



UNIVERSITY OF TARTU

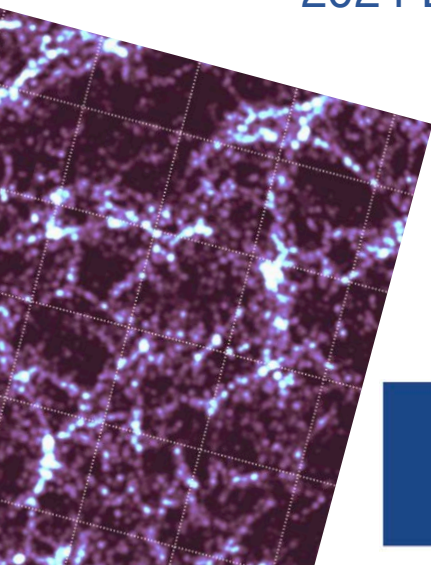
EXCOSM project overview

Elmo Tempel

2024 EXCOSM kick-off



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the European Union**



**BUILDING EXCELLENCE IN THE STUDY OF GALAXIES AND COSMOLOGY AT THE
UNIVERSITY OF TARTU (EXCOSM)**



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BUILDING EXCELLENCE IN THE STUDY OF GALAXIES AND COSMOLOGY AT THE UNIVERSITY OF TARTU (EXCOSM)

The ambition of the University of Tartu (UTARTU) is to actively participate in the next-generation galaxy evolution surveys that allow to map the cosmic web in unprecedented details.

Building upon its strengths in analysing current observational surveys, and thanks to the knowledge transfer from Leibniz Institute for Astrophysics Potsdam (AIP, Germany), University of Groningen (RUG, the Netherlands) and Université de Lorraine (UL, France), UTARTU will be able to become an expert and valuable partner in the studies of galaxies and their cosmic web environment.



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Project description



Enhancing University of Tartu's research capacity in galaxy and cosmology studies

Combined with new analytical frameworks, astronomical surveys and simulation data enable statistical inference to address unsolved questions about the formation and evolution of galaxies. The environment of galaxies significantly influences star formation, mass assembly, and orientation within cosmic web filaments. Success in these studies requires expertise in observations, cosmological simulations, cosmic web theory, and applied mathematics. In this context, the EU-funded EXCOSM project aims to enhance the University of Tartu's research capacity in hydrodynamical simulations, cosmic web theory, and spatial analysis. UTARTU will collaborate with partners to develop an improved cosmic web modelling method. This collaboration will strengthen partnerships, raise UTARTU's international visibility, and contribute to the understanding of cosmic web studies and galaxy evolution.



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Project Information

EXCOSM

Grant agreement ID: 101159513

DOI

[10.3030/101159513](https://doi.org/10.3030/101159513)

EC signature date

16 April 2024

Start date

1 October 2024

End date

30 September 2027

Funded under

Widening participation and spreading excellence

Total cost

No data

EU contribution

€ 1 499 601,00

Coordinated by

TARTU ULIKOOL

Estonia

Objective



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The current era of large astronomical surveys and simulations produces massive amounts of new data. When combined with new analytical frameworks, it will allow for statistical inference to tackle many unsolved questions, such as the role of the cosmic web in the formation and evolution of galaxies. The current observations show the environment of galaxies plays a major role in the star formation quenching, mass assembly, and even the orientation of the galaxies in the cosmic web filaments. To succeed in studies like this requires combining knowledge and experience in observations, cosmological simulations, cosmic web theory, and applied mathematics. This proposal aims to strengthen the research capacity of the University of Tartu (UTARTU) in these subjects. The advanced partners of the project are internationally renowned experts in hydrodynamical simulations, cosmic web theory, cosmic web finders, and applied geometric and spatial analysis. Thanks to the knowledge transfer from advanced partners, this project will provide UTARTU with the required expertise to actively participate in the next-generation galaxy evolution surveys that allow mapping of the cosmic web in unprecedented detail. In collaboration with the partners, an improved method for cosmic web modelling will be developed that builds on the experience of the Bisous model (developed in UTARTU) and other cosmic web finders that the partners have developed (DisPerSE, NEXUS+, VWEB). This new GalaxyWeb model aims to simultaneously detect the groups and filaments directly from the observed redshifts of galaxies and work efficiently with significantly higher target densities and the non-trivial selection functions of the next-generation surveys. This twinning proposal will help ensure long-term mutually beneficial collaboration between the four project partners, raise the international visibility and attractiveness of UTARTU, and contribute to the cosmic web studies and understanding of galaxy evolution.



