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 high-energy/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

I week

- **Tuesday, November 19th, 12:00-13:30** (room M)
  - 12:00-12:30 Introduction to the X-ray laboratory module: C. Vignali [30 min]
  - 12:30-13:30 Pills of statistics: C. Vignali [60 min]

- **Wednesday, November 20th, 9:00-11:00** (room M)
  - 9:00-11:00 Chandra tutorial: C. Vignali [120 min]

- **Thursday, November 21st, 14:00-18:00** (room M)
  - 14:00-15:15 Fundamental parameters of X-ray telescopes and detectors: M. Dadina [75 min]
  - 15:15-16:15 XMM-Newton tutorial: S. Marchesi [60 min]
  - 16:15-16:30 *break*
  - 16:30-18:00 Presentation of data analysis projects [90 min]

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

- **Friday, November 22nd, 9:00-13:00 + 14-16** (room M)
  - 9:00-10:00 Chandra and XMM-Newton notebooks: E. Bronzini [60 min]
  - 10:00-11:00 XSPEC tutorial: C. Vignali [60 min, part I]
  - 11:00-11:15 *break*
  - 11:15-11:45 XSPEC tutorial: C. Vignali [30 min, part II]
  - 11:45-12:45 Fermi data analysis: E. Bronzini [60 min]
  - 13:00-14:00 *break*
  - 14:00-14:30 Fermi notebook: E. Bronzini [30 min]
  - 14:30-15:00 Information on software installation and selection of the projects by the groups [30 min]
  - 15:00-16:00 First steps in data analysis

X-ray laboratory module: Data handling

Following weeks

26.11	12-13:30	room M Ue3
27.11	9-11	room M Ue3
28.11	14-18	room M Ue3
29.11	9-13 + 14-16	room M Ue3
~~02.12~~	~~11:30-13:30~~	~~room 1B Ue1 (50 posti)~~
03.12	12-13:30	room M Ue3
04.12	9-11	room M Ue3
05.12	14-18	room M Ue3
06.12	9-13 + 14-16	room M Ue3
~~09.12~~	~~11-13~~	~~room E Ue1 (48 posti)~~
10.12	12-13:30	room M Ue3
11.12	9-11	room M Ue3
12.12	14-18	room M Ue3
13.12	9-13 + 14-16	room M Ue3 Thesis defense

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 (you do not need to install ThinLinc now!)

X-ray laboratory: groups and projects

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59 students → 17 groups of 3 students each + 2 group of 4 students = 19 groups

List of groups as for the optical module of the lab

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 & Knot** [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	TXS 0506+056	**High-energy data centered on neutrino detection → LC, spectrum, source variability** [multi-messenger SED, …]	Fermi

- Each X-ray lab data-handling/exercise consists of a mandatory and an optional part
- Each group choses one X-ray lab exercise (‘target’). 19 groups vs. 6 targets: the same target cannot be chosen by more than 3 groups, with one exception (one target chosen by 4 groups)

X-ray laboratory webpage

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

X-ray Laboratory 2024

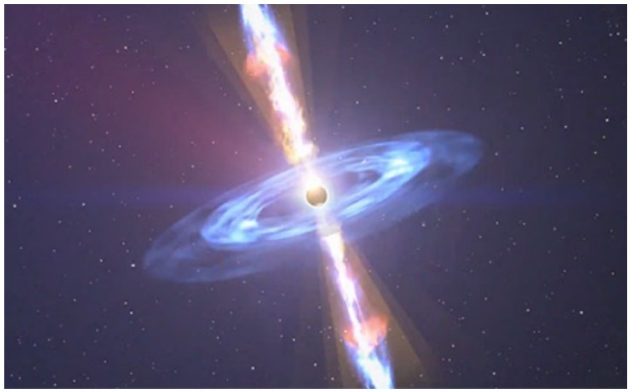
19 November 2024 to 6 December 2024
Europe/Rome timezone

https://indico.ict.inaf.it/event/3089

- Overview
- TIMETABLE
- TUTORIALS & NOTEBOOKS
- PROJECTS
- USEFUL MATERIAL
- CONFIGURATION/SETUP
- USEFUL LINKS
- TEACHERS
- BIBLIOGRAPHY

**** WELCOME TO THE *X-RAY LABORATORY 2024* ****

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 high-energy emission (X-ray/gamma-ray).



Design: E. Torresi

The laboratory will be held from November 19th to December 6th.

Students are introduced to the current problematics of supermassive black holes to contextualize their data analysis projects. At the end of the laboratory, students re required to present their results in a PowerPoint presentation, similar to that at an Astrophysical Conference.

X-ray Laboratory 2024 is part of the Multiwavelength Astrophysics Laboratory course of DIFA Bologna.

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, then 'averaged' over the three modules → vote

[30-	outstanding	0
[29-30[	excellent	E
[28-29[	very good	VG
[26-28[	good	G
[23-26[	satisfactory	Sa
[18-23[	sufficient	Su
<18	failed	F

- Communication to the students at the end of all three labs
- Students can either accept the vote or have an oral examination (**previous votes are then not considered anymore**) → the 'classic' exam at the end of the lab is then optional (students' choice)
  - **RADIO/mm LAB**: written report (one per group)
  - **OPTICAL LAB/X-RAY LAB**: powerpoint presentation (one per group)
- Exams dates:
  - Radio/mm: reports due by 08.01.25, discussion+exams: week 27th–31st Jan.
  - Optical: powerpoint presentations, week 13th–17th Jan.
  - High-Energy: powerpoint presentations, week 20th–24th Jan.

For mark<18 and those not accepting the final vote: 14th Feb. (tbc)

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 (if the group is made of 3 persons, …)
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. III

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 the entire presentation clear in his/her mind (it is a work made by/within the group)

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
+
https://indico.ict.inaf.it/event/3089/

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