

**Two 2-year postdoctoral positions
in machine learning for 21cm cosmology
(Paris, France)**

We are offering two postdoctoral positions in machine learning for 21cm cosmology to join the team working on the ANR project SLEEC (Self-supervised LEarning for Exploring 21cm Cosmology). One position will be based at Observatoire de Paris and the other at Université Paris-Saclay. The appointment will be for two years, with a negotiable start date between March and October 2027.

Context. The Square Kilometre Array (SKA) will start operating in 2030. One of its main science goals is to map in three dimensions the 21cm signal from neutral hydrogen during the Epoch of Reionisation, the first billion years of cosmic history. This signal holds a wealth of information on the first galaxies and on the underlying matter distribution. However, it is high-dimensional, strongly non-Gaussian and depends on models that are still poorly constrained. The ANR-funded SLEEC project uses self-supervised and generative machine learning, in particular diffusion models, to get the most out of SKA data. It follows two complementary directions: building optimal summary statistics for parameter inference and inferring directly the physical fields behind the signal (field-level inference), building on LoReLi, a unique public database of about 10,000 radiative-transfer simulations of reionisation produced at Observatoire de Paris.

Position 1 – LUX, Observatoire de Paris: learned summary statistics for 21-cm inference.

Summary statistics of the 21-cm signal are often used as targets for inference of reionization models parameters. These statistics can be physically motivated (e.g. the power spectrum) or learned from the model-generated data using neural networks. Different goals can be considered in the learning process: optimality in terms of information content, insensitivity to the astrophysical model, optimal calibration (i.e. trustworthiness) of the posteriors, etc. The post-doc will explore these various goals for the learned summary statistics using machine learning approaches such as contrastive or self-supervised learning. This position requires solid experience with advanced machine learning and an interest in 21cm modelling.

Position 2 – IAS, Université Paris-Saclay, Orsay: field-level inference with diffusion models.

Beyond summary statistics, the full 21cm map can be used to constrain reionisation parameters and to reconstruct, pixel by pixel, the underlying matter density field, an approach called field-level inference. The posterior distribution of each density pixel can be sampled either with Bayesian methods combining an explicit likelihood, a differentiable forward model and efficient samplers such as Hamiltonian Monte Carlo (HMC), or with generative models such as denoising diffusion probabilistic models (DDPMs) guided by the 21cm observation. DDPMs are fast and flexible, but they sample from an implicit distribution learned from simulations, and it is still poorly understood how this distribution relates to the true Bayesian posterior, or how well it captures uncertainties. The postdoc will lead a comparison of these approaches, to understand whether DDPM can replace computationally expensive, but asymptotically exact, HMC sampling. Different research avenues will be explored, depending on the candidate's interests and suggestions, for instance hybrid methods combining learned priors with physical likelihoods (plug and play), joint inference of astrophysical parameters, or the inclusion of realistic SKA observational effects.

Environment. The successful candidates will join the SLEEC team, composed of two permanent researchers, two postdocs and three PhD students. The team is split between LUX (Observatoire de

Paris) and IAS (Orsay), who meet regularly. Both institutes are deeply involved in SKA preparation and offer access to substantial HPC resources.

The position includes funding to attend conferences and workshops, as well as the possibility to co-supervise students. Compensation will be commensurate with experience. Employment includes French national health and dental coverage, maternity and paternity leave, lunch and public transportation subsidies, and national pension benefits. The successful candidate will also have the opportunity to take a free French language course if they so wish.

Profile. Applicants should hold a PhD in astrophysics, cosmology, physics, statistics or machine learning by the start date. They should have experience with machine learning (ideally generative or self-supervised models) and/or Bayesian inference. Experience with 21cm cosmology or reionisation simulations is an asset but is not required.

Application details

- Application deadline: 30 November 2026
- Interviews: January 2027
- Selection: February 2027

Applicants should provide a CV with a publication list, a research statement (max. 3 pages, not including references), and a cover letter. The letter should explain why you are a good fit for the position, suggestions from the applicant on how their own research plans could fit into the SLEEC project, as well as the names of two referees to be contacted at the interview stage.

Applicants should upload all application material as a single pdf file by the November 30th deadline at [this link](#).

Informal enquiries are welcome: A. Gorce (adelie.gorce@universite-paris-saclay.fr) and B. Semelin (benoit.semelin@obspm.fr).