UNIVERSITY OF TARTU
Tartu Observatory

Rien van de Weygaert



university of
groningen

Noam Libeskind



Leibniz-Institut für
Astrophysik Potsdam

Radu Stoica



UNIVERSITÉ
DE LORRAINE

EXCOSM

Partners



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Long-term collaboration between TO and project partners

- PhD students:
 - Punyakoti Ganeshaiah Veena (2016-2020, Rien van de Weygaert, Elmo Tempel)
 - Maarja Bussov (2016-2020, Elmo Tempel, Radu Stoica)
- Postdocs:
 - Elmo Tempel (AIP 2016-2018)
 - Moorits Muru (AIP 2024-2026)
- Common research papers:
 - Tempel-Libeskind 24 papers (2013-2023)
 - Tempel-Stoica 9 papers (2013-2023)
 - Tempel-van de Weygaert 4 papers (2018-2021)
 - Tempel-Libeskind-Stoica-van de Weygaert 1 paper (2018)

EXCOSM

Project Roots



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Department of physics of galaxies and cosmology
Tartu Observatory
University of Tartu





PUTJD1203 (Moorits Mihkel Muru) — Potsdam AIP

Milky Way's and Andromeda's satellite galaxies' properties in state-of-the-art simulation HESTIA

PSG700 (Rain Kipper)

Mapping the dark matter of our Galaxy

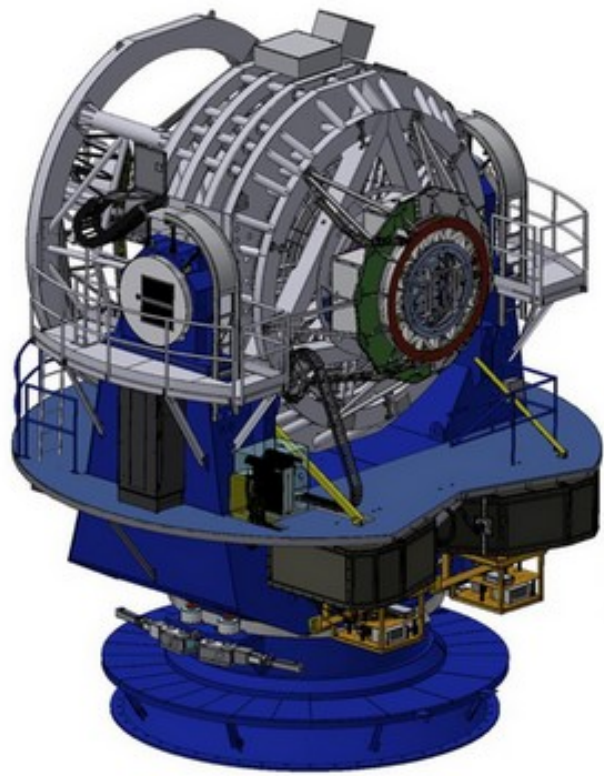
PSG938 (Maria Benito)

Dynamics in the Solar Neighbourhood: Acceleration Field and Matter Content (DYSNEI)

Physics of Galaxies and Cosmology

Overview of grants — JD & PSG





PRG1006 (Elmo Tempel)

Co-evolution of galaxies and the cosmic web



PRG2159 (Indrek Vurm)

Radiative and dynamical modeling of engine-powered superluminous supernovae

PRG2172 (Antti Tamm)

Galaxies out of nothing - the J-PAS view

Physics of Galaxies and Cosmology

Overview of grants — PRG



FOUNDATIONS OF THE UNIVERSE.

Luckiesh, M.

