lifetime of the Galaxy.[23] The problem was that even if some NSs were not kicked from the SC at birth (e.g., going through an electron-capture SN with a lower kick), these remnants should still mass-segregate towards the cluster core and eject themselves via close encounters.[24] We showed, however, that a retained population of stellar-mass BHs can actually quench the mass segregation of the less massive NSs for up to several Gyrs. Consequently, a sufficient population of MSPs can be retained in the SCs, and this *fully explains* the very high-energy excess emission (see Fig. 2, where our models fit exactly in the observed data).[25]

<u>Ex. 3 – Planetary captures:</u> In 2019, the star Betelgeuse (α Ori) showed peculiar dimming that could have been a sign of its soon explosion as a SN producing a BH.[26] Having previous experience with the kicks of stellar remnants I was naturally curious what would happen if a fast moving BH or NS encountered a planetary system (e.g., the Solar System) but there was *no answer*. Therefore, I led a collaborative effort to investigate this question and we summarised the distribution of possible outcomes (i.e., when the Solar System remains bound, or when it suffers a partial or complete disruption).[27] Moreover, our paper was also *the first to show* that an environment with NSs, BHs and stars can lead to the *formation by capture* of planetary systems around compact remnants, which was a previously unrealised channel (see also Fig. 3). In the case of NSs, those could even be detected within the active phase of the pulsar (which have been observed to posses planetary systems, even with multiple planets – e.g., PSR 1257+12 and PSR B1620–26)[28]. Our models further pointed to chaotic behaviour among some captured planets, especially in a system with a central BH – with abrupt changes in the semi-major axes and eccentricities. Verifying the chaos conjecture and elucidating the stability of the systems requires long-term dynamical evolution for a variety of encounter scenarios, including low-mass bodies, which is a topic of another MSc thesis I am currently co-supervising (another co-supervisor is my collaborator Steve Shore from the University in Pisa, and the local supervisor in Prague is [redacted]). ECLIPSE has a close connection to the question of planetary systems' stability in dense environments since our results concerning the remnant populations would validate the assumed initial conditions used in our paper and in the current MSc thesis.

<u>Summary:</u> We saw that the current theory of SCs is incomplete and needs updating to explain the recent observed and modelled features that even lead to paradoxical results. The aim to develop a mathematical understanding of the dynamical evolution of multi-

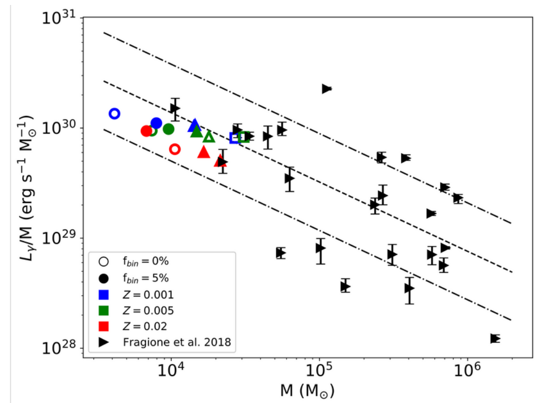

Fig. 2: Ratio of γ-ray luminosity to globular cluster mass L_γ/M as a function of the cluster mass. The coloured symbols represent the inferred L_γ/M from the modelled SCs studied in our work[25] with these initial masses: $3.0\times10^4\,M_\odot$ (circles), $5.0\times10^4\,M_\odot$ (triangles) and $7.5\times10^4\,M_\odot$ (squares). We assumed a recycling frac-tion $f_{rec} = 0.1$ (Abbate et al. 2018) and an average MSP γ-ray emission of $L_\gamma = 2\times10^{33}$ erg s^{-1} (Brandt & Kocsis 2015). The dashed line shows the best log-linear fit to the data (as in Fragione et al. 2018a) and the dashdotted lines show 1σ deviations. Figure taken from Fragione, Pavlík, & Banerjee (2018b).

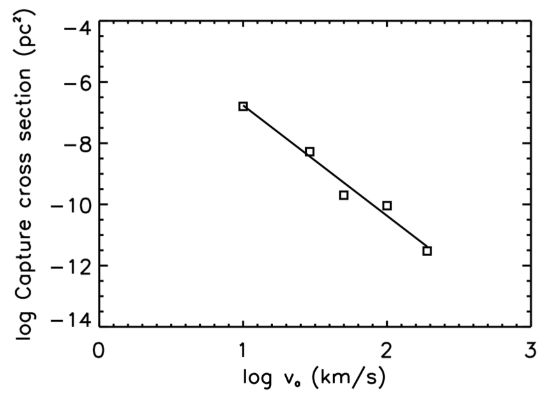

Fig. 3: Capture cross section for the Betelgeuse scenario (i.e., a 10-solar-mass BH encountering the Solar System at an angle of 16° from below the ecliptic plane), weighted by the frequency of models producing a capture of at least one planet. The data-points are calculated from our simulations (Pavlík & Shore, 2021) and we find a best fit scaling relation for the cross section, Σ_{cap}, to be:

$$\Sigma_{cap} = 7\times10^{-4}\,(v\,/\,\mathrm{km\,s^{-1}})^{-3.6}\ \mathrm{pc}^2$$

(Note that in some cases the capture of all 8 planets is also possible, although those outcomes are much more common after the encounter of the Solar System with a 2-solar-mass NS.)

