# 2025 SUMMER SCHOOL PROGRAM

# & ABSTRACTS

This program is also available on-line at:
https://ismgalaxies2025.sciencesconf.org/program/details.

# WEEK I

## Tuesday, July 22nd

| CEST Time | Title | Speaker |
|---|---|---|
| 08:30 – 08:45 | Welcome & Introduction | Frédéric Galliano |
| 08:45 – 10:15 | First Lightning Session | Everyone<br>Evangelia Ntormousi |
| 10:15 – 10:45 | Coffee Break | |
| **Part I<br>The Methods** | | |
| 10:45 – 12:30 | Lecture – A general introduction to machine-learning and deep learning methods | Adeline Paiement<br>Antoine Roueff |
| 12:30 – 14:00 | Lunch Break | |
| 14:00 – 15:45 | Second Lightning Session | Everyone<br>Evangelia Ntormousi |
| 15:45 – 16:15 | Coffee Break | |
| 16:15 – 18:00 | Lecture – Applications of unsupervised machine learning techniques for data exploration and discovery in ISM science | Dalya Baron<br>Pierre Palud |

## Wednesday, July 23rd

| CEST Time | Title | Speaker |
|---|---|---|
| 08:30 – 10:15 | Lecture – On the use of information measures and performance bounds in the ISM | Antoine Roueff<br>Jérôme Pety |
| 10:15 – 10:45 | Coffee Break | |
| 10:45 – 12:30 | Hands-on Projects | |
| 12:30 – 14:00 | Lunch Break | |
| 14:00 – 15:45 | Lecture – Bayesian inference and ISM studies: some statistical tools to make the most of your observations | Pierre Palud<br>Adeline Paiement |
| 15:45 – 16:15 | Coffee Break | |
| 16:15 – 18:00 | Hands-on Applications | |

## Thursday, July 24th

| CEST Time | Title | Speaker |
|---|---|---|
| 08:30 – 10:15 | Hands-on Applications | |
| 10:15 – 10:45 | Coffee Break | |
| 10:45 – 12:30 | Lecture – Numerical simulations of the galactic-scale interstellar medium | Simon Glover<br>Dalya Baron |
| 12:30 – 14:00 | Lunch Break | |
| 14:00 – 15:45 | Hands-on Applications | |
| 15:45 – 16:15 | Coffee Break | |
| **Part II<br>The Observations** | | |
| 16:15 – 18:00 | Lecture – Distant Galaxies with JWST | Emma Curtis Lake<br>Patrice Theulé |

## Friday, July 25th

| CEST Time | Title | Speaker |
|---|---|---|
| 08:30 – 10:15 | Lecture – Stellar population synthesis, the IMF, and stellar feedback across redshifts | Anna McLeod<br>Donatella Romano |
| 10:15 – 10:45 | Coffee Break | |
| 10:45 – 12:30 | Hands-on Applications | |
| 12:30 – 14:00 | Lunch Break | |
| 14:00 – 15:45 | Lecture – Magnetic fields in the ISM of the Milky Way and Nearby Galaxies | Kate Pattle<br>Annie Hughes |
| 15:45 – 16:15 | Coffee Break | |
| 16:15 – 18:00 | Hands-on Projects | |

# WEEK II

## Monday, July 28th

| CEST Time | Title | Speaker |
|---|---|---|
| 08:30 – 10:15 | Lecture – Extragalactic Astrochemistry: from nearby to high redshift galaxies | Serena Viti<br>Emmanuel Dartois |
| 10:15 – 10:45 | Coffee Break | |
| 10:45 – 12:30 | Hands-on Projects | |
| 12:30 – 14:00 | Lunch Break | |
| 14:00 – 15:45 | Lecture – UV-MIR ISM/Galaxy Studies | Danielle Berg<br>Serena Viti |
| 15:45 – 16:15 | Coffee Break | |
| 16:15 – 18:00 | Hands-on Projects | |

## Tuesday, July 29th

| CEST Time | Title | Speaker |
|---|---|---|
| 08:30 – 10:15 | Round table – Prospects in galaxies' ISM | All invited speakers<br>Evangelia Ntormousi<br>Antoine Roueff |
| 10:15 – 10:45 | Coffee Break | |
| **Part III<br>Theory / Microphysics** | | |
| 10:45 – 12:30 | Lecture – Interstellar grains: generation, ID, & processing | Emmanuel Dartois<br>Javier Goicoechea |
| 12:30 – 14:00 | Break | |
| 14:00 – 15:45 | Hands-on Projects | |
| 15:45 – 16:15 | Coffee Break | |
| 16:15 – 18:00 | Lecture – The physics and chemistry of the Interstellar Medium | Javier Goicoechea<br>Andrea Bracco |

