Introduction to Modern Cosmology
- COURSE SYLLABUS

1.	**Course title:** *Introduction to Modern Cosmology*	
2.	**Lecturer:** *dr hab. Wojciech Hellwing, prof. CFT PAN*	
3.	**Field, type and level of studies, year of study:** *astronomy, physics , all years of study*	
4.	**Course character:** *monographic lecture*	
5.	**Teaching method:** *traditional*	
6.	**Language:**	*English*
7.	**Course type and number of hours:** *lecture 30h*	
8.	**Estimated load of student's independent work:**	*10h*
9.	**Total workload and number of ECTS points:**	*40h, 3 ECTS*
10.	**Short description and main focus of the course:** *This is an introductory course in Cosmology, aimed primarily at Masters and PhD students but open to anyone who would like to know more about the Universe. It will focus mainly on describing the standard model of cosmology (Lambda Cold Dark Matter), its mathematical properties and the observational basis on which it stands.* *Some extra attention will be given to the biggest open questions and observational tensions*	

	in contemporary cosmology, including problems like: Hubble tension, lensing is low problem, Integrated Sachs-Wolfe signal tension, dark matter and dark energy challenge. The course will be mostly self-contained but some parts of the course will require a basic knowledge of general relativity, thermodynamics, and advanced classical mechanics, although the main concepts will be reviewed.	
11.	**References:** - *An Introduction to Modern Cosmology, Andrew Liddlde* - *Modern Cosmology, Scott Dodelson* - *Introduction to Cosmology, Barbara Ryden* - *Extragalactic Astronomy and Cosmology an introduction, Peter Schneider, 2nd edition, Springer* - *Lecture notes by Wayne Hu on "CMB Theory" (arXiv:0802.3688)* - *"The Early Universe" by Edward W. Kolb, Michael S. Turner* - *Galactic dynamics (2nd edition): Binney & Tremaine, Princeton series in Astrophysics* - *Formation and Evolution of Galaxies: Lectures given as Les Houches, Simon White, arXiv:astro-ph/9410043* - *Lecture notes for numerical cosmology: https://ui.adsabs.harvard.edu/abs/2015pta..conf...58H/abstract* - *More reading materials will be provided during the lectures*	
12.	**Prerequisites:** *basic general relativity will be a plus (but not needed strictly), classical mechanics, thermodynamics*	
13.	**Educational outcomes:**	**PQF level 8 codes:**
	Knowledge: *The student can explain the theoretical basis of the modern standard cosmological model (LCDM). The student can list and describe the most fundamental core observational data that supports the standard model. The student obtains basic knowledge of the core computational (simulation and BigData analysis) methods used in cosmology. The attendee also knows and can list the biggest current challenges (both theoretical and observational) in the field.*	*P8S_WG*
	Practical Skills: *The student can apply knowledge of core concepts in physics and astrophysics to understand cosmology. The student can make use of detailed information on current topics in cosmology in the research literature. The attendee can also perform a basic cosmological data analysis, understands the computational methods essential in modern cosmology and can formulate baseline predictions for core model observables (like time-function of the Hubble parameter, linear growth rate or power spectrum fluctuations).*	*P8S_UW, P8S_UK*
	Social Skills: *Students understand the importance of cosmology in a broad astrophysical and social context and are able to discuss cosmological topics with experts,*	*P8S_KK, P8S_KO*

	colleagues and laymen. Students are able to critically evaluate arguments presented in scientific and popular science discussions and articles.	
14.	**Evaluation of the educational outcomes:** *homework assignments and an oral exam*	
15.	**Criteria to complete the course:** *at least 75% attendance, final grade depends in 30% on the homework assignments score and in 70% on the oral exam score*	
16.	**Contact with the lecturer:** *email: hellwing@cft.edu.pl, office hours: TBA*	