22 Abazajian et al., 2014, Phys. Rev. D, 90, 023526; Calore et al., 2015, Phys. Rev. D, 91, 063003; Fragione et al., 2019, ApJ, 871, L8
23 Brandt & Kocsis, 2015, ApJ, 812, 15; Ackermann et al., 2017, ApJ, 840, 43
24 Heggie, 1975, MNRAS, 173, 729; Hut, 1983, ApJ, 272, L29; Heggie & Hut, 2003, The Gravitational Million-Body Problem: A Multidisciplinary Approach to Star Cluster Dynamics (Cambridge, UK: Cambridge University Press)
25 Fragione, **Pavlík** & Banerjee, 2018b, MNRAS, 480, 4955
26 Dupree et al., 2020, ApJ, 899, 68; Wheeler et al., 2016, MNRAS, 465, 2654
27 **Pavlík** & Shore, 2021, A&A, 648, L2
28 Wolszczan & Frail, 1992, Nature, 355, 145; Arzoumanian et al., 1996, in ASP Conference Series, Vol. 105, IAU Colloq. 160: Pulsars: Problems and Progress, ed. Johnston, Walker & Bailes, 525–530

component SCs on cosmological time scales is very challenging, however, my experience, motivation and vision allowed me to design a multidimensional approach, which I am now proposing, to reach this goal. Alongside the combination of up-to-date space- and ground-based observations and the implementation of different evolutionary models of SCs, the design of ECLIPSE will also allow me to go *beyond the state-of-the-art* and greatly improve my skillset. Within the secondment phase at *prg.ai*. I will learn to implement non-traditional techniques (i.e., artificial intelligence) which are currently proving useful in many research areas; very recently also in astronomy – ranging from characterising galaxy and SC morphology to identifying fast gamma-ray bursts.[29]

1.2 Soundness of the proposed methodology (including interdisciplinary approaches, consideration of the gender dimension and other diversity aspects if relevant for the research project).

Work Packages: The approach is based on an idealised, but self-consistent, framework upon which we build the theory. Then, we gradually increase its physical complexity and validate our findings. In the last stage we incorporate non-traditional tools to facilitate automation of our results. I will achieve this by deploying a strategy organised in the following four Work Packages (WP; see also the Gantt chart and tables in Sec. 3.1).

WP1 – Numerical models: I will begin by evaluating the key parameters of the SCs models that capture the evolutionary features reported in recent observations and my past research. Note that the parameter space can grow exponentially when considering more realistic models. To name a few:
- selecting the number of stars to represent open or globular clusters (from $\sim10^4$ to $\sim10^6$ or more),
- deciding on the type of stellar mass function – initial[30] or evolved, two-component[31] or three-component (which naturally arises from the masses of BHs, NSs, WDs and their progenitors),
- incorporating stellar evolution or multiple populations, and choosing a distribution for stellar remnants' kicks,
- and including additional factors such as primordial mass segregation, binary stars, and the strength of the Galactic tidal field, or stellar velocity anisotropy.

My initial research will lead to the first pass models on which I will perform quantitative analysis of the effects of different initial conditions on the evolution of the computed systems by means of a detailed assessment of their structural and kinematic properties. Then, I will iterate between updating the next set of parameters, performing long-term dynamical simulation, and analysing the subsequent outputs. This methodical approach will enable me to effectively generate a library of representative models of semi-realistic SCs. I will use those to continue quantifying the effects of the initial conditions on the long-term evolution and to build a comprehensive theoretical framework in the next stage of this programme. Striking a balance between the predictive value of our models and the computational time needed is crucial. This is where the two-way exchange of knowledge with senior scientists of the host institution (ASU) and international collaborators and experts in the field is key (see Sec. 1.3).

WP2 – A new theoretical framework: The examples I provided above show the need to focus primarily on describing old stellar systems, particularly around core collapse and in their post-core-collapse stages since this is mainly where the dynamics of remnants plays a role and the current theory is insufficient. Therefore, I will employ a combination of analytical arguments and fitting techniques to the library of models computed in WP1 and compare them to the existing theory. I will then quantify its shortcomings on concrete examples. Based on our current pre-assessment, we should focus on the distribution of stellar masses, the radial density profile, and energy equipartition of various mass groups. I will also investigate energy and angular momentum exchanges between stars and binary stars which is particularly important since my current (yet unpublished) research is already uncovering some discrepancies in the evolution of binaries in SCs which are related to their initial stellar velocity distributions. I will then evaluate the relative importance of these effects based on the results from WP1. In essence, my approach will involve deriving suitable modifications to the existing theory, which will form the building blocks of the new and more comprehensive theoretical framework – i.e., scaling relations, analytical and empirical formulae, and numerical implementation.

WP3 – Validation on real systems: The next important component of this project will extend our new theoretical framework to more complex systems than those modelled in WP1 by using large and more realistic numerical models of SCs along with publicly available observational data on globular clusters from *HST*, *Gaia* and *JWST*. More realistic numerical simulations are usually characterised by large number of stars, continuous mass function, stellar evolution, external Galactic tidal field, primordial binary stars, and anisotropic velocity distributions. Some even have a central intermediate-mass BH which can then play an important role in the velocity distribution of stars or the characteristics

29 e.g., Bialopetravičius & Narbutis, 2020, AJ, 160, 264; Fraix-Burnet D., 2023, MNRAS, 523, 3974; Dai et al., 2023, arXiv:2307.02335; Raquel et al., 2023, MNRAS, 524, 1668; and citations therein
30 Kroupa, 2001, MNRAS, 322, 231
31 Breen & Heggie, 2013a, MNRAS, 432, 2779; Breen & Heggie, 2013b, MNRAS, 436, 584

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of binary stars.[32] Since my international collaborators and I have published Open Access studies on similar systems in the past, I will primarily test the robustness of the new theoretical framework on those.