## Wednesday, July 30th

| CEST Time | Title | Speaker |
|---|---|---|
| 08:30 – 10:15 | Lecture – Probing the complexity of the Interstellar Medium at radio wavelengths | Andrea Bracco<br>Danielle Berg |
| 10:15 – 10:45 | Coffee Break | |
| 10:45 – 12:30 | Hands-on Projects | |
| 12:30 – 14:00 | Lunch Break | |
| 14:00 – 15:45 | Lecture – Nucleosynthesis and galactic chemical evolution | Donatella Romano<br>Chiaki Kobayashi |
| 15:45 – 16:15 | Coffee Break | |
| 16:15 – 18:00 | Hands-on Projects | |

## Thursday, July 31st

| CEST Time | Title | Speaker |
|---|---|---|
| 08:30 – 10:15 | Hands-on Projects | |
| 10:15 – 10:45 | Coffee Break | |
| 10:45 – 12:30 | Lecture – What we can learn from simulations of galaxies | Éric Emsellem<br>Simon Glover |
| 12:30 – 14:00 | Lunch Break | |
| 14:00 – 15:45 | Round table – Everything you need to know about research that no one teaches you | All invited speakers<br>Jérôme Pety<br>Annie Hughes |
| 15:45 – 16:15 | Coffee Break | |
| 16:15 – 17:55 | Hands-on Project Presentations | All participants<br>Frédéric Galliano |
| 17:55 – 18:00 | Concluding remarks | Frédéric Galliano |


# A general introduction to machine-learning and deep learning methods

**Adeline PAIEMENT**

**(Université de Toulon, France)**

Tuesday, July 22, 2025, 10:45–12:30

This introductory lecture aims to provide an overview of machine learning (ML) and deep learning (DL) methods, with scientific applications in mind. We will briefly review the tasks that may be tackled, and the working principles of ML and DL. We will not go into the details of specific methods, as this will be covered in following lectures. Rather, we will focus on how to deploy them in practice, and how to interpret their results to favour an informed and appropriate usage.


# Applications of unsupervised machine learning techniques for data exploration and discovery in ISM science

**Dalya BARON**

**(Stanford University, USA)**

Tuesday, July 22, 2025, 16:15–18:00

In this lecture, we will explore several classes of algorithms that belong to the family of unsupervised machine learning. These algorithms are called *unsupervised* because they do not require "ground truth" labels or target variables for training. Instead, they operate directly on the data and are used for clustering, component separation, dimensionality reduction, data visualization, and outlier detection. These methods are particularly useful for exploring the complex and heterogeneous datasets common in ISM science and can facilitate new discoveries.

We will begin with a broad discussion of the motivation for using data science and machine learning techniques in the context of data exploration and discovery. From there, we will work together to understand how to apply these tools effectively to astronomical datasets. Since all of these methods rely on some notion of distance or similarity to relate astronomical objects, we will first look at different ways to represent data and consider the tradeoffs of each approach. We will then survey dimensionality reduction, clustering, and outlier detection techniques, and discuss how to interpret their outputs meaningfully. Finally, we will go through a set of guidelines for incorporating unsupervised machine learning into our own research in a safe and constructive way.

## Bibliography

- *Machine Learning in Astronomy: a practical overview*, Baron, D., 2019, Arxiv


# On the use of information measures and performance bounds in the ISM

**Antoine ROUEFF**

**(Université de Toulon, France)**

Wednesday, July 23, 2025, 08:30–10:15

When an astronomer tries to infer a physical quantity from observations, he first has to choose among the many possible techniques: from the well-known weighted least squares and maximum likelihood estimators, to the more recent random forest and neural network estimators, through the Bayesian estimators. However, the best-performing estimator depends on the considered problem. A careful astronomer would thus need to implement all the different techniques to choose the best one for his problem. This is of course out of question because of the required time.