Note: This is not the actual book cover

TK202 (Elmo Tempel) — KBFI, TÜ, TalTech

Centre of Excellence: Foundations of the Universe

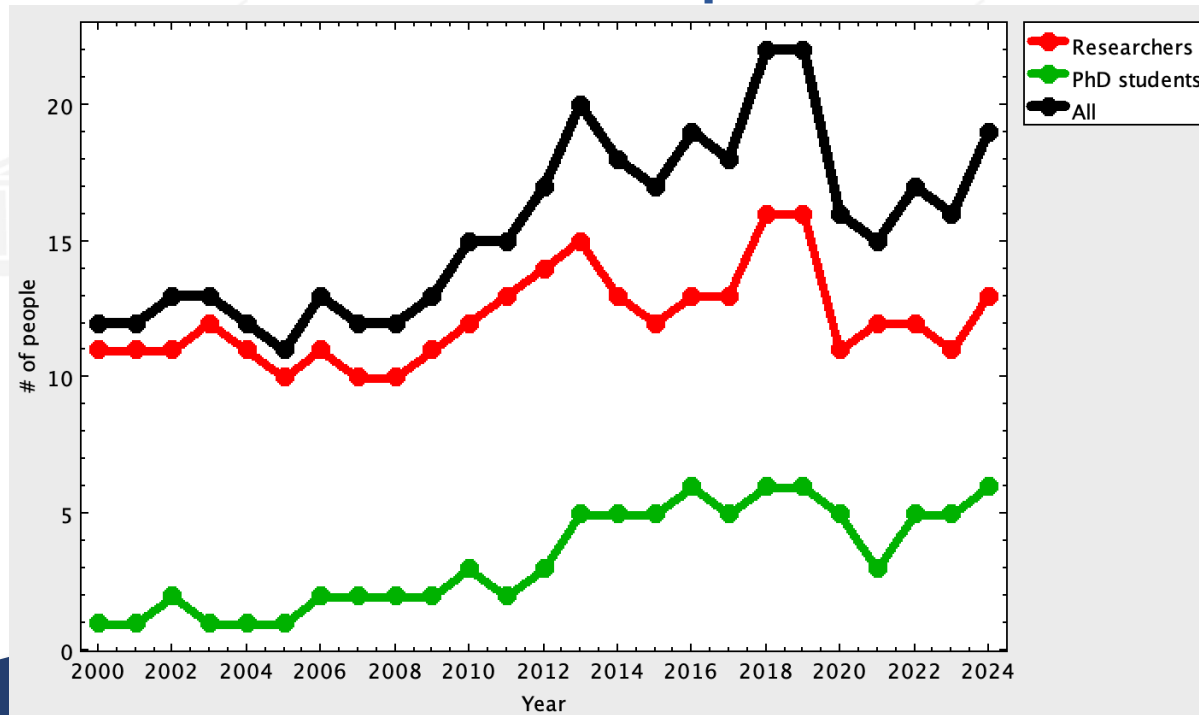
EXCOSM (Elmo Tempel) — EU Twinning grant

Building excellence in the study of galaxies and cosmology
at the University of Tartu

