CURRICULUM OF THE ASTRONOMY MSC PROGRAM

(Notations: K: colloquium; G: practical class mark)

COMPULSORY COURSES:

Subject & responsible teacher	Lecture + practical class; type of reporting for each semester				Total		Credits
	1	2	3	4	L.	P.	
General background:							
A11 Partial differential equation *mc2n1pd1, mc2n2pd1 [J. Karátson]*		2+1 K+G 4 cr.			2	1	4
A21 Relativity fc2n1re1 *[L. Palla]*	2+0 K				2	0	2
A22 Fields and particles fc2n1er1 *[L. Palla]*		2+0 K			2	0	2
Total credits	2	6	0	0	6	2	8
Main material:							
S11 Astronomical instrumentation 1-2 cc2n1mt1, cc3nlmt2 *[Á. Süli]*	2+0 K	0+2 G			2	2	4
S12 Astronomical IT cc2n3ci1 *[E. Forgács-Dajka]*	0+2 G				0	2	2
S13 Astronomical spectroscopy 1-2 cc2n4sp1-2 *[L.V. Tóth]*	0+2 G	0+2 G			0	4	4
S21 Seminar in modern astronomy 1-4 cc2n5cs1-4 *[E. Forgács-Dajka]*	0+2 G	0+2 G	0+2 G	0+2 G	0	8	8
S22 Summer internship cc2n6sg1 *[Á. Süli]*		0+4 G			0	4	4
S31 Observational astronomy 1-4 cc2n1oc1-4 *[K. Petrovay]*	2+0 K	2+0 K	2+0 K	2+0 K	8	0	8
S41 Celestial machanics 1-4 cc2n1em1-4 *[Zs. Sándor]*	2+0 K	2+0 K	2+0 K	2+0 K	8	0	8
S51 Theoretical astrophysics 1-4 cc2n1ea1-4, cc2n2ea1 *[K. Petrovay]*	3+1 K	2+0 K	2+0 K	2+0 K	9	1	10
S61 Galactic astronomy 1-4 cc2n1gc1-4 *[L.V. Tóth]*	2+0 K	2+0 K	2+0 K	2+0 K	8	0	8
S62 Structure of the Universe 1-2 cc2n1us1-2 *[L. Dobos]*			2+0 K	2+0 K	4	0	4
Total credits	16	18	12	12	39	21	60

OPTIONAL COURSES:

Subject & responsible teacher	Lecture + practical class; type of reporting for each semester				Total		Credits
	1	2	3	4	L.	P.	
K Optional courses in the subject field	4+0 K	0+4 G	4+0 K	0+4 G	8	8	16
V Optional courses in other subjects	4+0 K	2+0 K			6	0	6
D Thesis work 1-2 *cc2n5ssa, cc2n5ssb [K. Petrovay]*			0 S	0 S	0	0	0
Total credits	4	6	4	0	14	8	22
Grand total	26	30	22	12	51	39	90

Optional courses on offer (non-exclusive list):

Subject & responsible teacher	Lecture + practical class; type of reporting for each semester		Total		Credits
	fall semester	spring semester.	L.	P.	
Radio astronomy 1-2 *{S. Frey]*	2+0 K	2+0 K	4	0	4
Infrared astronomy 1-2 *[L. V. Tóth]*	2+0 K	2+0 K	0	4	4
Astrostatistics 1-2 *[L. Balázs]*	2+0 K	2+0 K	4	0	4
Dynamics of stellar systems 1-2 *[L. Balázs]*	2+0 K	2+0 K	4	0	4
Advanced IT in astronomy IT 1-2 *[E. Forgács-Dajka]*	2+0 K	2+0 K	4	0	4
Astronomy from space 1-2 *[L. V. Tóth]*	2+0 K	2+0 K	4	0	4
The history of astronomy 1-2 *{G. Kutrovátz]*	2+0 K	2+0 K	4	0	4
Introduction to astronomy 1-4 *[K. Petrovay]*	4+0 K	4+0 K	4	0	8
Astrometry 1-2 *[Á. Süli]*	2+0 K	2+0 K	4	0	4
Astrophysics 1-2 *[K. Petrovay]*	2+0 K	2+0 K	4	0	4
IT in astronomy 1-3 *[Á. Süli]*	0+4 G	0+2 G	0	6	6

The list is non-exclusive, further optional courses are offered every year.

Course title: Advanced Astronomical Information Technology 1-2	**Credits: 2 x 2 = 4**
Type of class: lecture + practical class, and number of 45-min classes per week, for each semester: 2 + 0, 0 + 2 Language of teaching: English	
Type of reporting (colloquium / practical mark / other): colloquium	
Recommended semester: 1 - 2	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): Semester 1: Review of programming skills: algorithms, C or C++ programming languages. Overview of the basic numerical methods; implementing Euler's method; implementing Runge-Kutta methods; elements of parallel programming; CUDA / OpenMP / MPI Semester 2: overview of astronomical image processing; IDL (Interactive Data Language) programming language; data analysis using IDL; image processing using IDL; IDL Astronomy Users Library (http://idlastro.gsfc.nasa.gov)	
Recommended reading: Press & Teukolsky: Numerical recipes. 3rd ed., Cambridge UP, 2007 Bowman: An introduction to programming with IDL. Academic press, 2005	
Responsible teacher (*name*, *position*, *degree*)**:** E. Forgács-Dajka, assistant professor, PhD	
Other teachers involved:	

Course title: Astrometry 1-2	**Credits: 2 x 2 = 4**

Type of class: lecture + seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester:

Lecture, 2 + 0

Language of teaching: English

Type of reporting (colloquium / practical mark / other): colloquium

Recommended semester: 1-2

Preconditions: none

Course summary (knowledge/competencies to be acquired):

Semester 1 focuses on the basics of astrometry (coordinate systems, time, effects perturbing the observations) and the methods of transformations and reductions. Particular attention is paid on the acquirement of skills in conversion calculations.

Topics: Spherical astronomy; Astronomical coordinate systems; Transformation between coordinate systems; Rising and setting of celestial bodies; Time and calendar; Effects perturbing the observations; Precession and nutation

Semester 2 gives on introduction to the subject of celestial mechanics.

Topics: Two-body problem; Elliptical motion; Orbital elements and their connections to the constants of integration; Kepler's laws; Orbit determination from three observations; Restricted three-body problem; Jacobi-integral and zero-velocity curves; Stability of the equiblirium points; Perturbation theory; Dynamics of the Solar System

Recommended reading:

Smart & Green: Textbook on spherical astronomy. Cambridge UP, 1977

Smart: Celestial mechanics. Literary Licensing, 2013

Responsible teacher (*name*, *position*, *degree*)**:** Áron Süli, assistant professor, PhD

Other teachers involved

Course title: Astronomical instrumentation 1-2	**Credits: 2 x 2 = 4**
Type of class: lecture + seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester: Lecture / practical class; 2 + 0, 0 + 2 Language of teaching: English	
Type of reporting (colloquium / practical mark / other): colloquium / practical mark	
Recommended semester:	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): Semester 1: Overview of large astronomical databases and their uses. Observational and practical work, guided reading. Topics: Identification of objects in astronomy; The evolution of notation, naming and catalogization of stars and stellar like objects; Modern stellar catalogs, their contents and usage; Partition of the sky, the role of the constellations; Sky maps, sky atlases; SAO Atlas, Large photographic surveys, Carte du Ciel, NGS-POSS, SDSS Semester 2: Introduction to observational and data analysis techniques in astronomy. Basics of CCD technology and processing of the raw data from a CCD unit. Topics: Astronomical coordinate systems; Introduction to the Izsák telescope and CCD camera; Introduction to the principles of CCD cameras, photo effect, charge coupling; Major sources of noise in CCD images: dark current, pixel non-uniformity, shot noise, CCD read noise. Introduction to Linux and IRAF; Guided night observations - star clusters and other objects; Individual telescope practice, dark current and flatfields; Introduction to spectroscopy	
Recommended reading: Kitchin: Astrophysical techniques. 5th ed., Taylor & Francis, 2009,ISBN 978-1-4200-8243-2.	
Responsible teacher (*name*, *position*, *degree*)**:** Áron Süli, assistant professor, PhD	
Other teachers involved	

Course title: Astronomical Information Technology	**Credits: 2**
Type of class: laboratory classification / consultation. and number of 45-min classes per week, for each semester: practical class, 0 + 2 Language of teaching: English	
Type of reporting (colloquium / practical mark / other): practical mark	
Recommended semester: MSc Semester 1	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): Review of programming skills: - algorithms - C / C++ programming language Introduction to astronomical image processing: - technical images (bias/dark/flat) - astronomical image format (fits) Introduction to IDL (Interactive Data Language) programming language: - IDL used for data input/output/analysis - IDL used for fits image format - IDL used for scientific visualization - using the IDL Astronomy Users Library (http://idlastro.gsfc.nasa.gov)	