Information measures and performance bounds provide an alternative view of the data, independent on the choice of the estimation technique. On the one hand, for a given joint probability density function (pdf) of the observable and the physical quantity of interest, information theory allows one to quantify the dependence between the observable and the parameter of interest. On the other hand, the performance bounds provide estimation precisions for a given physical regime.

This course provides an introduction to the main information theory concepts, namely the entropy and mutual information. I will show how these information measures can be used for the selection of the most informative lines in astrophysics [1]. Then, after showing a connection between information theory and estimation theory, I will discuss several ways to define an optimal estimator. Finally, I will present the Cramér-Rao lower bound which can be used 1) to quantify the gain in precision provided by new observations, and 2) to find out whether all the information from the data has been extracted, and 3) to build an interval of confidence [2,3].

During the hands-on sessions, you will use these concepts on actual examples. Some Python codes will be provided to generate simulated data.

## Bibliography

**Application to ISM studies:**

*[1]* Einig, L., Palud, P., Roueff, A., et al. 2024, A&A, 691.

*[2]* Roueff, A., Pety, J., Gerin, M., et al. 2024, A&A, 686.

*[3]* Segal, L., Roueff, A., Pety, J., et al. 2024, A&A, 692.

**Useful Textbooks:**

*[5]* "Fundamentals of Statistical Signal Processing: Estimation Theory" by S. Kay, published by Prentice Hall.

*[6]* "Elements of Information Theory" by Cover & Thomas, published by Wiley.


# Bayesian inference and ISM studies: some statistical tools to make the most of your observations

**Pierre PALUD**

**(APC, Paris, France)**

Wednesday, July 23, 2025, 14:00–15:45

Bayesian inference methods are now central to data analysis in astrophysics, providing a principled framework for incorporating prior knowledge, extracting insight from high-dimensional, complex data, including uncertainty quantifications. This lecture introduces the Bayesian paradigm, its key probability distributions, and three commonly used estimators: the Maximum Likelihood Estimator (MLE), the Maximum A Posteriori (MAP), and the Minimum Mean Squared Error (MMSE).

To build intuition, we will first examine these estimators in the simple case of conjugate priors, where closed-form solutions exist. We will then move to the general case, introducing Markov Chain Monte Carlo (MCMC) methods. Finally, we will explore applications of Bayesian methods to studies of the interstellar medium, such as physical parameter inference with astrophysical simulators.

The goal of this class is to provide the main theoretical concepts and some practical tools to help astrophysicists incorporate Bayesian reasoning into their research.

## Bibliography

**For a general overview of MCMC methods:**

- Robert, C. P. & Casella, G. *Monte Carlo Statistical Methods* (Springer New York, New York, NY, 2004) doi:10.1007/978-1-4757-4145-2.
- Palud, P., PhD thesis, 2023, chapter 2 https://theses.hal.science/tel-04424965.

**For a general overview of statistical inference applications to interstellar medium:**

- Palud, P., PhD thesis, 2023, chapter 3 https://theses.hal.science/tel-04424965.


# Numerical simulations of the galactic-scale interstellar medium

**Simon GLOVER**

**(University of Heidelberg, Germany)**

Thursday, July 24, 2025, 10:45–12:30

The interstellar medium (ISM) is a highly complex coupled system. Many different physical processes influence its behaviour, acting over a broad range of length and time scales. It is difficult or impossible to capture the full breadth of this physics with simple analytical models, and for this reason detailed numerical simulations have long played a central role in the theoretical study of the ISM.

In this lecture, I will briefly introduce the main physical ingredients that have to be included in any comprehensive numerical model of the ISM, and will discuss the approaches that we can use to simulate these on computers. I will talk about how computational resource limits affect the scope of what we can simulate and will discuss some of the computational trade-offs that they force us to make. I will present several different state-of-the-art models as instructive examples and will close by giving my thoughts on where the field is headed in the future.