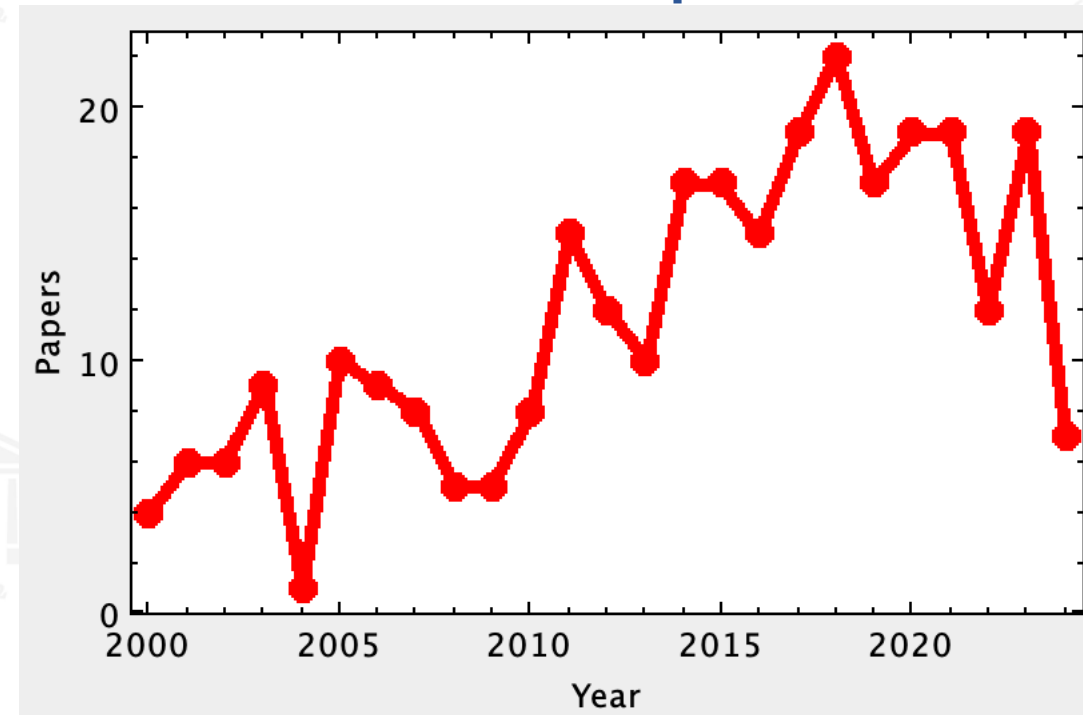
Physics of Galaxies and Cosmology

Overview of grants — TK & Twinning

Number of People

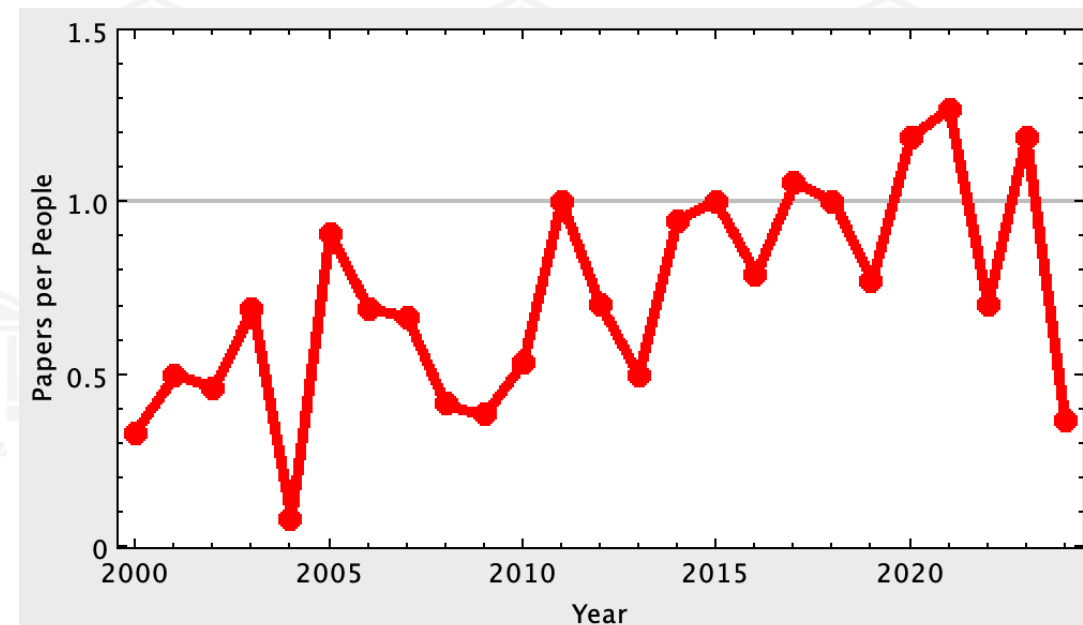


Number of Papers



Physics of Galaxies and Cosmology

General statistics about the department





EXCOSM project details



Objective 1: To strengthen research capacity of the UTARTU Galaxy Physics and Cosmology group

Objective 2: To improve multiple areas of research management at UTARTU

Objective 3: To ensure long-term mutually beneficial collaboration between the four project partners

Objective 4: To implement a cutting-edge pilot research project allowing UTARTU to apply its new knowledge and lay the foundation for future research

Objective 5: To raise international visibility and attractiveness of UTARTU

EXCOSM

Objectives

DATA from multi-object spectroscopic survey facilities: WEAVE, DESI, MOONS, 4MOST, etc