Validating the theoretical framework of SCs' evolution on the galactic and cosmological scale will be the last step. As we saw above, the stellar populations originating in SCs, such as MSPs, have impact on the observed properties of our Galaxy. Furthermore, from the very recent research which investigated the effect of MSPs from stellar streams and concluded that they may be responsible for the γ-ray emission in the so-called Fermi bubbles at the Galactic poles.[33] In a recently published article, we were also investigating the formation and dynamical evolution of binaries in ultra-faint dwarf galaxies (UFDs), which is not only driven by the collisional effects associated with the binary–binary/single star encounters (as in SCs) but also by the tidal effects from the dark matter halo. Thus, UFDs and also ultra-compact galaxies need to be considered. Finally, we will utilise the long-term research line pursued by [redacted] at ASU who recently, in a broad collaboration,[34] investigated the dust-enshrouded stars observed within the Galactic centre. They proposed that these stars are remnants of a dissolved SC whose formation was initiated in the circumnuclear disk.

WP4 – Artificial intelligence: In the last stage of ECLIPSE, I will utilise machine-learning techniques to create and test a toolkit that would semi-autonomously apply our new framework for SCs' evolution to observational data and numerical models. During this stage, I will primarily go through training at *prg.ai* to expand my skillset. In the second half of my secondment, I will develop the above-mentioned AI algorithm. Some of the planned outcomes from the toolkit are a reliable identification of SCs (models and observations) at different stages of their evolution and figuring out a probable set of initial conditions that could have led to this evolutionary stage. I will train the algorithm on the publicly available observational data sets as well as on my library of models (see WP1) and other published models. This will enable me to compare how those inputs affect the AI outcomes and to test the algorithm against biases.

Data management and sharing plan: Throughout the duration of ECLIPSE, I will use two main IT systems – the internal network of ASU, and the National Grid MetaCentrum, with whom the Academy has a partnership. The data collected, processed and generated during this programme will concern:

a) observational datasets of SCs and their constituents from various surveys and catalogues,
b) numerical simulations of SCs, and
c) outputs of our analyses.

I will adhere to the European Union policies on data management and sharing,[35] the policies of ASU and MetaCentrum, as well as the policies of the journals where my research will be published. Here is an outline of my plan to ensure that my research contributes to the scientific community and advances our collective knowledge:

1) The data will be collected in accordance with ethical guidelines and stored securely on the ASU's network or on the storage provided by MetaCentrum.

2) The data will be organised using a consistent and well-documented system that allows for easy retrieval, analysis, and interpretation.

3) To promote Open Access, the data will be made available through appropriate channels such as repositories or data archives throughout the project and after it has ended. Access to the data will be made available under the appropriate licenses, considering any legal or ethical restrictions.

4) The data will be preserved for future use by depositing them in an appropriate data repository, e.g., on magnetic tapes. This will ensure the longevity and accessibility of the data for future research.

5) Proper citation practices will be followed to ensure that the data are credited to the appropriate source and that the use of the data is transparent and documented.

Open science: I am committed to making scientific knowledge, research tools and results accessible to the community. Thus, in accordance with the institutional policy, I always implement open science best practices in the presentation of all results and data from my research. For instance, I use public codes for my research and I write my own source code in open-source programming languages such as Python or Bash. I publish in Open Access journals with a peer-review process, place preprints on arXiv, and even review other articles for different journals.

Equality, diversity and inclusiveness: I fully believe that our responsibility as researchers and educators is to promote inclusiveness and diversity, and to make science accessible to people coming from all socioeconomic and ethnic backgrounds. For instance, in my past job as a postdoc and a then professorial position at Indiana University, whether I was teaching, performing research or having day-to-day interactions on campus, I was following the Equality

32 Aros et al., 2021, MNRAS, 508, 4385
33 Crocker et al., 2022, Nature Astronomy, 6, 1317
34 Peißker et al., 2021, ApJ, 923, 69
35 https://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-data-management/data-management_en.htm

and Diversity Plan of Indiana University[36] to create a more diverse and equal workspace for students, colleagues and staff. This included adopting positive culture for working, presentation in a respectful and gender-neutral manner, and encouraging participation. Since my students came from diverse educational backgrounds with different experiences, I also concentrated on meeting them at their individual levels and helping them progress (e.g., during office hours).

Throughout the duration of ECLIPSE, I will continue creating a positive working environment and follow the principles of the European Charter for Researchers and the Code of Conduct, which ASU has adopted since 2020. I will further adhere to the objectives set out in the Institute's Gender Equality Plan.[37] Note that the Institute supports the work and development of individual researchers regardless of their gender, it also provides and oversees the assurance of high quality and ethical standards in the research undertaken.

1.3 Quality of the two-way transfer of knowledge between the researcher and the host.

The two-way transfer of knowledge is the most important aspect of this programme that will foster a dynamic and mutually beneficial learning experience. I plan to learn several techniques which will enable me to become a more versatile scientist (e.g., be among the first to implement AI in astronomical research at ASU) but at the same time I also bring a large skillset to ASU which I plan to transfer to the scientists and students either in a close collaboration within this project or through dedicated seminars. Here are some specific examples, related to the WPs of ECLIPSE:

I am an expert in simulating dynamical systems within the *N*-body approach, even on parallel architectures with GPUs and multiple CPUs.[38] Furthermore, I also have experience with combining *N*-body and hydrodynamical simulations in order to study more realistic young SCs. In WP1, I will, therefore, not only address the specific initial conditions, as described above, but also the simulation methods. I will, therefore, closely collaborate with experts to come up with the optimal set of initial conditions and simulation methods which will enable me to complete this stage of the programme effectively – with my local mentor at ASU, [redacted] (a full professor of astrophysics and a former director of ASU), and also with foreign institutions (e.g., Indiana University and University of Edinburgh, where I already have many connections and current collaborators).