Recommended reading: Press & Teukolsky: Numerical recipes. 3rd ed., Cambridge UP, 2007 Bowman: An introduction to programming with IDL. Academic press, 2005:
Responsible teacher (*name*, *position*, *degree*)**:** Emese Forgács-Dajka, assistant professor, PhD
Other teachers involved:

Course title: Astronomical spectroscopy 1-2	**Credits: 2 x 2 = 4**

Type of class: lecture/ seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester:

lab, 0 + 2

Language of teaching: English

Type of reporting (colloquium / practical mark / other): practical mark

Recommended semester: 1-2

Preconditions: none

Course summary (knowledge/competencies to be acquired):

- Electromagnetic radiation, astronomical sources in the visible and other spectral ranges
- History and basics of astronomical spectroscopy
- Spectroscopes, how they work and their application in astrophysics
- Infrared and ultraviolet spectra of stars, interstellar medium, galaxies, AGN-s
- X-ray sources and their spectra
- Spectral analysis software tools: IDL, IRAF, and CLASS (GILDAS)
- Reduction and analysis of HI 21cm, CO (J=1-0) 2,6mm and NH_3 (1,1) 1,3cm spectra
- Reduction and analysis of optical spectra of stars, spectral classification
- Reduction and analysis of optical spectra of galaxies, determination of redshift
- Writing spectroscopic observation proposals for measurements with facility telescopes: one for the visible and one outside the visible range

Recommended reading:

Philip Massey and Margaret M. Hanson, „Astronomical Spectroscopy”, http://www.physics.uc.edu/~hanson/AstronomicalSpectroscopy.pdf

Responsible teacher (*name*, *position*, *degree*)**:** L. Viktor Tóth, ass. prof., PhD

Other teachers involved: -

Course title: Astronomy from space 1-2	**Credits: 2 x 2 = 4**

Type of class: lecture/ seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester:

lecture, 2 + 0

Language of teaching: English

Type of reporting (colloquium / practical mark / other): colloquium

Recommended semester: 1-2

Preconditions: none

Course summary (knowledge/competencies to be acquired):

- Motivation for space research, scientific and social environment, political and legal issues
- Phases of space missions, critical points and examples
- Chronology and milestones of lunar and planetary exploration
- High energy and infrared astronomy and space applications
- Space observatories and observations
- Orbits, trajectories and maneuvers
- Rocket engines and fuels and their use
- Launch vehicles, and spaceports
- On-board systems
- Hungarian space research, achievements and science teams
- Major space research and technology institutions and organizations (ESA, NASA, JAXA)

Recommended reading:

Basics of Space Flight (2013), NASA, http://www2.jpl.nasa.gov/basics/index.php)

Responsible teacher (*name*, *position*, *degree*)**:** L. Viktor Tóth, ass. prof., PhD

Other teachers involved: -

Course title: Astrophysics 1-2	**Credits: 2 x 2 = 4**
Type of class: lecture + practical class, and number of 45-min classes per week, for each semester: 2+0 Language of teaching: English	
Type of reporting (colloquium / practical mark / other): colloquium	
Recommended semester: 1 - 2	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): Semester 1: Elements of potential theory,: shell theorems, virial theorem, Poisson equation. Basics of cosmology. Elements of radiative transfer. Thermal radiation. Random walk, diffusive approximation, transport coefficients, Rosseland opacity. Equations of stellar structure. Overview of stellar evolution. Semester 2: Eddington's critical luminosity. Stellar winds and driving mechanisms. Parker's solar wind model. Spherical (Bondi) accretion. Scattering in 1/r potential. Application to plasmas: transport coefficients. Application to stellar systems: stellar encounters, collisional relaxation. Basics of stellar dynamics. Elements of gravitational lensing. Free-free transitions, bremsstrahlung. Thermal bremsstrahlung. Elements of the theory of accretion, thin accretion disks, Shakura-Sunyaev model.	
Recommended reading: Kutner: Astronomy – A physical perspective. Cambridge UP, 2003 Bradt: Astrophysics processes. Cambridge UP, 2008.	
Responsible teacher (*name*, *position*, *degree*)**:** Kristóf Petrovay	
Other teachers involved: Zs. Sándor	

Course title: Astrostatistics 1-2	**Credits: 2 x 2 = 4**
Type of class: lecture + practical class, and number of 45-min classes per week, for each semester: 2+0 Language of teaching: English	
Type of reporting (colloquium / practical mark / other): colloquium	
Recommended semester: 1 - 2	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): Fundamental principles and results of broad fields of statistics applicable to astronomical research. The material is roughly at a level of advanced undergraduate courses in statistics. Semester 1: Probability; Statistical inference; Probability distribution functions; Nonparametric statistics; Data Smoothing; Semester 2: Regression; Multivariate analysis; Clustering, classification; Censored and truncated data; Time series analysis; Spatial point processes;	
Recommended reading: Eric D. Feigelson and Jogesh H. Babu: Modern Statistical Methods for Astronomy With Applications, Cambridge, University Press	
Responsible teacher (*name*, *position*, *degree*)**:** Lajos Balázs, private professor, DSc	
Other teachers involved:	

Course title: Celestial Mechanics 1-4	**Credits: 4 x 2 = 8**
Type of class: lecture + seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester: Lecture, 2 + 0 Language of teaching: English	
Type of reporting (colloquium / practical mark / other): colloquium	
Recommended semester: 1-4	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): Semester 1: General perturbation theory Canonical perturbation theory: Hamilton-Jacobi method, action-angle variables. The fundamental theorem of perturbation theory, Delaunay's lunar theory and elimination method. Poincaré-Zeipel method. Theory of resonant perturbations. Lie transform perturbation theory. Superconvergent perturbation theory. Ordered and chaotic motions: KAM theory. Ordered and chaotic orbits in the restricted three-body problem. Lyapunov indicators. Poincaré mappings. Hénon-Heiles problem. Symplectic mappings, symplectic integrators. Semester 2: Dynamics of planetary systems Resonances of first and second order. Resonant encounters, capture into and passing through a resonance. Multiple resonances. Resonances in the Solar System. Dynamics of the Solar System: Motion of giant planets. Stability of the Solar System. Rotation of the planets and moons. Dynamics of resonant asteroids. Exoplanetary systems: Dynamical classification of multiple planetary systems. Resonant, interacting and hierarchical systems. Planet-disk interactions. Stability of exoplanetary systems. Semester 3: The three-body problem The general three-body problem: Equations of motion and first integrals. The Lagrange-Jacobi equation. Classification of final configurations. The Euler-Lagrange solutions. The restricted three-body problem: Equations of motion, the Jacobi-integral. Equilibrium solutions and their stability. Zero velocity curves. Regularization transformations. Periodic and numerical solutions.	

The elliptic restricted three-body problem. The Hill-problem. Semester 4: Theory of artificial satellites The gravitational potential. Terrestrial gravitational perturbations. Lunisolar perturbations. Non-gravitational perturbations.
Recommended reading: Smart: Celestial mechanics. Literary Licensing, 2013
Responsible teacher (*name*, *position*, *degree*)**:** Zsolt Sándor, assistant professor, PhD
Other teachers involved

Course title: Dynamics of stellar systems 1-2	**Credits: 2 x 2 = 4**
Type of class: lecture + practical class, and number of 45-min classes per week, for each semester: 2+0 Language of teaching: English	
Type of reporting (colloquium / practical mark / other): colloquium	
Recommended semester: 3 - 4	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): A comprehensive description of the dynamical structure and evolution of galaxies and other stellar systems Semester 1: Introduction; Potential Theory; Orbits of stars; Equilibria of Collisionless Systems Semester 2: Stability of Collisionless Systems; Disk dynamics and spiral structure; Kinetic theory; Collisions and encounters; Galaxy formation	
Recommended reading: James Binney and Scott Tremaine: Galactic Dynamics (Second Edition), Princeton University Press	
Responsible teacher (*name*, *position*, *degree*)**:** Lajos Balázs, private professor, DSc	
Other teachers involved:	

