Multiwavelength Astrophysics Laboratory:
High-energy (X-ray) module

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A few notes before starting

- Differently from the other two labs (optical and radio/mm), students will be in contact with several staff researchers and a PhD student (tutor). You will *receive a significant amount of inputs and suggestions by different people* − then you will do your own, motivated choices − and *you will be treated as you were part of a research group*. This is a fundamental experience if your goal is to do research in your career.

- The X-ray module is thought and 'built' differently from the other labs. Tutorials are still present, but organized in such a way that students should primarily listen and understand how to reduce and analyze X-ray data without necessarily typing commands on their own simultaneously with the teacher.

- Commands can be found in slides/on-line threads/tutorials/notebooks; it is not mandatory to remember specific commands but to understand the principles of the analysis and the fundamental steps.

- During their own data analysis, to ease and speed-up the process, students are suggested to write in a file all of the commands, including a description of what they are doing. This is helpful to (i) remember the fundamental steps of the analysis for the final powerpoint presentation and to (ii) repeat procedures, if needed, using a simple 'cut & paste'.

X-ray laboratory module: Lessons + Tutorials. I

Useful: review some AGN lessons (on Virtuale)

- AGN classification/demography/Unified scheme – lesson 3
- AGN X-ray spectral components – lesson 4
- Radio-jetted AGN (RL-AGN) – lesson 5
- AGN evolution and AGN-galaxy coevolution – lesson 10
- Feedback in AGN – lesson 13

You are supposed to already know
about these topics from last/current academic year

Available on the Lab website

- X-ray surveys and AGN evolution (S. Marchesi)
- AGN spectral energy distribution and AGN-galaxy coevolution (L. Barchiesi)
- AGN feedback: multi-wavelength indications and X-ray winds/outflows (E. Bertola)

First week of high-energy lab

- Fundamental parameters of X-ray telescopes and detectors
- Pills of statistics and applications to X-rays
- Chandra/XMM/XSPEC/Fermi tutorials
- Presentation of data handling projects

X-ray laboratory module: Lessons + Tutorials. II

- **Monday - 13/11 (11-13, room 1C-UE1)**
  - 11:15-11:45 Introduction to the X-ray laboratory module: C. Vignali [30 min]
  - 11:45-11:55 break
  - 11:55-12:55 Pills of statistics: C. Vignali [60 min]

- **Thursday - 16/11 (14-18, room M-UE3)**
  - 14:15-15:30 Fundamental parameters of X-ray telescopes and detectors: M. Dadina [75 min]
  - 15:30-15:45 break
  - 15:45-17:45 Chandra tutorial: C. Vignali [120 min]

- **Friday - 17/11 (all day, room M-UE3)**
  - 9:15-10:45 presentation of data analysis projects [90 min]
  - 10:45-11:00 break
  - 11:00-13:00 XMM-Newton tutorial: E. Torresi [120 min]
  - 13:00-14:15 break
  - 14:15-15:15 high-energy data analysis: P. Grandi [60 min]
  - 15:15-15:30 break
  - 15:30-17:00 XSPEC tutorial: C. Vignali [90 min]
  - 17:00-18:00 setup for data analysis

→ students'choice of the project (with some rules)

- **Thursday - 23/11 (14-18, room M-UE3)**
  - Data analysis - day 1

- **Friday - 24/11 (all day, room M-UE3)**
  - Data analysis - day 2

- **Thursday - 30/11 (14-18, room M-UE3)**
  - Data analysis - day 3

- **Friday - 01/12 (all day, room M-UE3)**
  - Data analysis - day 4

Remote computers will be made available to students
Bring also your laptops for remote connection and if you would prefer to work on your own computer (with software already installed)

Suggestions to all: install the client ThinLinc (https: www.cendio.com/thinlinc/download) for remote connection (Linux/Windows/MacOS)

Further instructions later

X-ray laboratory: groups and projects

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44 students → 14 groups of 3 students each + 1 group of 2 students

X-ray laboratory: groups and projects

Mandatory; […] optional part (one of those suggested)

Test	Target	Goal	Data
1	Pictor A	**Nucleus** [Eastern Lobe; magnetic field]	XMM
2	Pictor A	**Jet & Hotspot** (knots; SED hotspot; NuSTAR spectra)	Chandra
3	NGC 3783	**Nucleus** [additional observation, different state]	XMM
4	NGC 5135	**Nucleus + companion SFG** [NuSTAR spectra]	Chandra [NuSTAR]
5	CDF-S	**Plots on mosaic catalogs + comparison vs. 7Ms CDF-S + obscured AGN spectral analysis** [CR → Flux conversion; other X-ray spectra]	Chandra
6	XXX	**Analysis of a high-energy source** [SED; nearby sources]	Fermi