The research goal of WP2 is the most challenging aspect of ECLIPSE, however, my collaborators and I have the skills to tackle it. I have experience with fitting techniques and semi-analytical analysis of numerical models, which enabled me to, e.g., publish a new method for identifying core collapse in SCs.[39] On top of that, I also plan to work with my senior external collaborators (e.g., University in Pisa, University of Edinburgh) alongside the local group at ASU to extend my skillset, which will allow me to derive and test a new theoretical framework for SCs evolution.

The fundamental difference between real observed clusters (topic of WP3) and models (from WP1 and WP2) is that the latter are seen in 2D projection and we *do not know* their whole history. Thus, the intermediate step is to flatten the 3D models from our library and evaluate how to change the theoretical framework to 2D to match real systems more closely. I have experience with similar procedures from my previously published research[40] but I will also closely collaborate with the local observational astronomers at ASU Ondřejov to master other important data processing techniques.

I have a lot of experience in classical programming and data analysis, therefore, I am excited about the opportunity planned out for WP4. I will use the training provided by my secondment host (*prg.ai*) to gain experience in developing AI algorithms, which I will later use in analysing the different evolutionary stages of observed and modelled SCs. Furthermore, I also plan to train myself in the topics related to using AI in research – from revealing biases, to the role of human input and intervention (as also detailed in my ethics self-assessment).

1.4 Quality and appropriateness of the researcher's professional experience, competences and skills.

I am an active scientist in the area of stellar dynamics and a Junior Member of the IAU. As an astrophysicist, I am driven by my curiosity for understanding the intriguing nature of the universe. My passion has guided me through a range of academic milestones: Bachelor's degree in Physics, Master's degree in Astronomy and Astrophysics (with a prize-winning thesis), an additional Czech doctorate in Natural Sciences, and culminating in a PhD in Theoretical Physics, Astronomy and Astrophysics from Charles University, Prague (see also my CV).

During my doctoral studies, I have been awarded *competitive three-year funding* from the Grant Agency of Charles University and computational time at the largest Czech data facility, MetaCentrum. This allowed me to *publish four peer-reviewed articles, mainly as a leading author, and a data catalogue*, on which I based my thesis. I presented my research at conferences and gave invited seminars abroad in Pisa and Rome. In Spring 2016, I was also *invited as a*

36 https://diversity.iu.edu/about/diversity-definition.html
37 https://www.asu.cas.cz/gender-equality-plan
38 Aarseth, 2003, Grav. N-Body Simulations. Cambridge Univ. Press; Nitadori & Aarseth, 2012, MNRAS, 424, 545; Wang et al., 2015, MNRAS, 450, 4070
39 **Pavlík** & Šubr, 2018, A&A, 620, A70
40 **Pavlík**, Kroupa & Šubr, 2019a, A&A, 626, A79; **Pavlík**, Kroupa & Šubr, 2019b, VizieR, J/A+A/626/A79; **Pavlík** & Vesperini, 2022a, MNRAS, 509, 3815

visiting student to University of Edinburgh – there, I became fully involved in the MODEST initiative, devoted to "Modelling and Observing DEnse STellar systems"; in 2017, I was *invited to co-author the meeting review article*.[41]

After PhD, I was *offered a research position* at the Czech Academy of Sciences with [redacted] and [redacted] as my local supervisors. I studied the properties of binaries in star-forming regions and summarised my findings in *two solo-authored peer-reviewed articles*. Later in 2020, I accepted a *postdoctoral fellowship* in the United States at Astronomy Department, Indiana University Bloomington (IU) to work with Enrico Vesperini. We published *four research papers* dedicated to stellar kinematics in SCs and are currently working remotely on more.

For the year 2022–23, I was appointed a lecturer for the Physics Department, IU, to teach two undergraduate courses: *Basic Physics of Sound* (intended for non-science majors) and *Physics 3: Modern Physics* (required course). Additionally, in each course, I was *supervising* one Assistant/Grader. Recently, I have also started *mentoring MSc students*: [redacted] from the University in Pisa (locally supervised by Steve Shore), who defended in 2022 with honours; and currently [redacted] from Charles University, with [redacted] as the local supervisor.

Throughout my career, I have also actively engaged in outreach and public education. In 2012, I became an *editor* and author for the Czech astronomy magazine "Astropis", and an organiser of the Czech Astronomy Olympiad (AO). I have been leading STEM workshops of AO for which I have successfully secured *five years of competitive ministerial funding as a PI*. I led our medal-winning Czech team to the International AO four times, for which I have been *recognised by the Czech Minister of Education*. During my PhD, I also worked as a *full-time educator* at Planetarium Prague. I have translated popular science books for Czech publishing houses and organized numerous public lectures or science festivals (in the Czech Republic and the United States) aimed at inspiring the next generation of scientists.

My long-term ambition is to establish my own research group in stellar and Galactic astronomy of dense stellar systems, including the effects of Einstein's Theory of Relativity, and become a leading figure in these fields. Therefore, I am developing my research profile through a multi-dimensional approach – combining simulations, theory, and observations – to be more versatile and promote synergy between the observational and theoretical communities. I am confident that with the help of ECLIPSE, I will be closer to achieving my goals.