Course title: Fields and particles	**Credits: 2**
Type of class: lecture/ seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester: 2 Language of teaching: English	
Type of reporting (colloquium / practical mark / other):	
Recommended semester: second	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): Variational principle of field theory, Symmetries and conservation laws, Classification of elementary particles and interactions, Quantum electrodynamics and the photon, Weak interaction and the neutrinos, Strong interaction (quarks and hadrons), Symmetry breaking, Foundations of the Standard Model	
Recommended reading: L.B. Okun: Leptons and quarks (North Holland 1984) D.H. Perkins: Introduction to high energy physics (Addison-Wesley 1987) O. Nachtmann: Elementary particle physics (Springer, 1987)	
Responsible teacher (*name*, *position*, *degree*)**: Laszlo Palla, professor, DSc**	
Other teachers involved:	

Course title: Galactic astronomy	**Credits: 4 x 2 = 8**

Type of class: lecture/ seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester:

lecture, 2 + 0

Language of teaching: English

Type of reporting (colloquium / practical mark / other): colloquium

Recommended semester: 1-4

Preconditions: none

Course summary (knowledge/competencies to be acquired):

- Basic properties of the Milky Way galaxy
- Star clusters and associations
- Distance measurements inside and outside the Milky Way
- Stellar kinematics
- Stellar dynamics
- Rotation of the Milky Way
- Spiral structure of the Milky Way
- The central region of the Milky Way, active galactic nuclei
- Galactic halo and corona
- Chemistry, populations, cosmic abundances
- Galactic magnetic fields
- Morphological classification of galaxies
- Photographic and spectroscopic properties of galaxies
- Galaxy formation and evolution
- The Local Universe

Recommended reading:

James Binney & Michael Merrifield, 1998, Galactic Astronomy, Princeton U.P., ISBN: 9780691025650

Simon P. Driver, 2010, Galactic Astronomy, http://star-www.st-and.ac.uk/~spd3/Teaching/AS2001Gal/as2001.html

Responsible teacher (*name*, *position*, *degree*)**:** L. Viktor Tóth, ass. prof., PhD

Other teachers involved: -

Course title: History of Astronomy 1 – 2.	**Credits: 2 x 2 = 4**
Type of class: lecture, 2 + 0 Language of teaching: English	
Type of reporting: colloquium	
Recommended semester: N/A	
Preconditions: none	

Course summary (knowledge/competencies to be acquired):

Competencies:

- a general understanding of the main problems, periods, and paradigms in the history of astronomy
- familiarity with the historical contexts and factors that contributed to the emergence and evolution of fundamental astronomical concepts, problems, and methods
- a basic understanding of astronomy practiced as culture in different civilizations and at various times
- an ability to view astronomical content in a historical dimension
- an implicit grasp of the characteristic methods, questions, and perspectives of professional history of science
- a critical ability to reflect on meta-scientific issues and problems, acquire a rich understanding of the nature of science

Main topics:

Semester 1

- Archeoastronomy
- Ancient Egypt and Mesopotamia
- Ancient China, Mezo-America
- Greek Presocratic period
- Greek standard astronomy and cosmology (Plato, Eudoxus, Aristotle)
- Greek non-standard astronomy and cosmology (Heracleides, Aristarchus)
- Greek technical astronomy (Hipparchus, Ptolemy)
- Medieval Islamic Astronomy
- Medieval period in Europe
- Early Renaissance in Europe
- Copernicus in general

- Copernicus in details (*vs*. Ptolemy)

Semester 2

- Copernican impact in the late 16th century
- Kepler
- Galileo
- Late 17th century, the Scientific Revolution
- Newton
- Observational astronomy in the 18th century
- Celestial mechanics in the 18th century
- Discovery of the Solar System in the 19-20 centuries
- Astronomical instrumentation in the 19-20 centuries
- Astrophysics in the 19-20 centuries
- Cosmology and extragalactic astrnonomy in the 19-20 centuries
- Space science – from the beginning to recent achievements

Recommended reading:

- J. North: *Cosmos: An Illustrated History of Astronomy and Cosmology* (UCP, 2008)
- A. Berry: *A Short History of Astrnomy* (Dover, 1961)
- L.E. Dreyer: *A History of Astronomy from Thales to Kepler* (Dover, 1953)
- C.M. Linton: *From Eudoxus to Einstein* (Cambridge, 2004)
- T. Kuhn: *The Copernican Revolution* (Harward, 1957)
- D. Leverington: *A History of Astronomy from 1890 to the Present* (Springer, 1995)

Responsible teacher (*name*, *position*, *degree*)**: Gábor Kutrovátz**, assistant, PhD

Other teachers involved: --

Course title: Infrared astronomy 1-2	**Credits: 2 x 2 = 4**

Type of class: lecture/ seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester:

lecture, 2+0

Language of teaching: English

Type of reporting (colloquium / practical mark / other): colloquium

Recommended semester: any

Preconditions: none

Course summary (knowledge/competencies to be acquired):

- The discovery and use of infrared
- History of infrared astronomy
- Definition of infrared and the origin of the infrared radiation
- Transmission, background noise
- Infrared photometry
- All-sky surveys
- Infrared satellite observatories
- The interstellar medium in infrared
- Young stellar objects
- Extragalactic infrared astronomy
- The infrared confusion
- Infrared astronomy in Hungary

Recommended reading:

Tóth, L.V., Zahorecz, S., Kiss, Cs., 2013, „Infrared astronomy”, http://elte.prompt.hu/sites/default/files/tananyagok/InfraredAstronomy/book.pdf

Responsible teacher (*name*, *position*, *degree*)**:** L. Viktor Tóth, ass. prof., PhD

Other teachers involved: -

Course title: Introduction to astronomy 1-4	**Credits: 4 x 2 = 8**
Type of class: lecture + practical class, and number of 45-min classes per week, for each semester: 2+0 Language of teaching: English	
Type of reporting (colloquium / practical mark / other): colloquium	
Recommended semester: 1 - 4	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): Semester 1: Sky and Solar System Semester 2: Stars and galaxies Semester 3: Instruments and techniques Semester 4: Methods and procedures	
Recommended reading: Karttunen et al.: Fundamental Astronomy. 5Th ed., Springer, 2003, ISBN 978-3-540-34143-7	
Responsible teacher (*name*, *position*, *degree*)**:** Kristóf Petrovay	
Other teachers involved: E. Forgács-Dajka	

Course title: IT in Astronomy 1-3	**Credits: 3 x 2 = 6**

Type of class: lecture/ seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester:

laboratory, 0 + 2

Language of teaching: English

Type of reporting (colloquium / practical mark / other): practical mark

Recommended semester: 1-3

Preconditions: none

Course summary (knowledge/competencies to be acquired):

Semester 1: an introduction to the application of Information Technology in astronomy. After a brief review of operating systems currently in use, the module provides notes and practical exercises in the astronomical application of IT. Self-study exercises are biased towards applications appropriate for astronomy, using Internet resources.

Topics: Operating systems, shell scripts, programming languages, programming in C, numerical methods, LaTeX word processing, image manipulations

Semester 2: students are presented with the appropriate knowledge in the C-programming language and its use to create basic but full fledged applications for simple tasks.

Topics: Introduction to C Programming; Brief History of C; The Edit-Compile-Link-Execute Process; Structure of C Programs; Pre-processor Directives; Data Types; Input and Output Functions; Conditional Execution; Loops; Functions and Prototypes, Functions as C's Building Blocks; Arrays, Pointers, Pointers And Arrays; Header Files; Command Line Parameters

Semester 3: The LaTeX typesetting language. Basics of HTML syntax. Compression methods, image, videa and audio file formats. FITS file format and its manipulation. Symbolic mathematics packages: Maple, Matlab.

Recommended reading:

Kernigan & Ritchie: The C programming language. 2Nd ed., Prentice hall, 1988, ISBN 978-0131103627

Responsible teacher (*name*, *position*, *degree*)**:** Áron Süli, assistant professor, PhD
Other teachers involved:

Course title: Observational astronomy 1-4	**Credits: 4 x 2 = 8**
Type of class: lecture + practical class, and number of 45-min classes per week, for each semester: 2+0 Language of teaching: English	
Type of reporting (colloquium / practical mark / other): colloquium	
Recommended semester: 1 - 4	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): Semester 1: Planetology Classification and characteristics of planetary bodies. Formation of the Solar System. Formation and evolution of planets. Moon and Mercury. Venus. Earth as a planet. Mars. Gas giants. The Jovian system. Sytems of Saturn, Uranus, Neptune. Small solar system bodies. Interplanetary dust. Semester 2: The Sun Historical introduction. Standard solar model, solar neutrinos. Helioseismology. Solar rotation. Instrumentation for solar observing. Polarisation of light and its applications in solar physics. The quiet photosphere. Chromosphere and corona. Activity phenomena: sunspots, faculae, prominences, flares, CMEs. Active regions and the solar activity cycle. Basics of solar dynamo theory. Solar wind and the heliosphere. Semester 3: Special stars and objects Stars with anomalous spectra: Ae/Be stars, C and S spectral types, Wolf-Rayet stars. Variable stars. Pulsating variables. Eruptive variables. Rotating and cataclysmic variables változócsillagok. Binary stars. Supercompact variables X-ray binaries. Miniquasars, black hole candidates. Quasars and active galactic nuclei. Semester 4: Remarkable individual objects Mapping of the Milky Way Galaxy. Spiral arms. The galactic center. Remarkable objects in the Sagittarius and Carina arms. Remarkable objects in the Perseus ar, Crab nebula. Our cosmic neighbourhood, the Orion spur. The Orion star forming region. The nearest stars. Remarkable star clusters. Magellanic clouds. Local group. >>Virgo Supercluster. Remarkable objects beyond our supercluster.	