UL:

Advanced applied **mathematics**
methods, cooperation with
multiple disciplines

Knowledge & skills transfer

UTARTU:

Analysis of **observation** data;
observation selection function;
mathematical models;
computing facilities; 4MOST

AIP:

N-body & hydrodynamical
simulations; computing
facilities; 4MOST; funding
ERC funding success;
financial management

RUG:

Simulations of gas accretion & outflow
processes; cosmic web **theory** & galaxy;
evolution; computing facilities; 4MOST;
MSCA funding success; pre- & post-
award; project management

Observation selection
function

GalaxyWeb
model

Understanding of Cosmic Web & Galaxy Evolution

Application of developed mathematical
methods in other fields



WP1 (UTARTU) Project management

WP4 (RUG)

Improving UTARTU research management, enhancing networking and sustainability of the partnership

WP 2 (AIP)

**Knowledge transfer in
cosmological hydrodynamical
simulations and cosmic web
theory**

WP3 (UTARTU/UL)

**Pilot Research Project:
Characterising the cosmic web
environment and connectivity**

WP5 Dissemination and communication

Work package WP1 – Project management

Work Package Number	WP1	Lead Beneficiary	1 - UTARTU
Work Package Name	Project management		
Start Month	1	End Month	36

Objectives
O1.1 To set up effective project management structures and communication channels.
O1.2 To monitor the activities of the participants and ensure progress towards the milestones, deliverables, and objectives of the project in line with the EC rules and requirements.
O1.3 To ensure data management is in line with FAIR principles.

Work package WP2 – Knowledge transfer in cosmological hydrodynamical simulations and cosmic web theory

Work Package Number	WP2	Lead Beneficiary	2 - AIP
Work Package Name	Knowledge transfer in cosmological hydrodynamical simulations and cosmic web theory		
Start Month	2	End Month	34

Objectives
O2.1 To increase UTARTU knowledge on how to work with hydrodynamical simulations data. O2.2 To transfer knowledge to UTARTU on cosmic web theory from simulations and observations perspective. O2.3 To enhance UTARTU expertise in applied mathematics. O2.4 To promote internal collaboration between various fields of space research at UTARTU. O2.5 To organize an international summer school for PhDs on Large-scale structure of the Universe.

Work package WP3 – Pilot Research Project: Characterising the cosmic web environment and connectivity

Work Package Number	WP3	Lead Beneficiary	1 - UTARTU
Work Package Name	Pilot Research Project: Characterising the cosmic web environment and connectivity		
Start Month	13	End Month	36

Objectives
O3.1 To develop an innovative GalaxyWeb model for cosmic web characterisation
O3.2 To test the developed model using cosmological simulations
O3.3 To compare the developed model with currently available algorithms
O3.4 To construct group and filament catalogues based on the GalaxyWeb model applied to the 4MOST survey data

Work package WP4 – Improving UTARTU research management, enhancing networking and sustainability of the partnership

Work Package Number	WP4	Lead Beneficiary	3 - RUG
Work Package Name	Improving UTARTU research management, enhancing networking and sustainability of the partnership		
Start Month	2	End Month	36

Objectives
O4.1 To improve UTARTU proposal preparation skills and provide it with experience in leading various types of proposals
O4.2 To enhance UTARTU project management and post-award practices
O4.3 To increase networking between project partners
O4.4 To ensure long-term sustainability of the partnership
O4.5 To promote gender equality and inclusive working environment

Work package WP5 – Dissemination and communication

Work Package Number	WP5	Lead Beneficiary	1 - UTARTU
Work Package Name	Dissemination and communication		
Start Month	1	End Month	36

Objectives
O5.1 To set up infrastructure for effective project dissemination and communication O5.2 To raise research profile of UTARTU O5.3 To raise attractiveness of UTARTU as a mobility destination for talents O5.4 To stimulate interest in project topics among the general public and promote the field among young female students O5.5 To organize a high-profile final conference to disseminate project results to target audiences