Astronomical Institute of the Czech Academy of Sciences is the ideal institution for me to carry out this programme. My enthusiasm and skills combined with [redacted]' vision in theoretical and mathematical astrophysics, and the world-leading expertise in observational astrophysics (via the Ondřejov research group) make this research environment a perfect fit for my scientific aims and professional growth. I have also received the strongest support from ASU, with the hope that ECLIPSE will be another success in their long-standing tradition of excellence.

2. IMPACT

2.1 Credibility of the measures to enhance the career perspectives and employability of the researcher and contribution to his/her skills development.

As the recipient of the fellowship, I will have the opportunity to work with world-class experts in the field of stellar dynamics and access state-of-the-art resources in academia and industry. The planned collaborations and scientific tasks will enable me to develop advanced research skills (e.g., the synergy of numerical models and observations, the formulation of theoretical approaches, and AI development), to produce high-quality publications, and establish a strong research profile. Consequently, I will enhance my reputation in the field, leading to new professional opportunities (e.g., in job offers and student supervisions). The programme ECLIPSE is, therefore, truly the ideal way to achieving a leading role in my field.

2.2 Suitability and quality of the measures to maximise expected outcomes and impacts, as set out in the dissemination and exploitation plan, including communication activities.

Dissemination activities: Public education and outreach is a pivotal part of scientific endeavours since they bridge the gap between scientists and the public, build trust in scientific findings, inspire STEM professionals, and promote a well-informed society capable of making informed decisions. Therefore, as part of the programme ECLIPSE, I designed the following activities: I will publish *dedicated permanent websites*, publicise through social media platforms and research platforms, and the Institute's website. Since the models calculated for this project mainly use Newtonian mechanics, there is a *transversal benefit* to utilise them *in physics and astronomy teaching* (in school, planetariums, science centres, etc.). I will be also preparing audio-visual material, exhibitions and displays for these purposes, freely available on the website. For instance, I plan to work mainly with Planetarium Prague and ESERO[42] to reach the broadest audience in the Czech Republic. I will further work with ASU's office for communication and

41 Varri, Cai, Concha-Ramírez, Dinnbier, Lützgendorf, **Pavlík**, Rastello, Sollima, Wang, and Zocchi, 2018, Computational Astrophysics and Cosmology, 5, 2
42 https://www.planetum.cz/; https://esero.spaceacademy.cz/

outreach to maximise the impact of this project among the general public. Lastly, I will evaluate feedback from public outreach professionals, students, and teachers for my own curriculum development.

Management of intellectual property: This is a crucial part of the project in order to protect the interests of all people involved. We identified the following key topics and strategy.

Data management: We will develop a robust data management plan that ensures secure storage, accessibility, and long-term preservation of research data. This plan is detailed above.

Open access: We will promote Open Access publication of scientific articles to increase the dissemination of research findings and foster collaboration (see also Sec. 1.2).

Copyright and authorship: All researchers involved in this programme will adhere to the ethical guidelines for scientific collaboration and publishing. We will establish clear criteria for authorship based on significant contributions to the research, and ensure all authors consent to their inclusion. We will always acknowledge funding agencies and institutions in publications to recognize their support.

Monitoring and compliance: I will regularly monitor the implementation of this strategy and address any disputes or conflicts promptly, transparently and fairly with the help of the host Institute.

2.3 Sustainability of the candidates' research project in the Region. Opportunities to continue the research through regional/international collaboration with relevant industry or academic sectors.

Research impact: Results of this project will have a significant impact on several key questions in contemporary theoretical and observational astrophysics that rely on the properties of SCs and stellar remnants in these environments. Specifically:

- retaining NSs and BHs in a SC leads to the formation of BH–BH, NS–NS or mixed gravitational wave sources.[43] These events are key for multi-messenger astronomy, and knowing the properties of the stellar remnant populations will help us predict the merger rates and constrain the interpretation of current and future observations with LIGO and LISA;
- successive BH mergers in SCs could explain the existence of pair-instability supernova mass-gap remnants;[44]
- having a stable BH-dominated core in a SC is important for the formation and growth of intermediate-mass black holes by consecutive mergers;[45]
- an environment with NSs, BHs and stars can lead to the formation (by capture) of planetary systems around dark remnants, which is a formation channel that I was the first to explore, and we now need to probe in detail (see also above);
- it will also shed light on high-mass ratio binary stars or binaries composed of one BH and one normal star, whose origin and properties are now intensively debated.[46]

Our findings will be published in the lead journals in the field – i.e., Astrophysical Journal, Astronomical Journal, Astronomy & Astrophysics, and Monthly Notices of the Royal Astronomical Society, including their Letters to the Editor. This will increase their visibility and accessibility to other researchers in the field.

Benefits for the Czech Republic and individuals: The proposed collaboration within this programme will have many outcomes and benefits for all parties involved. Since my collaborators will have the opportunity to contribute their expertise to a significant research project, they will establish new relationships with other researchers, enhance their local and international visibility, and increase their impact on science.

For ASU, this project will strengthen its research profile, increase its research output, and enhance its worldwide reputation as leading research institutions in the field of stellar dynamics. It will also provide opportunities for research staff and students to engage with the project and contribute to their professional development. Additionally, the collaboration will lead to the creation of new knowledge and leading to scientific breakthroughs. Furthermore, my international collaborations will foster scientific and cultural exchanges and contribute to my country's reputation as a hub of scientific excellence.

For *prg.ai*, ECLIPSE will provide the ability to expand their portfolio with world-class astrophysical research. Since the use of AI in astronomy is still in its infancy, this programme will lead to new collaborative possibilities and promote unrealised business opportunities.