Recommended reading:

Milone & Wilson: Solar System Astrophysics I-II, 2nd ed., Springer, 2014, ISBN 978-1-4614-8848-4 and ISBN 978-1-4614-9090-6
Stix: The Sun. 2nd ed., Springer, 2002, ISBN 978-3-642-56042-2
Böhm-Vitense: Introduction to Stellar Astrophysics: Volume 1, Basic Stellar Observations and Data. Cambridge UP, 1989, ISBN 978-0521348690

Responsible teacher (*name*, *position*, *degree*)**:** Kristóf Petrovay

Other teachers involved:

Course title: Partial differential equations	**Credits: 4**

Type of class: lecture/ seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester: 2+1

Language of teaching: English

Type of reporting (colloquium / practical mark / other):

Recommended semester: 2

Preconditions: calculus

Course summary (knowledge/competencies to be acquired):

First order linear and quasilinear PDEs.

Second order linear PDEs, classification.

Parabolic and hyperbolic initial value problems.

Hilbert spaces, Fourier series, linear operators.

Elliptic boundary value problems.

Eigenvalue problems, separation of variables. Fourier series expansion of the solution.

Green's function, spherical functions.

Parabolic and hyperbolic initial- boundary value problems.

Fourier transform, wavelets.

Recommended reading: W. A. Strauss, Partial Differential Equations: An Introduction , Wiley, 2007

Responsible teacher (*name*, *position*, *degree*)**:** János Karátson, assoc prof.

Other teachers involved:

Course title: Radio astronomy 1-2	**Credits: 2 x 2 = 4**

Type of class: lecture / seminar / practical class / lab / consultation, and number of 45-min classes per week, for each semester:

2 lectures per week, 2 semesters

Language of teaching: English

Type of reporting (colloquium / practical mark / other): colloquium

Recommended semester: 1 and 2

Preconditions: none

Course summary (knowledge/competencies to be acquired):

1st semester:

- History of radio astronomy, atmospheric radio window
- Basic definitions and terms, radio emission mechanisms
- Instrumentation: single-dish radio telescopes and interferometers
- Very Long Baseline Interferometry networks, data processing, image reconstruction; applications in astrophysics, astrometry and geodesy
- Next-generation radio astronomy instruments

2nd semester:

- Classification of celestial radio sources
- Radio astronomy in the Solar System
- Galactic radio astronomy, the Galactic Centre
- Extragalactic radio sources, active galactic nuclei
- Cosmological applications
- Cosmic microwave background radiation

Recommended reading:

Verschuur G.L., Kellermann K.I. (eds.), Galactic and extragalactic radio astronomy, 2nd edition, Astronomy and Astrophysics Library, Berlin: Springer, 1988

Gurvits L.I., Frey S., Rawlings S. (eds.), Radio astronomy from Karl Jansky to microjansky, EAS Publications Series, Vol. 15, Les Ulis: EDP Sciences, 2005

Responsible teacher (*name*, *position*, *degree*)**:** Sándor Frey
Other teachers involved:

Course title: Relativity	**Credits: 2**
Type of class: lecture/ seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester: s 2 + 0 Language of teaching: English	
Type of reporting (colloquium / practical mark / other):	
Recommended semester: 1	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): The principle of special relativity. Minkowski spacetime. Relativistic kinematics, velocity additions, Lorentz transformation, time dilatation, Lorentz contraction. Astrophysical applications: superluminal motions, relativistic beaming. Relativistic dynamics. 4-vectors, mass increase. Principle of general relativity. Curved manifolds, curved spacetime, covariant and contravariant representation. Einstein equations. Robertson-Walker metrics, Schwarzschild and Kerr metrics. Astrophysical applications: perihelion motion, light deflection, dynamics around black holes.	
Recommended reading: Hraskó: Basic relativity. Springer, 2011. Shapiro & teukolsky: Black holes, white dwarfs and neutron stars. Wiley, 1983	
Responsible teacher (*name*, *position*, *degree*)**:** Laszlo Palla, professor, DSc	
Other teachers involved:	

Course title: Seminar in Modern Astronomy 1-2-3-4	**Credits: 4 x 2 = 8**

Type of class: lecture/ seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester: seminar, 0 + 2

Language of teaching: English

Type of reporting (colloquium / practical mark / other): practical mark

Recommended semester: MSc Semester 1/2/3/4

Preconditions: none

Course summary (knowledge/competencies to be acquired):

Students gain experience in giving scientific presentations and in reading/processing scientific papers.

Astronomical Seminar 1:

- giving a 15-20 minutes long presentation, based on a short scientific paper

Astronomical Seminar 2:

- giving a 15-20 minutes long presentation, based on a long (min. 10 pages) scientific paper

Astronomical Seminar 3:

- giving a 20-40 minutes long presentation, based on one or more scientific papers of total lebgth exceeding 10 pages, in the form of a free review of the subject

Astronomical Seminar 4:

- giving a 20-40 minutes long presentation, based on one or more scientific papers of total lebgth exceeding 10 pages, in the form of a free review of the subject

Recommended reading:

http://astro.elte.hu/astro/en/library/

Responsible teacher (*name, position, degree*)**: Emese Forgács-Dajka, assistant professor, PhD**
Other teachers involved: K. Petrovay

Course title: Structure of the Universe 1-2	**Credits: 2 x 2 = 4**
Type of class: lecture, 2 + 0 Language of teaching: English	
Type of reporting: colloquium	
Recommended semester: 3/4	
Preconditions: none	
Course summary: Semester 1: Cosmology Brief history of cosmology - introduction to general relativity - models of the expanding universe - the standard cosmological model – thermodynamics of the expanding universe – particles in the early universe – cosmic microwave background – dark matter and dark energy – paradoxes of standard cosmology – the inflationary model Semester 2: Large-scale structure Brief introduction to galaxies – extragalactic distance measures – active galaxies and quasars – galaxy clusters – surveying the large-scale structure – visible and dark matter – surveying the invisible matter – statistical description of the distribution of matter – origin and evolution of large-scale structure – the cosmic microwave background and its connection to the large-scale structure	
Recommended reading: • Steven Weinberg: Cosmology • Barbara Ryden: Introduction to Cosmology • Carroll and Ostlie: Introduction to Modern Astrophysics • L. D. Landau: Classical Theory of Fields • Peter Coles: Cosmology: The Origin and Evolution of Cosmic Structure • Carroll and Ostlie: Introduction to Modern Astrophysics	
Responsible teacher: László Dobos, PhD, teaching assistant	
Other teachers involved:	

Course title: Summer internship	**Credits: 4**
Type of class: lecture/ seminar / practical class / lab / consultation. and number of 45-min classes per week, for each semester: laboratory Language of teaching: English	
Type of reporting (colloquium / practical mark / other): practical mark	
Recommended semester: 3	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): The aim of the summer internship is to provide hands-on practice for the students in the field of observations. The studenst will use the instruments located at Piszkéstető, Baja or in Szombathely. During the internship students will acquire the following capacity: - Identify the most prominent features of the night sky - Use the instruments and make measurements with them - Data reduction of the raw data: The images are first processed for bias and dark subtraction; flat-field correction - With the reduced data, analysis may finally be performed	
Recommended reading:	
Responsible teacher (*name*, *position*, *degree*)**:** Áron Süli, assistant professor, PhD	
Other teachers involved:	