Work Package No	Work Package name	Lead Beneficiary	Effort (Person-Months)	Start Month	End Month	Deliverables
WP1	Project management	1 - UTARTU	16.00	1	36	D1.1 – Project Management and Risk Management Plan D1.2 – Data Management Plan D1.3 – Interim staff exchange and progress report
WP2	Knowledge transfer in cosmological hydrodynamical simulations and cosmic web theory	2 - AIP	43.00	2	34	D2.1 – Summer school report D2.2 – Scientific goal for Observing time proposal D2.3 – Scientific goal for Computing time proposal
WP3	Pilot Research Project: Characterising the cosmic web environment and connectivity	1 - UTARTU	44.00	13	36	D3.1 – List of submitted and published research papers and submitted proposals
WP4	Improving UTARTU research management, enhancing networking and sustainability of the partnership	3 - RUG	32.00	2	36	D4.1 – Joint research strategy (first version) D4.2 – Joint research strategy D4.3 – Set of proposal preparation and management guidance
WP5	Dissemination and communication	1 - UTARTU	28.00	1	36	D5.1 – Project website D5.2 – Plan for dissemination, exploitation and communication activities D5.3 – Update on dissemination and exploitation activities plan

Deliverable No	Deliverable Name	Work Package No	Lead Beneficiary	Type	Dissemination Level	Due Date (month)
D1.1	Project Management and Risk Management Plan	WP1	1 - UTARTU	R — Document, report	PU - Public	4
D1.2	Data Management Plan	WP1	1 - UTARTU	DMP — Data Management Plan	PU - Public	6
D1.3	Interim staff exchange and progress report	WP1	1 - UTARTU	R — Document, report	SEN - Sensitive	17
D2.1	Summer school report	WP2	1 - UTARTU	R — Document, report	PU - Public	14
D2.2	Scientific goal for Observing time proposal	WP2	1 - UTARTU	R — Document, report	SEN - Sensitive	18
D2.3	Scientific goal for Computing time proposal	WP2	1 - UTARTU	R — Document, report	SEN - Sensitive	26
D3.1	List of submitted and published research papers and submitted proposals	WP3	1 - UTARTU	R — Document, report	PU - Public	36
D4.1	Joint research strategy (first version)	WP4	1 - UTARTU	R — Document, report	SEN - Sensitive	9
D4.2	Joint research strategy	WP4	1 - UTARTU	R — Document, report	SEN - Sensitive	33
D4.3	Set of proposal preparation and management guidance	WP4	1 - UTARTU	R — Document, report	SEN - Sensitive	34
D5.1	Project website	WP5	1 - UTARTU	DEC —Websites, patent filings, videos, etc	PU - Public	1
D5.2	Plan for dissemination, exploitation and communication activities	WP5	1 - UTARTU	R — Document, report	PU - Public	6
D5.3	Update on dissemination and exploitation activities plan	WP5	1 - UTARTU	R — Document, report	PU - Public	35

Milestone No	Milestone Name	Work Package No	Lead Beneficiary	Means of Verification	Due Date (month)
1	Project management structures set up	WP1, WP5	1 - UTARTU	Project Management (PM) team and Steering Committee (SC) were established. Kick-off took place. Project Management Plan (D1.1) submitted and adopted. Project webpage (D5.1) is set up and in active use.	4
2	Dissemination and communication strategies formulated	WP1, WP5	1 - UTARTU	Plan for dissemination, exploitation and communication activities (D5.2) and Data Management Plan (D1.2) is submitted.	6
3	Summer school to PhD students took place	WP3, WP2	1 - UTARTU	Summer School "Large scale structure of the Universe: from cosmology to galaxies" took place and summer school summary report is submitted (D2.1)	14
4	Networking is underway	WP1, WP4, WP2	1 - UTARTU	First consortium meetings and staff visits took place. Ideas for joint projects emerge: first version of Joint Research Strategy is submitted (D4.1). Interim Staff Exchange and progress report is submitted (D1.3).	17
5	UTARTU scientific knowledge and skills enhanced	WP3, WP5, WP2	1 - UTARTU	Two planned in-person workshops/trainings took place. Observing time proposal is submitted (D2.2). Communication activities for the general public are taking place; UTARTU actively attends conferences and promotes itself among students.	18
6	Sustainability of the partnership ensured	WP3, WP4, WP2	1 - UTARTU	Joint research strategy ready (D4.2) and joint proposals submitted (D2.2, D2.3).	33
7	UTARTU international profile and attractiveness raised	WP3, WP4, WP5	1 - UTARTU	Articles from pilot research submitted/published (D3.1). The final high-profile event (conference)	36