Stellar dynamics simulations require state-of-the-art computational methods and equipment, hence, my project has the potential to drive innovation in the field and facilitate upgrades to multidisciplinary research systems. For instance,

43 see the catalogue gw-openscience.org/eventapi/html/GWTC
44 Belczynski et al., 2016a, A&A, 594, A97; Woosley & Heger, 2021, ApJ, 912, L31
45 e.g., Ziosi et al., 2014, MNRAS, 441, 3703; Hong et al., 2020, MNRAS, 498, 4287; Maliszewski et al., 2022, MNRAS, 514, 5879
46 Cohn et al., 2021, MNRAS, 508, 2823; Cohn et al., 2022, ApJ, 930, 96; Shikauchi et al., 2020, PASJ, 72, 45; and references therein

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my ongoing interactions with technicians at Indiana University's supercomputing centre were beneficial to further refining the high-performance computing systems; in Fall 2022 they also *invited me as a key speaker* to their computing workshop. I anticipate similar fruitful interactions at ASU and prg.ai that will further advance high-performance computing in the the Czech Republic, with potential benefits across such fields as data analytics, machine learning, and engineering.

Societal impact: Overall, this project will reveal new astrophysical phenomena, leading to more insights into the universe's complexity. Beyond its scientific significance, this research has the potential to benefit society in several ways. An improved understanding of the properties of SCs and stellar remnants could lead to more informed decisions about designing future observational facilities and space projects. Additionally, the results of this research may inspire and train the next generation of scientists and engineers, leading to technological advancements and future discoveries. Overall, ECLIPSE represents a major step forward in our understanding of the universe and our place within it.

3. IMPLEMENTATION

3.1 Quality and effectiveness of the work plan and assessment of risks.

Timeline: Fulltime commitment is necessary to accomplish the research, training and public engagement planned in the project ECLIPSE. Hence, I will follow the timeline outlined in the Gantt chart below with the following Work Packages. Research tasks (corresponding to WP1–4, as detailed in Sec. 1) are in Tabs. 1–4. Dissemination and public societal engagement activities (labelled as WP5) are in Tab. 5 and also further described in Sec. 2. Management and monitoring (labelled as WP6) is described in Tab. 6). The milestones and deliverables are summarised in Tabs. 7 & 8, respectively, and the contingency plans are proposed in Tab. 9. The duration of each task is based on my past experience and training needs, and given in project months (pm).

ECLIPSE		**Gantt chart**														**Project months (pm)**															
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
WP1	**T1.1**		M1																												
	T1.2			D1				M2																							
	T1.3								D2																						
WP2	**T2.1**											M3				D3															
WP3	**T3.1**																	M4													
	T3.2																			D4											
	T3.3																				M5		D5								
WP4	**T4.1**																									M6					
	T4.2																														D6
WP5	**T5.1**																														
	T5.2		D7														D8													D9	
WP5	**T6.1**	M0											D10										D11								D12

Table 1: Work Package 1 – Numerical models
(T1.2 and T1.3 are done simultaneously as the models are completed)
T1.1 [pm 1–2] – Design of a survey of SC models.
T1.2 [pm 2–7] – Computation of the models in the survey.
T1.3 [pm 3–8] – Analysis and characterisation of the models.

Table 3: Work Package 3 – Validation on real systems
T3.1 [pm 16–18] – Testing the new framework on complex models.
T3.2 [pm 17–19] – Computation of projected observables and comparison with observational data.
T3.3 [pm 20–22] – Validation on galactic and cosmological scales.

Table 2: Work Package 2 – A new theoretical framework
T2.1 [pm 9–15] – Employing fitting techniques to derive analytical and empirical relations for the theoretical framework that describes the long-time dynamical evolution SCs.

Table 4: Work Package 4 – Artificial intelligence
T4.1 – Training activities to develop the required skillset.
T4.2 – Developing, testing, and application of the AI algorithms for SCs' evolution.

Table 5: Work Package 5 – Dissemination and public societal engagement activities
T5.1 – Presenting the project results at scientific conferences and workshops, visiting international collaborators and giving seminars.
T5.2 – Participation at (or organisation of) outreach activities for general public; primary/secondary/high school educational activities; inclusive science activities; and production of audio-visual materials that can be used in public displays. Regular updates of websites and engagement of audience through social media and research platforms.

Table 6: Work Package 6 – Management and progress monitoring
T6.1 – Main group meetings with all collaborators to monitor progress of the project. Smaller local meetings with my mentor, [redacted], will be planned more frequently or as needed so they are not indicated here.

Table 7: List of deliverables

Deliverable	WP	Tasks	Description	pm
D1	1	T1.2	Visualisation of the first set of models used in the study.	3
D2	1	T1.2,T1.3	**Article** presenting results of WP1	8
D3	2	T2.1	**Article** presenting results of WP2	15
D4	3	T3.1,T3.2	**Article** presenting results of T3.1 and T3.2	19
D5	3	T3.3	**Article** presenting results of T3.3	22
D6	4	T4.2	**Article** and algorithm presenting results of T4.2	30
D7	5	T5.2	Publishing a permanent website for sharing outreach and educational materials.	2
D8,D9	5	T5.2	Report of educational, outreach and diversity activities in T5.3.	16, 29
D10,D11,D12	6	T6.1	Progress reports.	12, 22, 30

Table 8: List of milestones

Milestone	WP	Description	Verification	pm
M0	6	Writing of Career Development Plan.	Schedule regular group meetings to monitor progress.	1
M1	1	Finalise the first set of initial conditions for the models	Second group meeting with the collaborators.	2
M2	1	Completion of all the models and analyses for WP1.	Fourth group meeting. Article preparation and submission in month 8.	7
M3	2	Completion of data analysis of the models from WP1. Empirical base for developing the theoretical framework.	Fifth group meeting.	11
M4	3	Selection of models and datasets to use in T3.1 and T3.2.	Article preparation and submission within the next months. Sixth group meeting.	17
M5	3	Selection of models and datasets to use in T3.3.	Seventh group meeting.	20
M6	4	Completion of training at the secondment institution.	Eighth group meeting.	25

Assessment and mitigation of risks that might endanger the project objectives: My strategy to minimize the risk of delays in the execution of the WPs is *to allow for max. three tasks running simultaneously* throughout the duration of the project. That includes max. two research tasks (WP1–4) and one training/outreach/educational activity (WP5), see the Gantt chart above. The most disruptive cases of potential delay are listed in Table 9 with predicted probabilities.