Course title: Theoretical astrophysics 1-4	**Credits: 4 + 3 x 2 = 10**
Type of class: lecture + practical class, and number of 45-min classes per week, for each semester: 3+1, 2+0, 2+0, 2+0 Language of teaching: English	
Type of reporting (colloquium / practical mark / other): colloquium	
Recommended semester: 1 - 4	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): Semester 1: Physical foundations Thermodynamics: ideal gas, partial ionisation, Saha equation. Degeneration of matter. Nuclear reactions. Basics of fluid mechanics and magnetohydrodynamics. Linear perturbations, waves in homogeneous media, perturbations in stratified media. Turbulence and convection. Radiative transfer equation Semester 2: Stellar structure and evolution Application of fluid mechanics to stars. Thermodynamics of stellar plasma. Radiative and convective transfer of energy. Simplified models, polytropic spheres. Numerical methods in the modelling of steallr structure and evolution. Stability of stars: theory of linear pulsation. Basics of numerical modelling of nonlinear pulsations. Introduction to asteroseismology. Stellar evolution: energy production and nucleosynthesis. Phases of stellar evolution. Semester 3: Radiative transfer Saha equation, Fowler-Milne theory of stellar spectra. Radiative equilibrium in stellar atmospheres. Transfer equation. Limb darkening. Theory of Fraunhofer lines. Mechanisms of absorption, damping, Doppler broadining. Theory of the growth curve, determination of stellar composition. Nontehrmal radiation processes: synchrotron radiation, nonthermal bremsstrahlung, comptonisation. Semester 4: Diffuse matter Radiative transfer and radiative processes in diffuse media. Interstellar molecules. The fluid dynamics of diffuse matter, shock waves. Interstellar dust and gas. Interstellar magnetic fields. Interstellar medium in the Milky Way Galaxy. Star formation. Planetary nebulae and supernove remnants.	

Recommended reading:

Kippenhahn & Weigert: Stellar structure and evolution. 2nd ed., Springer, 2012, ISBN 978-3-642-30304-3
Rybicki & Lightman: Radiative processes in astrophysics. Wiley, 1986, ISBN 0-471-82759-2
Choudhuri: The physics of fluids and plasmas.Cambridge UP, 1998, ISBN 978-0521555432
Dopita & Sutherland: Astrophysics of the diffuse universe. Springer, 2003, ISBN 978-3-662-05866-4

Responsible teacher (*name*, *position*, *degree*)**:** Kristóf Petrovay

Other teachers involved: E. Forgács-Dajka, Zs. Sándor, L. V. Tóth

Course title: Thesis work 1-2	**Credits: 0**
Type of class: lecture + practical class, and number of 45-min classes per week, for each semester: 0 + 10, 0 + 20 Language of teaching: English	
Type of reporting (colloquium / practical mark / other)signature	
Recommended semester: 3- 4	
Preconditions: none	
Course summary (knowledge/competencies to be acquired): Semester 1: Getting acquainted with the literature of the topic of the thesis. Preparing a summary of previous work in the field. Starting the research, presentation of the initial results. Semester 2: Finishing the researcg, presentation of the results. Writing and presenting the thesis.	
Recommended reading: N/A	
Responsible teacher (*name*, *position*, *degree*)**:** Kristóf Petrovay	
Other teachers involved: E. Forgács-Dajka, Zs. Sándor, Á. Süli, L. V. Tóth	

CSILLAGÁSZ MSC – AZ ANGOL NYELVŰ KÉPZÉS SZEMÉLYI ÉS TÁRGYI FELTÉTELEI

Személyi feltételek:

az idegen nyelvű képzésben résztvevő **oktató** neve	**tud. fok. /cím** (PhD/ DLA/ CSc/ DSc/ akad.)	**munkakör** (ts. / adj./ e/f doc./ e/f tan./ tud. mts./ egyéb)	**részvétel az ismeretátadásban**		**előadóképes idegennyelv-tudás bizonyítéka(i)**
			tantárgy előadója **I*/N**	gyak. fogl.-t tart **I*/N**	
			***:** részben vagy egészben		
Szakfelelős:					
Petrovay Kristóf	DSc	egy.tanár	I	I	VOME
Oktatók:					
Balázs Lajos	DSc	egy.magántanár	I	N	E
Dobos László	PhD	egy.ts.	I	N	ME
Forgácsné Dajka Emese	PhD	egy.adj.	I	I	E
Frey Sándor	PhD	tud.tanácsadó	I	N	E
Karátson János	DSc	egy.docens	I	I	VE
Kutrovátz Gábor	PhD	egy.ts.	I	N	OE
Palla László	DSc	egy.tanár	I	N	ME
Sándor Zsolt	PhD	egy.adj.	I	N	OME
Süli Áron	PhD	egy.ts.	I	I	E
Tóth László Viktor	PhD	egy.adj.	I	I	VE

Rövidítések:

V – felsőfokú nyelvvizsga;

O – min. 1 félév angol nyelvű oktatás külföldi intézményben vagy hazai intézményben külföldi hallgatóknak;

M – min. 1 éves hallgatói vagy kutatói munkatapasztalat angol nyelvterületen.

E – min. 6 angol nyelvű konferenciaelőadás

A képzés **tárgyi feltételei**, a rendelkezésre álló **infrastruktúra** bemutatása:

- Tantermek, előadótermek, laboratóriumok és eszközellátottságuk, műhelyek, **gyakorlóhelyek**

- 34 férõhelyes digitális planetárium
- asztrofizikai obszervatórium 40 cm-es, fix felállítású RCC teleszkóppal
- 15 cm Zeiss Coudé teleszkóp (a svábhegyi Konkoly Obszervatóriumban)
- Meade hordozható távcső
- fotometriai laboratórium
- együttműködés keretében hozzáférés több vezető hazai obszervatórium távcsöveihez
- hozzáférés nagyszámú kari kezelésű tanteremhez

- Számítástechnikai, oktatástechnikai ellátottság

10 gépes hallgatói gépterem, speciális csillagászati szoftverekkel (IRAF, IDL, SAOimage...) felszerelt gépekkel.

- Könyvtári ellátottság; a papíralapú, illetve elektronikusan elérhető fontosabb szakmai folyóiratok és a szak szempontjából fontos szakkönyvek könyvtári, ill. internetes elérhetősége, *a könyvtár ezen adatait tartalmazó honlap címe*

- a főbb csillagászati szakfolyóiratok elektronikusan elérhetők, több, mint 100 évre visszamenőleg is
- csillagászati kézikönyvtár (a kari könyvtár kihelyezett részlege)
- hallgatói hozzáférés a kari könyvtárhoz

http://astro.elte.hu/astro/hun/konyvtar

- A hallgatói tanulmányok eredményes elvégzését segítő további szolgáltatások, juttatások, a biztosított taneszközök *(tankönyv, jegyzet* ellátás stb.), mindezek ***az idegen nyelven folyó képzésben az adott idegen nyelvű anyaggal!***

Elektronikus segédanyagok az egyes kurzusok honlapján.

- Az oktatás egyéb, szükségesnek ítélt feltételei (*ha vannak)*

Résumé of teacher involved in the Astronomy MSc programme

Name: Lajos Balázs

Contact (e-mail and phone no.): balazs@konkoly.hu, +36 1 3722500/6623

Position: private professor

Affiliation (department, faculty, institution): Department of Astronomy, Eötvös University, Budapest

Degrees / qualifications (MSc, PhD, dr. Habil. Dsc): DSc

Previous employments:
Director of the stronomical Instituteof the Hungarian Academy of Scences (1997-2009)

Studies:

- Physics and Astronomy (1960-65), Eötvös University, Budapest

Publication activity: (numerical summary, or a few representative publications):
No. of scientific papers: 169
No of independent citations: 907

MTMT ID: 07523

Languages: English, German, Russian, Hungarian

Membership and offices held in professional organisations; awards:

- Member of the Iinternational Astronomical Union
- Hungarian Society of Natural Sciences (President of Dept. of Astronomy and Space
- Sciences)

- Detre award (1978)
- Order of Merit of Hungary, Officer's Cross (2011)

Other:

Curriculum Vitae

Name: László Dobos, PhD
Date of birth: 10/29/1978
Position: teaching assistant
Affiliation: Dept. of Physics of Complex Systems, Institute of Physics, Faculty of Sciences
Contact: e-mail: dobos@complex.elte.hu
phone: +36 1 411 6500 / 6560
mobile: +36 30 387 86 03
web: http://www.vo.elte.hu/~dobos

1993-1997	secondary school: Berzsenyi Dániel Gimnázium, Budapest special mathematics class
1997-1999	Technical University of Budapest, electric engineering (did not graduate)
1999-2002	Software developer at small companies
2003-	Regular visiting student/scientist at the Johns Hopkins University
2007	MSc in physics, Eötvös Loránd University
2012	PhD in astrophysics, Eötvös Loránd University
2012-	Teaching assistant at Eötvös Loránd University

