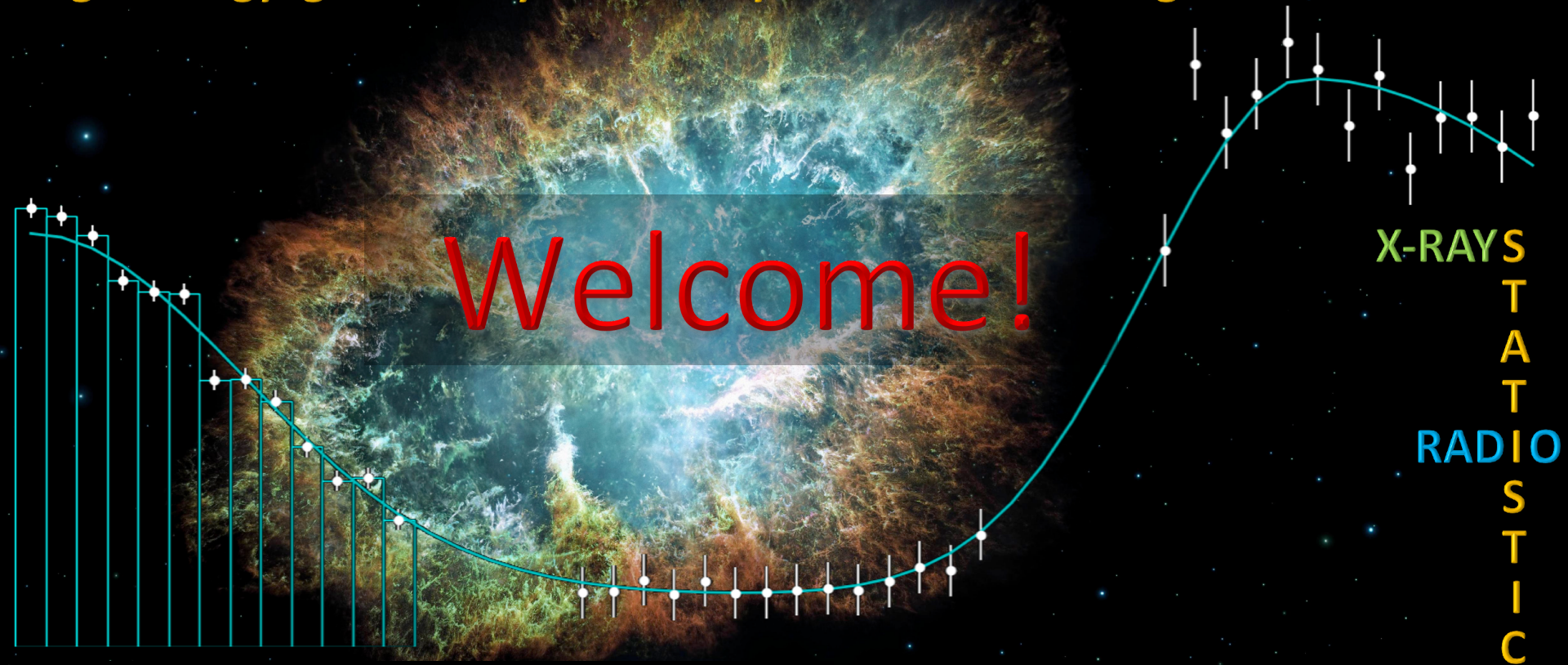
PHYSTAT-Gamma 2022, 28-30 Sep 2022

Statistical methods for data analysis:
High-energy gamma-ray astronomy in a multiwavelength context



LOC: Gerrit Spengler, Thomas Lohse, Ullrich Schwanke
(Humboldt University Berlin), Manuel Meyer (University of Hamburg)
PHYSTAT: Olaf Behnke (DESY), Louis Lyons (Imperial College)

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14:00 → 18:00 **Survey Session: Statistical methods for MWL counterpart identification**

14:30 **Session introduction** 5m

Speaker: Ullrich Schwanke

14:35 **Counterpart identification: Overview** 30m

Speaker: Tamas Budavari

15:05 **Discussion** 15m

15:20 **VHE gamma-ray surveys with CTA** 30m

The Cherenkov Telescope Array (CTA) will be the first astronomical observatory fully covering the gamma-ray sky in an energy range from 20 GeV up to 300 TeV. The observatory will be composed of two arrays of tens of telescopes located in La Palma, Spain, and Paranal, Chile.

Among the Key Science Projects proposed by the CTA Consortium, Galactic and extragalactic surveys will be conducted during the first years of operation. With an unprecedented sensitivity and improved angular resolution, CTA surveys promise the discovery of several hundred of new gamma-ray sources, but the challenges coming along with the analyses of these data will also scale up. We will focus on the challenges of source variability, extended sources modeling, source confusion, source association with multi-wavelength catalogues, classification in source populations, and sources contamination due to the systematic errors in the modeling of instrumental and astrophysical backgrounds.

Speakers: Jean-Philippe Lenain, Quentin Remy

lenain_remy_cta_ca...