Table 9: Risks and contingency plans (L – low, M – medium, H – high)

Risk	WP	Description	Prob	Impact	Contingency plan
R1.1	1	Delay of achieving M1.	L	T1.2,T1.3	Postponing D1 by a month; work on T1.2 and T1.3 is still possible.
R1.2	1	Delay of achieving M2.	L–M	T1.3,T2.1	Postponing D2 by a month; some work on T2.1 is still possible.
R2.1	2	Delay in achieving M3.	L	T2.1	Continuing work related to T2.1 is still possible.
R3.1	3	Delay in achieving M4.	L–M	T3.1,T3.2	Start of T3.2 is still possible as planned but may also be postponed by a month. Postponing D4 may not be necessary.
R3.2	3	Delay in achieving M5.	L	T3.3,T4.1	Postponing M5 by a month. D5 and the start of T4.1 may still be possible as scheduled but may also be postponed by a month.
R4.1	4	Delay in achieving M6.	M	T4.2	Postponing the start of T4.2 by a month.

3.2. Relevance, feasibility and benefit for the research project objectives of the planned secondment. Quality of the secondment choice in terms of at least one of the following principles: intersectorality, interdisciplinarity or international mobility.

By combining numerical models with AI development, I am presenting a unique opportunity to advance the theoretical framework for the dynamical evolution of SCs and enhance our understanding of these systems. The secondment phase of ECLIPSE at an AI company *prg.ai* is specially designed to help achieving my research objectives. The placement at *prg.ai* provides an ideal environment for my training needs to gain expertise in AI techniques and methodologies. Furthermore, with my background in astrophysics and numerical modelling, I already have a solid foundation for grasping AI concepts and being able to efficiently apply them to the study of SCs.

The selection of *prg.ai* as the secondment host exemplifies my strong commitment to interdisciplinarity. Combining the fields of astrophysics and AI development is an innovative approach to studying SCs. By immersing myself in a non-academic AI-focused environment, I will promote and foster collaboration across different disciplines, gaining insights and expertise from professionals outside the traditional astrophysics domain. This fusion of knowledge and perspectives will also lead to new discoveries in astronomy and potential business opportunities for AI. Additionally, being one of the first to include AI in astrophysical research within the Czech Republic and at ASU showcases the pioneering nature of my research project ECLIPSE and the potential for advancing both scientific and technological frontiers. This will undoubtedly attract new talents to my country, as well as introduce more versatility in my scientific profile, which will allow me to reach academic and non-academic positions worldwide. Both of these aspects show the potential for international mobility during and after the end of my programme.

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Zápis z jednání Steering Committee MERIT ze dne 11.12.2023

Přítomni:

- [redacted] – předsedající Steering Committee
- [redacted] – člen Steering Committee
- [redacted]. – člen Steering Committee
- [redacted] – členka Steering Committee
- [redacted] – Programová manažerka MERIT
- [redacted] – Finanční manažerka MERIT

Omluvena:

- [redacted] – členka Steering Committee

Agenda:

1. **Zahájení, schválení programu schůze**

Program schůze:

- **Rekapitulace stavu úkolů z minulého jednání**
- **Představení výběrového procesu**
- **Schvalování předložených projektů**
- **Termíny následujících jednání + zamyšlení nad informacemi potřebnými pro monitoring vědeckých projektů**

Návrh usnesení:

Řídicí komise MERIT bere na vědomí program jednání.

Výsledky hlasování

Pro: 4; Proti: 0

Přijaté usnesení:

Řídicí komise MERIT bere na vědomí program jednání.

2. **Úkoly z minulého jednání**

- Vytvořeno sdílené úložiště pro členy SC v prostředí Microsoft 365
- Aktualizovaný jednací řád a seznam zúčastněných partnerských institucí programu MERIT poslán členům SC
- Připravena Dohoda o mlčenlivosti (Non-disclosure agreement) kvůli zajištění důvěrnosti informací členů Steering Committee, podepsána všemi členy (přílohy tvořily ještě prohlášení v AJ: Prohlášení o důvěrnosti, neexistenci střetu zájmů a nediskriminaci, kvůli splnění podmínek projektu vůči EU)

Návrh usnesení:

Řídicí komise MERIT bere na vědomí stav úkolů z minulého jednání.

Výsledky hlasování

Pro: 4; Proti: 0

Přijaté usnesení: *Řídicí komise MERIT bere na vědomí stav úkolů z minulého jednání.*

3. **Stručné představení výběrového procesu**

- PPT prezentace Programové manažerky

Návrh usnesení:

Řídicí komise MERIT bere na vědomí informaci o průběhu výběrového procesu první výzvy programu MERIT.

