….Introduction to Observational Astrophysics….
- COURSE SYLLABUS

1.	**Course title:**	
	Introduction to Observational Astrophysics	
2.	**Lecturers:**	
	Piotr Wielgórski, Paulina Karczmarek (CAMK PAN)	
3.	**Field, type and level of studies, year of study:**	
	interdisciplinary lecture, astronomy, all years of study	
4.	**Course character:**	
	GeoPlanet interdisciplinary lecture (item 2, Tab. 1, Program of the Studies)	
5.	**Teaching method:**	
	On-line	
6.	**Language:**	*English*
7.	**Course type and number of hours:**	
	Lecture, 30h divided into 15 1.5-hour-long lectures on Fridays at 11:00	
8.	**Estimated load of student's independent work:**	*20h*
9.	**Total workload and number of ECTS points:**	*50h, 3 ECTS*
10.	**Short description and main focus of the course:**	
	This course provides a comprehensive technical foundation in observational astrophysics, from the historical and modern techniques used to determine our Earth's shape and size, to the physics and evolution of stars, to methods of distance determinations relying on electromagnetic and gravitational waves, to the analysis of the modern "Crisis in Cosmology" (the discrepancy between local and early-universe measurements of the Hubble constant). The main focus of the course is to gain understanding how stars function and evolve, and why certain stars (like Cepheids or Type Ia Supernovae) are used as reliable distance benchmarks. Observational techniques (photometry, spectroscopy, and interferometry) will be thoroughly explored and their importance for the robust cosmic distance scale explained. *Lecture 1: The shape and size of Earth* *Lecture 2: The celestial sphere & parallax, constellations & stars naming* *Lecture 3: How stars shine (nuclear fusion), Hertzsprung-Russell diagram* *Lecture 4: Stellar Evolution I* *Lecture 5: Stellar Evolution II* *Lecture 6: Observations at different wavelengths*	

	Lecture 7: Different ways to observe light: photometry, spectroscopy, interferometry, polarimetry *Lecture 8: Pulsating stars as distance indicators* *Lecture 9: Eclipsing binaries as geometric distance tools* *Lecture 10: Other methods: clusters and main sequence fitting, Tully-Fisher relation, TRGB, J-AGB* *Lecture 11: Type Ia supernovae, cataclysmic* *Lecture 12: The Hubble-Lemaître Law* *Lecture 13: Hubble Tension* *Lecture 14: Multimessenger astronomy: gravitational waves, cosmic radiation* *Lecture 15: Future observatories & distance precision (JWST, Rubin, ELT)*	
11.	**References:** ● *Conny Aerts,"Stellar Structure and Evolution", link: https://fys.kuleuven.be/ster/education/sse/sse-2021-studentversion.pdf* ● *scientific publications selected by the lecturers before a given lecture, e.g. G. Pietrzyński et al. (2019), "A distance to the Large Magellanic Cloud that is precise to one per cent", link to the pdf: https://arxiv.org/pdf/1903.08096*	
12.	**Prerequisites:** *None*	
13.	**Educational outcomes:** ***Knowledge:*** ● *Understand the historical and modern methods of measuring the Earth's shape, size, and rotation* ● *Explain the nuclear processes (pp-chain, CNO cycle) and evolutionary pathways (protostar to compact remnants) that define a star's lifecycle* ● *Identify and explain the hierarchy of "standard candles" and "standard sirens," including the physical mechanisms of Cepheids, type Ia Supernovae, and eclipsing binaries.* ● *Understand the theoretical and observational roots of the H_0 discrepancy between early-universe (CMB) and late-universe (local) measurements* ● *Describe the operation and limitations of detectors across the electromagnetic spectrum and in the multi-messenger regime (gravitational waves)*	**PQF level 8 codes:** *P8S_WG, P8S_WK*
	Practical Skills: ● *Distinguish between different types of variable stars based on the shape of the light curves* ● *Distinguish between statistical and systematic errors, specifically in the context of the cosmic distance scale.* ● *Utilize astronomical databases (Gaia Archive, NED, VizieR, Simbad)* ● *Evaluate high-impact journal papers and retrieve the key informations*	*P8S_UW, P8S_UK*

	Social Skills: ● *Present complex astrophysical concepts and the "Crisis in Cosmology" clearly to an audience of interdisciplinary peers (geologists, planetary scientists, etc.)* ● *Develop the ability to pivot between different scales of magnitude (from the planetary scale of Earth to the megaparsec scale of the expanding universe)* ● *Critically evaluate the contributions of the scientific paper to its respective field*	*P8S_KK, P8S_KO*
14.	**Evaluation of the educational outcomes:** *Essay, homework assignments individually and in groups*	
15.	**Criteria to complete the course:** *Final grade depends on the evaluation of the essay and homeworks*	
16.	**Contact with the lecturer:** *email: pwielgor@camk.edu.pl, pkarczmarek@camk.edu.pl*	