Current research activity

- Investigating physical properties of galaxy populations in cosmological context
- Investigating optimization of scientific databases and building analysis tools for astronomical data
- Distributed database systems
- Statistical properties of social networks

Teaching Experience

- Extragalactic astronomy and cosmology
- Numerical methods in physics
- Stellar and galaxy populations
- Astronomical databases
- Design and Implementation of Large-scale Scientific Databases
- Digital signal processing lab
- Programming .Net

Languages

Hungarian (native), English (fluent, B2 complex), Spanish (B2 complex), Russian, German

Publication summary

MTMT ID: 10019755

Publication types	Number		Citations	
	Total	Detailed	Independent	All
I. Scientific papers	10	---	---	---
In international journal	---	10	33	43
II. Books	0	---	---	---
III. Book chapters	5	---	---	---
In English	---	5	0	1
In Hungarian	---	0	0	0
IV. Conference papers	21	---	0	0
In English	---	20	36	85
In Hungarian	---	1	0	0
Scientific publications total	**36**	**---**	**69**	**129**
Other scientific publications	---	3	0	0

Total impact factor	40,5	---	---	---
Number of citations	---	---	69	129
Hirsch index	7	---	---	---

Popular science publications				
Books	0	---	0	0
Other publications	1	---	0	0
Citations in theses, other publications	---	---	15	26
Total citations	---	---	84	155

Publications

Publications in refereed English language journals

1. János Szüle, Dániel Kondor, **László Dobos**, István Csabai, Gábor Vattay: “Lost in the City: Revisiting Milgram's Experiment in the Age of Social Networks”, 2014 in PloS one vol. 9 issue 11 pp. e111973
2. Ching-Wa Yip, Michael W Mahoney, Alexander S Szalay, István Csabai, Tamás Budavári, Rosemary FG Wyse, **Laszlo Dobos**: “Objective Identification of Informative Wavelength Regions in Galaxy Spectra”, 2014 in The Astronomical Journal vol. 147 issue 5 pp. 110
3. Tamas Budavari, **Laszlo Dobos** and Alexander S. Szalay „Sky Query: Federating Astronomy Archives”, 2013 in Computing in Science & Engineering vol. 15 issue 3 pp. 12-20
4. **Gy Kerekes**, István Csabai, László Dobos, Márton Trencséni: “Photo-Met: A non-parametric method for estimating stellar metallicity from photometric observations” 2013 in Astronomische Nachrichten vol. 334 issue 9 pp. 1012-1015
5. Varga, J., Csabai, I., **Dobos, L.** „Revealing a strongly reddened, faint AGN population with double image stacking”, 2012 in MNRAS Vol. 426 pp. 833-850
6. József Varga, István Csabai, **László Dobos**: “Refined position angle measurements for galaxies of the SDSS Stripe 82 co-added dataset” in Astronomische Nachrichten vol. 334 issue 9 pp. 1016-1019
7. **Dobos, László**; Csabai, István.; Yip, Ching-Wa; Budavári, Tamás.; Wild, Vivienne; Szalay, Alexander S. „A high-resolution atlas of composite Sloan Digital Sky Survey galaxy spectra”, 2012 MNRAS Vol. 420, pp. 1217
8. **Dobos, L.**, Yip, C-W., Csabai, I., Budavári, T., Szalay, A.S. „An Atlas of SDSS Composite Spectra”, 2012 MNRAS Vol. 420 pp. 1217-1238.
9. **Dobos, L.**, Csabai, I., „Order Statistics of the Early-Type Galaxy Luminosity Function”, 2011 MNRAS Vol. 414, pp. 1862.
10. Yip, Ching-Wa; Szalay, Alex S.; Wyse, Rosemary F. G.; **Dobos, László**; Budavári, Tamás; Csabai, Istvan, “Extinction in Star-forming Disk Galaxies from Inclination-dependent Composite Spectra”, 2010 in ApJ Vol. 709 pp. 780-790.
11. C. W. Yip, A. J. Connolly, D. E. Vanden Berk, R. Scranton, S. Krughoff, A. S. Szalay**, L. Dobos**, C. Tremonti, M. Taghizadeh-Popp, T. Budavári, I. Csabai, R. F. G. Wyse, Z. Ivezic, “Probing Spectroscopic Variability of Galaxies & Narrow-Line Active Galactic Nuclei in the Sloan Digital Sky Survey”, 2009 in AJ Vol. 137 pp. 5120-5133
12. Budavari, Tamas; Wild, Vivienne; Szalay, Alexander S.; **Dobos, Laszlo**; Yip, Ching-Wa, „Reliable Eigenspectra for New Generation Surveys”, 2009 MNRAS Vol. 394, Issue 3, pp. 1496-1502
13. Csabai, I.; **Dobos, L.**; Trencséni, M.; Herczegh, G.; Józsa, P.; Purger, N.; Budavári, T.; Szalay, A. S., „Multidimensional indexing tools for the virtual observatory” in Astronomische Nachrichten, Vol.328, Issue 8, p.852.

Conference papers in English

1. **L Dobos**, I Csabai, JM Szalai-Gindl, T Budavári, AS Szalay: “Point cloud databases”, 2014 in Proceedings of the 26th International Conference on Scientific and Statistical Database Management pp. 33
2. D Kondor, **L Dobos**, I Csabai, A Bodor, G Vattay, T Budavári, AS Szalay: “Efficient classification of billions of points into complex geographic regions using hierarchical triangular mesh”, 2014 in Proceedings of the 26th International Conference on Scientific and Statistical Database Management pp. 4
3. Tamás Sebők, Zsófia Kallus, Sándor Laki, Péter Mátray, József Stéger, János Szüle, **László Dobos**, István Csabai, Gábor Vattay: “Network Measurement Virtual Observatory: An Integrated Database Environment for Internet Research and Experimentation”, 2014 in Testbeds and Research Infrastructure: Development of Networks and Communities: 9th International ICST Conference, TridentCom 2014, Guangzhou, China, May 5-7, 2014, Revised Selected Papers
4. Dániel Kondor, István Csabai, **László Dobos**, J Szule, Norbert Barankai, Tamás Hanyecz, Tamás Sebok, Zsófia Kallus, Gábor Vattay: „Using Robust PCA to estimate regional characteristics of language use from geo-tagged Twitter messages”, 2013 in Cognitive Infocommunications (CogInfoCom), 2013 IEEE 4th International Conference on pp. 393-398
5. Zsófia Kallus, Norbert Barankai, Dániel Kondor, **Laszlo Dobos**, Tamás Hanyecz, Janos Szule, József Stéger, Tamas Sebok, Gábor Vattay, István Csabai: „Regional properties of global communication as reflected in aggregated Twitter data”, 2013 in Cognitive Infocommunications (CogInfoCom), 2013 IEEE 4th International Conference on pp. 429-434
6. **László Dobos**, J Szule, Tamás Bodnár, Tamás Hanyecz, Tamás Sebok, Dániel Kondor, Zsófia Kallus, József Stéger, István Csabai, Gábor Vattay: „A multi-terabyte relational database for geo-tagged social network data”, 2013 in Cognitive Infocommunications (CogInfoCom), 2013 IEEE 4th International Conference on pp. 289-294
7. **László Dobos**, István Csabai, Alexander S Szalay, Tamás Budavári, Nolan Li: „Graywulf: A platform for federated scientific databases and services”, 2013 in Proceedings of the 25th International Conference on Scientific and Statistical Database Management pp. 30
8. **Dobos, L.**, Budavári, T., Li, N., Szalay, A., Csabai, I. „SkyQuery: An Implementation of a Parallel Probabilistic Join Engine for Cross-Identification of Multiple Astronomical Databases”, 24th International Conference, SSDBM 2012 Proceedings pp 159-167
9. **Dobos, L.**, Szalay, S., Blakeley, J., Budavári, T., Csabai, I., Tomic, D., Milovanovic, M., Tintor, M., Jovanovic, A., „Array Requirements for Scientific Applications and an Implementation for Microsoft SQL Server”, 2011 Workshop on Array Databases at EDBT/ICDT 2011
10. Yogesh Simmhan, Roger S. Barga, Catharine Van Ingen, María A. Nieto-Santisteban, **Laszlo Dobos**, Nolan Li, Michael Shipway, Alexander S. Szalay, Sue Werner, Jim Heasley, “GrayWulf: Scalable Software Architecture for Data Intensive Computing”, 2009 at Hawaii International Conference on System Sciences - HICSS
11. **Dobos, L.**; Budavári, T.; Csabai, I.; Szalay, A. S.; Herczegh, G., „Improved Search in Spectrum Databases”, 2008 in Astronomical Data Analysis Software and Systems ASP Conference Series, Vol. 394
12. Peter Matray, István Csabai, Péter Hága, József Steger, **Laszlo Dobos**, Gábor Vattay, “Building a prototype for network measurement virtual observatory” at Conference: Mining Network Data - MineNet 2007

