Call for expression of interest for one (1) Ph.D. student fellowship position "Higher-order statistics for neutral hydrogen intensity mapping" at the Institute of Computer Science (ICS) Foundation for Research and Technology – Hellas (FORTH)

**Position:** One (1) position for the HORIZON project TITAN

**Project:** “TITAN – Frugal Artificial Intelligence and Application in Astrophysics” (Grant Agreement number: 101086741) funded under HORIZON-WIDERA-2022-TALENTS-01

**Desired starting date:** January 2nd, 2024

**Duration:** 1 year with yearly extensions for the duration of the Ph.D.

**Fellowship stipend:** approximately 1.400 euros/month (net)

**Location:** Heraklion, Crete, Greece

**Opening date:** 19/9/2023

**Closing date:** 15/10/2023

**Ref.:** “TITAN-Ph.D.studentIntensityMapping”

**Description.** Mapping the integrated emission of the 21-cm line of neutral hydrogen (HI) from all the galaxies at a given redshift—a technique known as HI intensity mapping—is the new frontier to probe the cosmic large-scale structure. It has a great potential for cosmology, as thanks to its exquisite redshift resolution it allows us to track the evolution of cosmic structures across time in a way unparalleled by traditional galaxy redshift surveys. However, the cosmological signal is minute compared to astrophysical foregrounds, which must be removed to the utmost accuracy not to bias cosmological results. Despite the technical challenges, a tremendous improvement has been made since the first detection of the cross-correlation signal between HI intensity mapping and the clustering of optical galaxies, and recently the first detection of the signal in auto-correlation has been made with data from the MeerKAT telescope—one of the precursors of the SKA Observatory. The SKA Observatory is currently being built in two locations, in South Africa and Australia, and will be the largest radio-telescope on Earth. It is expected to start observations already by the end of the decade.
Standard methods for deriving cosmological information from HI intensity mapping is via measurements of its power spectrum, analogously to what done with galaxy redshift surveys. However, it is well known that the power spectrum does not contain all of the information, as the nonlinear evolution of cosmic structures makes the density field non-Gaussian. Higher-order statistics are routinely used in galaxy surveys and the most standard ones, like the bispectrum, have been proposed for HI intensity mapping too. However, this is not the case for the most advanced techniques, like wavelet $l_1$-norm statistics or machine learning based summary statistics.

For this project, we look for one PhD student who will forecast the capability of such advanced higher-order statistics for HI intensity mapping, in the view of the upcoming SKA Observatory. They will apply these new statistical methods to simulated HI intensity mapping data for the first time. To this purpose, it will also be necessary to modify the existing techniques to account for the peculiarities of the HI intensity mapping signal, like its superb redshift resolution, opposite to its rather poor angular resolution (compared to optical surveys). Moreover, the telescope beam plays an important role, and it will have to be modelled accurately to extract the most of the information. All of this will be done with the most advanced techniques of machine learning and data analysis of cosmological maps. The goal is to forecast constraints on cosmological parameters as per the planned SKA Observatory HI intensity mapping survey, which will cover 5000 to 15,000 square degrees.

The doctoral student will be located at the premises of FORTH with a strong collaboration with the CosmoStat Laboratory at CEA Saclay. The doctoral student will be supervised by Jean-Luc Starck (FORTH/CEA), Stefano Camera (UniTO, Italy), and Vasiliki Pavlidou (FORTH).

**Required qualifications:**
- BSc and MSc in Physics, Computer Science, or a related field
- Good Knowledge of English
- Willingness and ability to work cooperatively within a team, to learn, and to adapt to the project
- Physical presence at FORTH, Heraklion, Crete for the duration of the position, with visits to CEA-Saclay (France).

**Desired qualifications:**
- Experience with the analysis of radio and/or optical observations

**Application Submission**
Interested candidates can submit their applications via [http://www.ics.forth.gr/jobs/en/](http://www.ics.forth.gr/jobs/en/) using the link “Apply for the position” under the announcement. Applications must include:
- Detailed CV, including qualifications and interests in the above areas and proof thereof
- Scanned copies of academic titles; academic transcripts for undergraduate and postgraduate degrees
- Letters of recommendation, detailed presentation of prior work, studies and/or publications, demonstrating knowledge of desired skills.

**Contact Information:**
For information and questions about the advertised position, the activity of the group or the Institute, please contact Jean-Luc Starck at jstarck@cea.fr and Panagiotis Tsakalides at tsakalid@ics.forth.gr.

**Selection procedure**
Applications will be evaluated by a 3-member committee headed by the ERA Chair, Dr. J-L. Starck, and they will be screened by the TITAN international scientific advisory board. In the case candidates are invited for an interview, they will either be invited to participate in person or via teleconference. Beyond scientific excellence, selection criteria will include gender and diversity aspects as well as complementary skills and fit of the candidate to the existing team.
Selection Announcement

The result of the selection will be announced on the website of ICS-FORTH. Candidates have the right to appeal the selection decision, by addressing their written objection to the ICS secretariat within five (5) days since the results announcement on the web. They also have the right to access (a) the files of the candidates as well as (b) the table of candidates’ scores (ranking of candidates results). All the above information related to the selection procedure will be available at the secretariat of ICS-FORTH in line with the Hellenic Data Protection Authority. Access to personal data of co-candidates shall be limited to personal data (and relevant data) and supporting documents which have been the basis of the evaluation of the candidates for the specific post(s). Prior to the announcement of the personal data and/or documents of the co-candidates to the applicant, FORTH will inform the data subjects in an appropriate way.

Disclaimer

FORTH is compliant with all legal procedures for the processing of personal data as defined by the Regulation EU/2016/679 on the protection of natural persons with regard to the processing of personal data.

FORTH processes the personal data and relevant supporting documents that you have submitted to us. Processing of that data is carried out exclusively for the needs and purposes of this specific call. Such data shall not be transmitted to or communicated to any third party unless required by law.

FORTH retains the above data up to the announcement of the final results of the call, unless further process and reservation is required by law or for purposes of exercise, enforcement, prosecution of certain one’s legitimate legal rights’ as defined in the Regulation EU/2016/679 and/or in national law.

We inform you that under the Regulation EU/2016/679 you have the rights to be informed about your personal data, access to, rectification and erasure, restrictions of process and objection to as provided by applicable regulation and national laws.

We acknowledge also to you, that you have the right to file a complaint to the national Data Protection Authority. For any further information regarding exercise of your personal data protection rights, you may contact the Data Protection Officer at FORTH at dpo@admin.forth.gr.

You have the right to withdraw your application and consent for the processing of your personal data at any time. We inform you that, in this case, FORTH shall destroy such documents and/or supporting documents submitted and shall delete the related personal data.