3.1.2 Timing

Project phase (month)	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	31	32	33	34	35	36						
WP1 Project Management (UTARTU)																																										
T1.1 Project coordination	S						S						S				D		S						S					S					S							
T1.2 Project implementation, compliance and reporting				D																																						
T1.3 Data management						D																																				
WP2 Knowledge transfer in cosmological hydrodynamical simulations and cosmic web theory (AIP)																																										
T2.1 Capacity building in analysing state-of-the-art hydrodynamical galaxy formation simulations						E																	D																			
T2.2 Knowledge transfer in cosmic web theory from observations and simulations perspective													E					D																								
T2.3 Enhancing expertise in applied mathematics																			E																							
T2.4 Improving collaboration between various fields of space research																																	E									
T2.5 Summer school Large-scale structure of the Universe: from galaxies to cosmology												E	D																													
WP3 Pilot Research Project: Characterising the cosmic web environment and connectivity (UTARTU/UL)																																					D					
T3.1 Improving galaxy group detection and mass estimation algorithms																																										
T3.2 Improving and Extending the Bisous galaxy filament finder algorithm																																										
T3.3 Developing the GalaxyWeb model for cosmic web detection and characterisation																																										
T3.4 Testing the developed group and filament detection algorithms																																										
WP4 Improving UTARTU research management, enhancing networking and sustainability of the partnership (RUG)																																										
T4.1 Training in proposal preparation and (joint) proposal submission						E							E																					D								
T4.2 Training in project management and guidance on post-award practices																																										
T4.3 Networking and professional connections																								E					E													
T4.4 Long-term sustainability of the partnership and joint strategy								D																									D									
T4.5 Promoting gender equality and inclusivity																																										
WP5 Dissemination and communication (UTARTU)																																										
T5.1 Dissemination and communication plan and tools	D					D						D																														
T5.2 Improved visibility of UTARTU research																																										
T5.3 Increased attractiveness of UTARTU for talented students and PhDs																																										
T5.4 Communication to the general public																																										
T5.5 Final project conference																																				E						
	D = deliverable									S = SC meeting																																

1.2.5 Open science practices and research data and output management

All project partners are committed and experienced in Open Science and FAIR principles, which this project is based upon. **Obtained results and produced training materials will be systematically and as early in the process shared outside the consortium.** This will include:

1.2.6 Gender dimension in EXCOSM

All project partners have gender equality plans, as well as other diversity/equality policies, in place and are committed to providing equal opportunities for women and their inclusion in leadership and decision-making. AIP, for example, has established an Equity and Inclusion Journal Club, where people who care about equality can come together and discuss diversity issues.⁵ In EXCOSM, partners will share their experiences, both successes and failures, in addressing gender equality and diversity in workplace, through

2.2 Measures to maximise impact - Dissemination, exploitation and communication #@COM-DIS-VIS-CDV@#

2.2.1 Plan for the dissemination, exploitation and communication activities

EXCOSM WP5 is dedicated to dissemination and communication activities. Detailed **Plan for dissemination, exploitation and communication activities (D5.2)** will be developed by M6 of the

- **Summer School:** Large-scale structure of the Universe: from galaxies to cosmology
 - 07-11 July 2025, Haapsalu, Estonia (Fra Mare Thalasso Spa Hotel)
- **Conference (~100 participants):** Cosmic Web and Galaxies related
 - Summer 2027, Tartu, Estonia
- **Workshop, led by AIP:** cosmological simulations and writing computing time proposals (Potsdam, March 2025)
- **Workshop, led by RUG:** cosmic web observations and writing observing time proposals (Groningen, autumn 2025)
- **Workshop, led by UL:** applied mathematical methods (Nancy)
- **Workshop, led by TARTU:** decided during the project

EXCOSM

Research related activities

- **UTARTU researcher visits to partner institutes**
- **Presenting our research in conferences**



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Thank you!



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