13. **Dobos, L.**; Csabai, I.; Trencséni, M.; Herczegh, G.; Józsa, P.; Purger, N., „Spatial Indexing and Visualization of Large Multi-Dimensional Databases” in Astronomical Data Analysis Software and Systems XVI ASP Conference Series, Vol. 376
14. Budavári, T.; **Dobos, L.**; Szalay, A. S.; Greene, G.; Gray, J.; Rots, A. H., „Footprint Services for Everyone” in Astronomical Data Analysis Software and Systems XVI ASP Conference Series, Vol. 376
15. **Dobos, L.**; Budavári, T.; Csabai, I.; Szalay, A. S., „New Features in the Spectrum Services for the Virtual Observatory” in Astronomical Data Analysis Software and Systems XV ASP Conference Series, Vol. 351.
16. **Dobos, L.**; Budavári, T.; Csabai, I.; Szalay, A. S., „Spectrum and Bandpass Services for the Virtual Observatory” in Astronomical Data Analysis Software and Systems (ADASS) XIII ASP Conference Proceedings, Vol. 314.

Publications in Hungarian

1. **Dobos László:** “A korai Univerzumban már látjuk a gravitációs hullámokat(?)”, 2014 at http://www.csillagaszat.hu/hirek/technikai_ujdonsagok/tu-foldi-tavcsovek/korai-univerzum-gravitacios-hullam/
2. Csabai I., Purger N., **Dobos L.**, Szalay S., Budavári T., „Az univerzum szerkezete”, 2007/12 Fizikai Szemle pp. 235-392.

Book chapters in English

1. **László Dobos**, Tamás Budavári, “Chapter 17: Web-based Tools – Spectrum and Filter Services for the VO” in book “The National Observatory: Tools and Techniques for Astronomical Research”, ASPCS, volume 382., 2007
2. Tamás Budavári, Alexander Szalay, György Fekete, **László Dobos**, Gretchen Greene, Jim Gray, Arnold Rots „Chapter 9: Web-based Tools - Footprint Services in the Virtual Observatory” in book „The National Observatory: Tools and Techniques for Astronomical Research”, ASPCS, volume 382., 2007

Résumé of teacher involved in the Astronomy MSc programme

Name: Emese Forgács-Dajka

Contact (e-mail and phone no.): e.forgacs-dajka@astro.elte.hu

Position: assistant professor

Affiliation (department, faculty, institution): Department of Astronomy, Institute of Geography and Earth Sciences, Faculty of Science, Eötvös University

Degrees / qualifications (Msc, PhD, dr. Habil. DSc): PhD (2004)

Previous employments:

Workplace: Eötvös University, Department of Astronomy
Position: assitant professor
Dates: September 2005 -

Workplace: University of Vienna, Institute of Astronomy
Position: senior postdoctoral fellow
Dates: August 2012 - August 2013

Workplace: ELTE-Soft Ltd.
Position: software testing and marketing
Dates: January 2010 - May 2014

Workplace: Konkoly Observatory of Hungarian Academy of Sciences
Position: assistant research fellow
Dates: November 2002 - May 2005

Studies:

Qualification: Astronomer and Physicist
Issuing office: Eötvös University, Budapest
Date: 1999
Level: MSc (summa cum laude)

Qualification: Computer Scientist and System Manager
Issuing office: Eötvös University, Budapest
Date: 1999
Level: State Diploma (summa cum laude)

Publication activity: (numerical summary, or a few representative publications):

33 scientific papers, 8 proceedings books (acting editor), ca. 200 independent citations

MTMT ID: 10012388

Languages:

English - intermediate
French - basic

Membership and offices held in professional organisations; awards:

International Astronomical Union (2005 -)
Member of Public Body of Hungarian Academy of Sciences (2005 -)
Roland Eötvös Physical Society (1999 - 2010)
Institute of Physics, London (2005 - 2006)

Other:

Résumé of teacher involved in the Astronomy MSc programme

Name: Sándor Frey

Contact (e-mail and phone no.): frey.sandor@fomi.hu, +36 27 200 802

Position: chief counsellor

Affiliation (department, faculty, institution): Satellite Geodetic Observatory, Institute of Geodesy, Cartography and Remote Sensing, Budapest

Degrees / qualifications (MSc, PhD, dr. Habil. Dsc): PhD

Previous employments:
MTA-BME Research Group for Physical Geodesy and Geodynamics, Budapest (2007-2011)

Studies:

- mathematics and physics teacher (1991) and astronomer MSc (1991), Eötvös Loránd University, Budapest
- astrophysics PhD (2001), Eötvös Loránd University, Budapest

Publication activity: (numerical summary, or a few representative publications):
total number of publications: 107, in journals: 59
independent citations: 389
cumulative impact factor: 235
Hirsh index: 13

Frey S., Gurvits L.I., Kellermann K.I., Schilizzi R.T., Pauliny-Toth I.I.K. (1997): High resolution radio imaging of the extremely distant quasars 1251-407, 1351-018, 1354-174 and 1508+572, Astronomy and Astrophysics, Vol. 325, pp. 511-515

Gurvits L.I., Kellermann K.I., Frey S. (1999): The ”angular size-redshift” relation for compact radio structures in quasars and radio galaxies, Astronomy and Astrophysics, Vol. 342, pp. 378-388

Fomalont E.B., Frey S., Paragi Z., Gurvits L.I., Scott W.K., Taylor A.R., Edwards P.G., Hirabayashi H. (2000): The VSOP 5 GHz Continuum Survey: The Prelaunch VLBA Observations, The Astrophysical Journal Supplement Series, Vol. 131, pp. 95-183

Frey S., Gurvits L.I., Paragi Z., Gabányi K.É. (2008): High-resolution double morphology of the most distant known radio quasar at z=6.12. Astronomy and Astrophysics, Vol. 484, pp. L39-L42

Deane R.P., Paragi Z., Jarvis M.J., Coriat M., Bernardi G., Fender R.P., Frey S., Heywood I., Klöckner H.-R., Grainge K., Rumsey C. (2014): A close-pair binary in a distant triple supermassive black hole system. Nature, Vol. 511, pp. 57-60

MTMT ID: 10001526

Languages: English, Russian

Membership and offices held in professional organisations; awards:

- Hungarian Astronautical Society (member since 1993; deputy general secretary since 2000)
- Hungarian Astronomical Association (member since 1993)
- Eötvös Loránd Physical Society (member since 1998)
- Committee on Space Research (COSPAR; associate since 2000)
- UN COPUOS, Global Navigation Satellite System working group (member, 2002-2003)
- Public body of the Hungarian Academy of Sciences, Committee of Astronomy and Space Physics (member, since 2002)
- Hungarian Academy of Sciences, Committee of Astronomy and Space Physics (member since 2008, secretary since 2011)
- International Astronomical Union (IAU; individual member since 2006)
- Club of Hungarian Science Journalists (member since 2009)
- Hungarian Scientific Council on Space Research (member since 2012)
- Program Committee, European VLBI Network (member since 2014)

Awards:

- PhD scholarship (1999, Hungarian Soros Foundation)
- Bolyai János Research Scholarship (2003, Hungarian Academy of Sciences)
- Nagy Ernő Prize (2005, Hungarian Astronautical Society)
- visiting professor (2012, Shanghai Astronomical Observatory, China)
- Hevesi Endre Prize (2015, Association of Hungarian Journalists)

Other:

Education activities:

- Radio Astronomy (since 2003; 2 semesters, special course in English for physics & astronomy MSc and PhD students, Eötvös Loránd University, Budapest)
- Radio Astronomy (from 2013; 1 semester, special course in Hungarian for physics & astronomy MSc and PhD students, University of Szeged)
- BSc thesis supervision (1 student, 2014, Eötvös Loránd University)
- MSc thesis supervision (>10 students since 2000, Eötvös Loránd University & Budapest University of Technology and Economics)
- PhD thesis co-advisor (2 students, Eötvös Loránd University & Budapest University of Technology and Economics)
- examination & defense committee member (>20 cases since 2004, Physics PhD School, Eötvös Loránd University)

Résumé of teacher involved in the Astronomy Msc programme

Name: Karátson János

Contact (e-mail and phone no.): karatson@cs.elte.hu

Position: assoc. prof.