## Bibliography

- Kim et al., 2023, ApJ, 946, 3
- Rathjen et al., 2025, MNRAS, 540, 1462
- Goeller et al., 2025, arXiv:2502.02646
- Kjellgren et al., 2025, arXiv:2502.02635


# Distant Galaxies with JWST

**Emma CURTIS LAKE**

**(University of Hertfordshire, UK)**

Thursday, July 24, 2025, 16:15–18:00

Understanding how galaxies form and evolve across cosmic time is a fundamental goal of extragalactic astronomy. Observations of very distant galaxies—seen as they were in the first few billion years after the Big Bang—offer a direct window into the early stages of galaxy evolution. In this talk, I will give a brief historical overview of how our understanding of these early systems developed prior to the launch of JWST, with a particular emphasis on the critical impact of the interstellar medium (ISM) on the interpretation of distant galaxy observations. I will then highlight some of the major advances in our understanding of high-redshift galaxies enabled by JWST and outline several key open questions that remain. Throughout I will address how local galaxy observations provide context and constraints for interpreting the high-redshift Universe. Finally, I will describe some of the primary techniques used to analyse distant galaxies, showing how they allow us to extract meaningful information from faint and often limited data. This overview will underscore the synergy between cutting-edge observations and methodological innovation in advancing our picture of galaxy evolution.


# Stellar population synthesis, the IMF, and stellar feedback across redshifts

**Anna MCLEOD**

**(Durham University, UK)**

Friday, July 25, 2025, 08:30–10:15

Understanding the properties of massive stars and how these influence their environments across cosmic time is crucial for constraining galaxy evolution and the initial mass function (IMF). Studies of resolved stellar populations in the nearby Universe claim to be able to provide key insights that can be applied to the distant Universe, but do true local analogs matching recent high redshift observations exist?

After an introduction the stellar population synthesis and the IMF, I will discuss how we can test the accuracy of the models, which are widely used to interpret integrated light from high-redshift galaxies by analyzing spatially resolved massive stars in local star-forming environments. These local benchmarks allow us to refine predictions of ionizing photon production, chemical enrichment, and feedback processes, ultimately improving our ability to infer the nature of massive stars and their role in early galaxy evolution. Thus, I will discuss how resolved stellar populations could bridge the gap between observations and models, shedding light on extreme stellar populations across redshift.


# Magnetic fields in the ISM of the Milky Way and Nearby Galaxies

**Kate PATTLE**

**(University College London, UK)**

Friday, July 25, 2025, 14:00–15:45

In this lecture, I will discuss the physics of the magnetised interstellar medium (ISM), briefly outlining how Maxwell's equations lead to the presence of magnetic pressure and tension in the ISM. I will discuss the insights which we are gaining into the energy balance, dynamics and evolution of the magnetized ISM from recent observations and simulations, on size scales ranging from nearby star-forming regions to the discs and winds of nearby galaxies. I will particularly discuss how we can infer the dynamic importance of magnetic fields from measurements of magnetic field strength and geometry in the interstellar medium, and the emerging evidence for how the interaction between magnetic fields, outflows and feedback may influence star formation efficiency on both small and large scales. Finally, I will briefly discuss how future instrumentation will allow us to further investigate magnetic fields over the full range of size and density scales in the ISM.

## Bibliography

- "The Physics of Fluids and Plasmas: An Introduction for Astrophysicists", Arnab Rai Choudhuri, Cambridge University Press, 2014: Chapter 6, "Basic Magnetohydrodynamics"
- "Magnetic fields in star formation: from clouds to cores", Pattle et al. 2023, Protostars and Planets VII, ASP Conference Series, Vol. 534, p.193


# Extragalactic Astrochemistry: from nearby to high redshift galaxies

**Serena VITI**

**(Leiden Observatory, Leiden University, The Netherlands)**

Monday, July 28, 2025, 08:30–10:15

Molecules pervade the cooler, denser parts of our Universe, in particular the reservoirs of the matter that forms stars and planets, and the gas in the centres of galaxies. In fact, observations across the Universe reveal a surprisingly large number of molecules and show how complex chemistry in space can become, despite the harsh environment of the interstellar medium. Molecules not only play a key role in the formation and the shaping of galaxies, but they are also great tools to trace of their physical characteristics. In this Lecture I will provide an overview of Astrochemistry within the context of the formation and evolution of galaxies. I will show how molecular emission can be used to explore and characterize the physical conditions and energetics, as well as, possibly, the evolutionary status of the interstellar medium. Finally, through an observational and theoretical tour of recent advances in the field, I will show how to make molecules into one of the most powerful diagnostics of the formation and evolution of stars and galaxies.