- Each X-ray lab test consists of a mandatory and an optional part
- Each group choses one X-ray lab test. At least two groups on the same data, and not more than three groups on the same topic

X-ray laboratory webpage

Lessons, Tutorials, Bibliography, threads, links to X-ray software + useful stuff…

X-Ray Laboratory Fall 2022

November 17, 2022 to December 2, 2022
Europe/Rome timezone

Enter your search term

https://indico.ict.inaf.it/event/2679/

- Overview
- TIMETABLE
- LESSONS
- TUTORIALS
- X-RAY PROJECTS
- CONFIGURATION/SETUP
- SOFTWARE
- USEFUL LINKS
- TEACHERS
- BIBLIOGRAPHY
- EXAMS

** WELCOME TO THE *X-RAY LABORATORY Fall 2022* **

In collaboration with the Department of Physics and Astronomy of the University of Bologna (DIFA), OAS-Bologna organizes combined seminars/laboratories, investigating Active Galactic Nuclei (AGN) through the analysis of their X-ray emission.

The laboratory runs from 17 November to 2 December.

Students are introduced to the current problematics of supermassive black holes to contextualize their data analysis projects. At the end of the laboratory, students summarize their experience in a power-point presentation organized as a professional communication at an Astrophysical Conference.

X-ray Lab is part of the Multiwavelength Astrophysics Laboratory course of DIFA Bologna.

Image credit: Dana Berry

Design: E. Torresi

INAF OAS BOLOGNA

ALMA MATER STUDIORUM A.D. 1088

Starts Nov 17, 2022, 12:00 PM
Ends Dec 2, 2022, 2:00 PM
Europe/Rome

Link to useful links with guides, threads, tutorials

USEFUL LINKS

XMM-Newton (SAS)

- XMM-Newton ABC Guide
- SAS Users Guide
- XMM-Newton threads
- XMM-Newton Users Handbook
- XMM-Newton pile up:

Chandra (CIAO)

- Introduction to CIAO
- Science Threads
- The Chandra ABC Guide to Pileup

NuSTAR

- NuSTAR link

ds9

- SAOImage DS9 Users Manual

XSPEC

- XSPEC on-line manual

Other useful links

1. Conversion table
2. Energy conversion
3. F-test
4. DeltaChi square distribution for a given number of dof and a given value of P
5. Calculation of the logarithmic error bars

Presentation of students' work and Exams. I

- Evaluation for each lab expressed in XX/30
- Evaluation criteria: commitment to the joint work, content of the presentation, quality of the oral discussion, use of appropriate language
- Communication of the results/vote at the end of the three labs.
- Students can either accept the vote ('average' of the three votes, corresponding to the three labs) or have an oral examination (in such a case, previous votes are not considered anymore) → the 'classic exam at the end of the entire course is then optional (students' choice)
- EXAMS for this module will be communicated very soon
- In case you will decide to re-do the exam for all the modules: on February

Presentation of students' work and Exams. II

1. About 10 minutes/student. Questions are typically at the end of each of the sub-parts of your presentation
2. The number of slides is indicatively 1 slide/minute. You must select what you want to show us and your main results (not everything!)
3. Prepare your presentation in such a way that it can be easily sub-divided into 3 sub-parts
4. We will **randomly** decide who is presenting what in each presentation
5. You can prepare hidden slides to be used just in case you want to properly answer to one of our questions
6. Avoid too many animations
7. It is fundamental that you **introduce the source in a broad scientific context** (i.e., what is the principal science problem that you may want to address), **identify the main points of the process of data analysis and interpretation** (within the available time) and that you are **fully prepared on these issues**

Presentation of students' work and Exams. II

RECAP

- Scientific problem and goals of the project
- Presentation of the source and its main properties
- Data available (having in mind the main characteristics of the adopted instruments)
- Data analysis
- Presentation of the results and discussion

Remember: Each student should have all the presentation clear in his/her mind

We will decide who (within each group) is presenting each sub-part of the presentation

Web page – Multiwavelength Astrophysics Lab course

https://www.unibo.it/sitoweb/cristian.vignali/en

Teaching → 96385 – Multiwavelength Astrophysics Laboratory

Please check the latest news/announcements for all updates

Lessons
Virtual Learning Environment
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