15:50 **Discussion** 15m

16:05 **Coffee break** 15m

16:20 **Identifying correct counterparts to high-energy sources by "multiwavelength educated guesses" imbibed in a Bayesian statistic environment** 30m

The identification of the counterparts to sources detected by
instruments with large positional uncertainties can not be done using match in coordinates, due to the very high number density of the ancillary source catalogs.
In addition, given that now the entire sky is literally covered by a plethora of multiwavelength surveys, the search for the counterparts by using a single band at a time is outdated. Instead, the entire SED for every single source in the sky can be created and used for discriminating the actual emitter from the field population.
Finally, at least with respect to X-ray observations, we have more than 20 years of XMM and Chandra detection with a secure counterpart that can be used for creating a training sample to educate our guess.
This is the basis of NWAY, a cross-matching code based Bayesian statistics that works with arbitrarily many catalogs, can handle varying positional errors, can incorporate additional prior information (the educated guesses and works accurately and fast in small areas and all-sky catalogues. In my talk, I will present how NWAY is now routinely used in the determination of the counterparts to Xray sources detected by e.g, ROSAT, XMMSlew, NUSTAR, and eROSITA. In particular, I will show how the prior (based on photometry, colors, parallax, and SNR of the detection) was built for eROSITA using Random Forest and tested on a validation sample providing 96% completeness and purity. The final goal is to discuss with the audience how a similar approach could be built for CTA.

Speaker: Mara Salvato

16:50 **Discussion** 15m

17:05 **Radio surveys** 30m

Speaker: Beatriz Mingo

17:35 **Discussion** 15m

Today

Thank You

- **Tuesday: Glen Cowan, Tim Ruhe**
- **Wednesday: Joshua Speagle, Axel Donath, Johannes Buchner, J Michael Burgees, James Linnemann**
- **Thursday: Eric Feigelson, Jogesh Babu, Tom Loredo, Jeff Scargle**
- **Friday: Tamas Budavari, Jean-Philippe Lenain, Quentin Remy, Mara Salvato, Beatriz Mingo**

- **All who shared their expertise in the chat and via email**

A Plea for CTA Consortium Members

- **Please think about your conclusions from this workshop and let us (Gerrit/Manuel/Ulli) know what measures you would like to see**
  - **More workshops with more specific topics (e.g. transient events)**
  - **Regular data analyis/statistics trainings**
  - **A board of statistics experts for analysis**
  - **Complementing software documentation (gammapy) with statistical background literature**
  - **Work out and note down best practices and suggestions**
  - **…**
  - **…**
- **Measures must be realistic and sustainable (given our related work of setting up the two CTA sites and the existing working groups)**
- **Your views and support would be most welcome**

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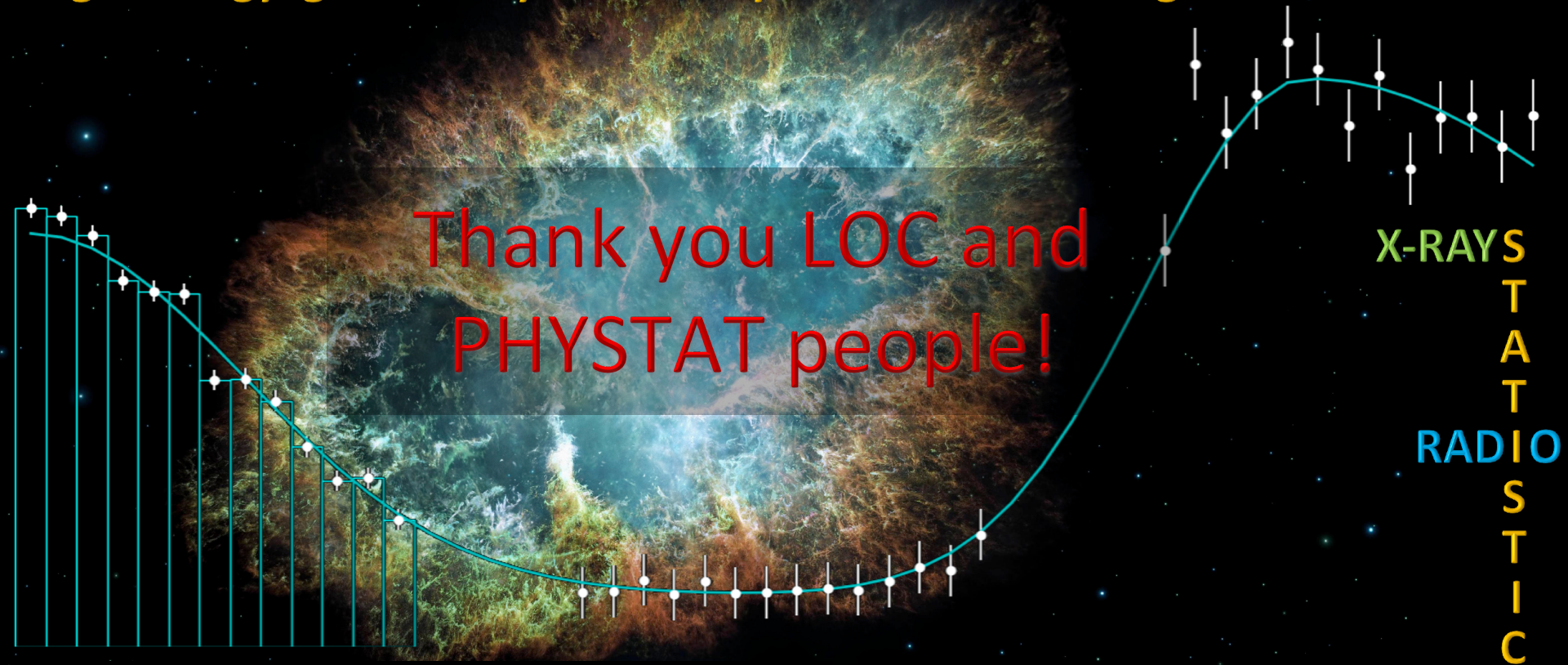

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