# UV-MIR ISM/Galaxy Studies

**Danielle BERG**

**(University of Texas, Austin, USA)**

Monday, July 28, 2025, 14:00–15:45

The ultraviolet (UV), optical, and mid-infrared (MIR) regimes each offer a uniquely powerful window into the physical conditions of the interstellar medium (ISM) in galaxies. In this lecture, we will explore how UV–MIR spectroscopy enables detailed measurements of gas-phase abundances, dust depletion patterns, and attenuation properties in nearby galaxies. We will highlight the synergy between UV, optical, and MIR diagnostics, particularly in low-metallicity and star-forming systems that serve as analogs to the early universe.

A major focus will be placed on recent advances from spatially resolved surveys using instruments such as MUSE and JWST/MIRI, which map ionized gas, metallicity gradients, and feedback-driven structures across galactic disks. We will also discuss dust attenuation and the geometry-dependent nature of extinction corrections. Looking ahead, I will introduce the Ultraviolet Explorer (UVEX) and Habitable Worlds Observatory (HWO) and their potential to revolutionize UV-optical ISM studies of the local universe through deep, wide-field spectroscopy. We will conclude with a discussion of how future observatories will jointly advance our understanding of ISM processes across cosmic time.

## Bibliography

Useful reading/links can be found here: https://www.danielleaberg.com/copy-of-useful-links.

## Biography

Danielle A. Berg is an assistant professor in the Department of Astronomy at the University of Texas at Austin. Her research focuses on the physical and chemical conditions of the interstellar medium (ISM) in galaxies across cosmic time, with an emphasis on understanding galaxy evolution through measurements of elemental abundances, ionizing radiation, and dust. She is a principal investigator of the HST CLASSY Treasury Survey and the CLASSYIR JWST Treasury Survey, is a science project lead for the NASA UVEX telescope, and is a leader of the CHAOS Survey and the JWST AURORA program, which is pioneering rest-frame UV diagnostics in high-redshift galaxies. Berg has played a leading role in developing empirical abundance calibrations for low-metallicity galaxies and is actively involved in future mission planning for the Habitable Worlds Observatories.


# Nucleosynthesis and galactic chemical evolution

**Donatella ROMANO**

**(INAF, Bologna, Italy)**

Wednesday, July 30, 2025, 14:00–15:45

In this lecture, the discussion will center on the production of elements in stars and on the chemical evolution of galaxies. More specifically, I will introduce the main ingredients of numerical chemical evolution models and compare their predictions to data for the Milky Way and other galaxies. Current uncertainties impacting our understanding of the formation and evolution of galaxies will be critically examined. The improvements that are expected in the coming decades thanks to current and future space missions as well as new instrumentation from the ground will also be discussed.


# Interstellar grains: generation, ID, & processing

**Emmanuel DARTOIS**

**(Institut des Sciences Moléculaires d'Orsay, France)**

Tuesday, July 29, 2025, 10:45–12:30

The interstellar medium is a physico-chemical laboratory where extreme conditions are encountered, and whose environmental parameters (*e.g.* density, reactant nature, radiations, temperature, time scales) define the composition of matter. Whereas cosmochemists can spectroscopically examine collected extraterrestrial material in the laboratory or via space probes, astrochemists must rely on remote observations to monitor and analyze the physico-chemical composition of interstellar solids. The observations give essentially access to the molecular functionality of these solids, rarely to elemental composition constraints and isotopic fractionation only in the gas phase. Astrochemists bring additional information from the study of analogs produced in the laboratory, placed in simulated space environments. In this presentation laboratory experiments will be presented, setting constraints on the composition of organic solids and molecules in the cycling of matter in the Galaxy.


# The physics and chemistry of the Interstellar Medium

**Javier R. GOICOECHEA**

**(IFF-CSIC, Madrid, Spain)**

Tuesday, July 29, 2025, 16:15–18:00

The ISM is one of the most beautiful components of a galaxy, and it plays a fundamental role as both the fuel for star formation and the end point of the material expelled by dying stars. It exists in a variety of ionization states, temperatures, and pressures.

In the first part of this lecture, I will introduce the main components and 'phases' of the ISM, along with their dominant heating and cooling mechanisms. In the second part, I will explain how atomic and molecular lines have become key tracers of the ISM. I will also provide a basic introduction to their formation, destruction, excitation, and radiative transfer mechanisms, as well as to gas line diagnostics and commonly used models.