Výsledky hlasování

Pro: 4; Proti: 0

Přijaté usnesení: *Řídicí komise MERIT bere na vědomí informaci o průběhu výběrového procesu první výzvy programu MERIT.*

4. **Schvalování předložených projektů**

- Členům komise byla předem sdílena tabulka s přehledem kandidátů, jejich umístění, včetně navrhovaných secondmentů, stručné abstrakty řešených projektů, a dále kompletní projektové návrhy a hodnotící reporty z obou kol hodnocení
- Všechny projekty prošly hodnocením v mezinárodním transparentním výběrovém řízení v souladu s pravidly programu MERIT.

Návrh usnesení:

Řídicí komise schvaluje celkem 23 projektů předložených do první výzvy programu MERIT, z nichž 15 projektů, které získaly v hodnocení nejvyšší skóre, budou podpořeny, a 8 rezervních projektů může být podpořeno v případě, že některý z podpořených projektů nebude realizován.

Výsledky hlasování

Pro:4 ; Proti: 0

Přijaté usnesení – *Řídicí komise schvaluje celkem 23 projektů předložených do první výzvy programu MERIT, z nichž 15 projektů, které získaly v hodnocení nejvyšší skóre, budou podpořeny, a 8 rezervních projektů může být podpořeno v případě, že některý z podpořených projektů nebude realizován.*

Řídící komise zároveň navrhuje prověřit zejména ruské žadatele a žadatele z třetích zemích z důvodu bezpečnostního rizika realizace jejich projektů (BIS).

5. **Plán pro druhou výzvu a termíny následujících setkání**

- ČERVENEC 2024 – monitoring po prvním reportovacím období (zprávy o průběhu realizace projektů, komunikační a diseminační aktivity vědců, účast vědců na akcích SIC apod.)
- ZÁŘÍ 2024 – schvalování projektů vybraných v druhé výzvě programu

- LEDEN 2025 – monitoring po druhém reportovacím období (zprávy o průběhu realizace projektů, komunikační a diseminační aktivity vědců, účast vědců na akcích SIC apod.)

Návrh usnesení:
Řídicí komise MERIT bere na vědomí plán pro druhou výzvu programu a termíny následujících jednání.
Výsledky hlasování
Pro:4; Proti: 0
Přijaté usnesení
Řídicí komise MERIT bere na vědomí plán pro druhou výzvu programu a termíny následujících jednání.
Řídíce komise stanovila termín na příští setkání k prvnímu reportovacímu období dne 25.7.2024.

6. **Zamyšlení nad informacemi potřebnými pro monitoring projektů**

- Monitoring bude probíhat jednou za 6 měsíců, informace budou pravidelně poskytovány ze strany výzkumných organizací (supervizor + vybraný stážista)

Návrh usnesení:
Řídicí komise MERIT bere na vědomí obsah monitorovacího reportu a schvalují navržené změny.
Výsledky hlasování
Pro:4.; Proti:0
Přijaté usnesení
Řídicí komise MERIT bere na vědomí obsah monitorovacího reportu a schvaluje navržené následující změny, které budou vloženy do monitorovacího reportu:
- neúspěchy a případné změny projektu,
- informace, zda je projekt v souladu s harmonogramem,
- informace o tom, v jakém stavu se projekt nachází,
- milníky projektu.
Monitorovací Report bude upraven a poslán Řídicí komisi k odsouhlasení.

Zapsala:
[redacted]
Programová manažerka MERIT

Zápis ověřil:
[redacted]
Předsedající Steering Committee

Příloha: Seznam schválených projektů

Seznam 15 kandidátů s nejvyšším skóre

Name of the candidate	Host organisation	Final score
[redacted]	ELI Beamlines Facility - The Extreme Light Infrastructure ERIC	95,8
[redacted]	Institute of Animal Physiology and Genetics of the Czech Academy of Sciences	95,7
[redacted]	National Institute of Mental Health	94,7
[redacted]	Astronomical Institute of the Czech Academy of Sciences	89,9
[redacted]	Astronomical Institute of the Czech Academy of Sciences	89,7
[redacted]	Institute of Animal Physiology and Genetics of the Czech Academy of Sciences	87,8
[redacted]	Institute of Thermomechanics of the Czech Academy of Sciences	85,6
[redacted]	Astronomical Institute of the Czech Academy of Sciences	84,1
[redacted]	ELI Beamlines Facility - The Extreme Light Infrastructure ERIC	83,3
[redacted]	Czech University of Life Sciences Prague	82,3
[redacted]	Institute of Physics of the Czech Academy of Sciences / HiLASE	81,5
[redacted]	Czech Technical University in Prague, Czech Institute of Informatics, Robotics, and Cybernetics	81,4
[redacted]	Research Institute of Geodesy, Topography and Cartography	81,1
[redacted]	Institute of Physics of the Czech Academy of Sciences / HiLASE	80,1
[redacted]	UCEEB Czech Technical University in Prague, University Centre for Energy Efficient Buildings	78,9

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Seznam 8 rezervních kandidátů

Name of the candidate	Host organisation	Final score
[redacted]	National Institute of Mental Health	76,8
[redacted]	Institute of Microbiology of the Czech Academy of Sciences	76,1
[redacted]	Research Institute of Geodesy, Topography and Cartography	76,1
[redacted]	Astronomical Institute of the Czech Academy of Sciences	74,7
[redacted]	UCEEB Czech Technical University in Prague, University Centre for Energy Efficient Buildings	74,6
[redacted]	National Institute of Mental Health	74,5
[redacted]	Institute of Animal Physiology and Genetics of the Czech Academy of Sciences	73,8
[redacted]	ELI Beamlines Facility - The Extreme Light Infrastructure ERIC	73,6