Affiliation (department, faculty, institution): Dept. Applied Analysis and Comput. Math., Mathematical Institute, Faculty of Sciences, ELTE

Degrees / qualifications (Msc, PhD, dr. Habil. DSc): dr. habil. DSc

Previous employments: ----

Studies: Mathematics

Publication activity: (numerical summary, or a few representative publications):
77 publications

MTMT ID: 10000168

Languages: English (proficient user, CEFR C1),

Membership and offices held in professional organisations; awards:
Editor at Numerical Linear Algebra and Applications (J.Wiley).
Farkas Gyula Prize (Bolyai János Math Soc, 2000)
Bolyai Plaquet (HAS, 2010)

Résumé of teacher involved in the Astronomy Msc programme

Name: Gábor Kutrovátz

Contact (e-mail and phone no.): kutrov@caesar.elte.hu, +36-20-4419950

Position: assistant

Affiliation (department, faculty, institution): Department of History and Philosophy of Science, Faculty of Sciences

Degrees / qualifications (Msc, PhD, dr. Habil. DSc): MSc (Physics and Astronomy), MA (Philosophy), PhD (History and Philosophy of Science)

Previous employments: --

Studies: Eötvös University of Budapest (MSc 1992-1999, MA 1996-2001), Budapest University of Technology and Economics (PhD 1999-2002, degree in 2006)

Publication activity: (numerical summary, or a few representative publications):
Numerical summary:

- Books: 3 (2 co-authored, 1 edited)
- Book chapters: 15 (8 in English, 7 in Hungarian)
- Papers: 14 (6 in English, 8 in Hungarian)
- Conferences: 32

A few publications:

- Kutrovátz, G., Zemplén, G.: "Social Studies of Science and Science Teaching" In M.R. Matthews et al. (ed.): *International Handbook of Research in History, Philosophy and Science Teaching*. Dordrecht, Springer, 2014. Pp. 1119-1141.
- Kutrovátz, G.: "Expert Authority and Ad Verecundiam Arguments" In F.H. van Eemeren, B. Garssen (eds.): *Exploring Argumentative Contexts*. Amsterdam, John Benjamins, 2012. Pp. 197-211.
- Kutrovátz, G., Zemplén G.: "Experts in Dialogue: An Introduction" *Argumentation* 25: 275-283. 2011
- Kutrovátz G., Láng B., Zemplén G. (eds.): *Határmunkálatok a tudományban*. [Boundary Work in Science] Budapest, L'Harmattan, 2010.
- Kutrovátz, G., Láng, B., Zemplén, G.: *A tudomány határai* [The Boundaries of Science] Budapest: Typotex. 2008

MTMT ID: 10026545

Languages: Hungarian, English

Membership and offices held in professional organisations; awards:
International Society for the Study of Argumentation
The International Society for the History of Philosophy of Science
Lakatos Fellow at London School of Economics (2008)

Bolyai János post-doc research scholarship (2007-2010)

Other:

Résumé of teacher involved in the Astronomy Msc programme

Name: Laszlo Palla

Contact (e-mail and phone no.): palla@caesar.elte.hu 36-1-3722704

Position: professor

Affiliation (department, faculty, institution): Department of Theoretical Physics

Degrees / qualifications (Msc, PhD, dr. Habil. Dsc): DSc

Previous employments:
1982-83 Theory Division CERN Geneva Switzerland (visiting scientist)
1987 Math. Dept. Durham University (UK) (visiting scientist)
1989-90 Math. Dept. Durham Univesity (UK) (visiting professor)

Studies:

Publication activity: (numerical summary, or a few representative publications):
102 publications 1662 independent citations
MTMT ID: Palla László

Languages: english, russian, german

Membership and offices held in professional organisations; awards:
1986 Prize of the Hungarian Academy of Sciences (awarded jointly with Z. Horvath and P. Forgacs)
2013 Grand Prize for Physics by the Physics Section of HAS

Other:

Résumé of teacher involved in the Astronomy MSc programme

Name: Kristóf Petrovay

Contact (e-mail and phone no.): K.Petrovay@astro.elte.hu, +36 1 3722500/6621

Position: professor, head of department

Affiliation (department, faculty, institution): Department of Astronomy, Eötvös University, Budapest

Degrees / qualifications (MSc, PhD, dr. Habil. Dsc): DSc

Previous employments:
Instituto de Astrofisica de Canarias (1995-1999)

Studies:

- Msc in Physics and Astronomy (1987), Eötvös University, Budapest
- PhD studes: Eötvös University, Budapest (1987-90); University of Oxford (1990-91)

Publication activity: (numerical summary, or a few representative publications):
total number of publications: 75, in journals: 37
independent citations: 540
cumulative impact factor: 135

MTMT ID: 10004267

Languages: English, Spanish, Hungarian

Membership and offices held in professional organisations; awards:

- Hungarian Academy of Sciences, Committee of Astronomy and Space Physics (member since; secretary 2006-2011)
- International Astronomical Union (IAU; individual member since 1992)

Awards:

- MTA Physics Prize (2004)

Other:

Résumé of teacher involved in the Astronomy Msc programme

Name: Sándor, Zsolt

Contact (e-mail and phone no.): sandor.zsolt@csfk.mta.hu

Position: assistant professor

Affiliation (department, faculty, institution): Department of Astronomy, Institute of Geography and Earth Sciences, Faculty of Sciences, Eötvös Loránd University

Degrees / qualifications (Msc, PhD, dr. Habil. DSc): PhD

Previous employments:

1999-2000: Konkoly Observatory of HAS, Budapest
2000-2007: Eötvös Loránd University, Budapest
2007-2011: Max Planck Institute for Astronomy, Heidelberg
2012-2014: Department of Astrophysics University of Vienna
2014-2015: Konkoly Observatory of HAS, Budapest

Studies:

University diploma (MSc) in mathematics, physics and astronomy Eötvös Loránd University, 1995
PhD in Physics 2003, Eötvös Loránd University

Publication activity: (numerical summary, or a few representative publications):

54 publications, 29 in refereed international journals
Number of independent citations: approx. 400

MTMT ID: 10028589

Languages: English (fluent), German (intermediate)

Membership and offices held in professional organisations; awards: IAU membership

Other:

Résumé of teacher involved in the Astronomy Msc programme

Name: Süli Áron László

Contact (e-mail and phone no.): A.Suli@astro.elte.hu, +36 1 3722500 / 6623

Position: assistant professor

Affiliation (department, faculty, institution): Eötvös University Department of Astronomy Budapest, Pf. 32, H-1518 Hungary

Degrees / qualifications (Msc, PhD, dr. Habil. DSc): PhD

Previous employments:

2007 – 2008	Protomix Zrt. - parttime software developer
2009 – 2012	Eötvös University Department - research fellow
2012 – 2013	University of Vienna - research fellow
2013 – 2014	Eötvös University Department - research fellow

Studies:

1992 – 1998	Eötvös University Department of Astronomy
1998	MSc in Astronomy, Eötvös University Department of Astronomy
1998 – 2004	PhD School in Physics, Eötvös University
2004	PhD in Physics

Publication activity: (numerical summary, or a few representative publications):
30 publications in international refereed journals
19 papers in conference proceedings

MTMT ID: 10012387

Languages: Hungarian (native), English (fluent), German (intermediate)

Membership and offices held in professional organisations; awards:
HAS corresponding member since 2008
IAU member since 2012

Other:

Résumé of teacher involved in the Astronomy Msc programme

Name: L. Viktor Tóth

Contact e-mail: l.v.toth@astro.elte.hu, **phone no.:** +3613722946

Position: assistant professor

Affiliation (department, faculty, institution): Department of Astronomy, Institute of Geography and Earth Sciences, Faculty of Sciences

Degrees / qualifications: PhD physics

Previous employments:
1992 Helsinki University Observatory, researcher **(**Academy of Finland grant)
1997 – 1998 Max-Planck Institut für Astronomie, Heidelberg, researcher **(**Max Planck Society grant)
2000 - 2001 University of Helsinki, post-doc fellow (Academy of Finland and Wihuri Foundation) also lecturing: "Infrared astronomy"
2001 – 2003 Max-Planck Institut für Astronomie, Heidelberg, researcher **(**staff)
2005 – 2007 MTA Konkoly Observatory Budapest, researcher

Studies: MSc astronomy, MSc mathematics and physics Eötvös University Budapest

Publication activity: 75 scientific publications (42 refereed, cumulative impact factor 95)

MTMT ID: 10001408

Languages: English (proficient user, CEFR C2), German (basic user, CEFR A2)

Membership and offices held in professional organizations; awards: International Astronomical Union Organizing Committee member

Other:
Editor of 4 popular scientific films