## Bibliography

- *The Physics and Chemistry of the ISM*, A. G. G. M. Tielens, Cambridge University Press, 2005.
- *Physics of the Interstellar and Intergalactic Medium*, B. Draine, Princeton University Press, 2011.
- *Interstellar Chemistry*, W. W. Duley and D. A. Williams, Academic Press, 1984.


# Probing the complexity of the Interstellar Medium at radio wavelengths

**Andrea BRACCO**

**(INAF - Osservatorio Astronomico di Arcetri, Italy)**

Wednesday, July 30, 2025, 08:30–10:15

The interstellar medium (ISM) is the galactic reservoir from which stars form, playing a central role in shaping galactic evolution. Star formation, in turn, is regulated by the physical and chemical complexity of the ISM, where the energy balance depends on the interplay of thermal and turbulent pressures, magnetic fields, cosmic rays, gravity, and stellar feedback. These components give rise to distinct ISM phases, which are dynamically linked across a wide range of spatial scales.

Understanding how these forces interact – across physical scales and environments – is a central goal of ISM studies. Yet tracing the ISM as a truly multiscale, multiphase medium remains observationally challenging.

Radio observations, spanning from meter to millimeter wavelengths, offer a unique window into the ISM. They allow us to probe all major gas phases – from ionized to molecular – and to trace fundamental processes such as turbulence, magnetic fields, and stellar feedback.

In this lecture, I will highlight the key contributions of radio astronomy, particularly at centimeter wavelengths and beyond, to our understanding of the ISM. We will focus on selected observational tracers: the 21 cm line of atomic hydrogen, synchrotron and free-free continuum emission, Faraday rotation, and radio recombination lines. I will discuss how these observations constrain ISM physics today and look ahead to the transformative capabilities of next-generation facilities, such as the Square Kilometre Array Observatory (SKAO).

## Bibliography

**ISM in general:**

- Draine, B. T. (2011), *Physics of the Interstellar and Intergalactic Medium*, Princeton University Press.
- Tielens, A. G. G. M. (2005), *The Physics and Chemistry of the Interstellar Medium*, Cambridge University Press.

**Multiphase ISM:**

- Ferrière, K. (2020), *Plasma Physics and Controlled Fusion*, vol. 62, issue 1, p. 014014.
- Hennebelle, P. & Inutsuka, S. (2019), Frontiers in Astronomy and Space Sciences, 6, 5.

**Synchrotron and Free-free:**

- Longair, M. S. (2011), Cambridge University Press (Vol. 1–2).
- Beck, R. (2015), The Astronomy and Astrophysics Review, Volume 24, article id.4, 57 pp.

**Faraday rotation:**

- Brentjens, M. A. & de Bruyn, A. G. (2005), A&A, 441, 1217.
- Ferrière, K. et al. (2021), Monthly Notices of the Royal Astronomical Society, Volume 507, Issue 4.

**HI:**


- Wolfire et al. (2003), The Astrophysical Journal, Volume 587, Issue 1, pp. 278-311.
- McClure-Griffiths, N. M. et al. (2023), Annual Review of Astronomy and Astrophysics, Volume 61, pp. 19-63.


**Radio Recombination lines:**


- Gordon, Mark A.; Sorochenko, R. L. (2009), *Radio recombination lines: their physics and astronomical applications*. Astrophysics and space science library. New York: Springer.
- Peters, W. M. et al. (2010), A&A, 525, A128.


# What we can learn from simulations of galaxies

**Éric EMSELLEM**

**(ESO, Garching, Germany)**

Monday, July 31, 2025, 10:45–12:30

Modelling and simulations have been key tools to probe physical processes, or mock the formation and evolution of astrophysical objects, since decades. They have now advanced as far as mocking entire universes, or detailed micro-physics, connecting with state-of-the-art observations in a way that would have been hard to envision 20 years ago. This still comes with a price to pay when we realise the limitations associated with such an exercise.

In this course, I will provide a glimpse of the potential of simulation work in the context of galaxy formation and evolution. I will emphasise my views on "what is a hydrodynamical simulation" and "how to use it", acknowledging the need to look back at the scientific (deductive, inductive) approach. I will focus on galaxies, and its key ingredients including stars, dark matter and most importantly the ISM. This course is meant as a first exposure to the experimental nature of "simulations", hoping it can help all researchers (observers, modellers, theoreticians) either to use those tools, or at least consider the associated results with reason.