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

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 PhD students. 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 (this option is, however, available using remote PCs).

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

- During 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' of the commands.

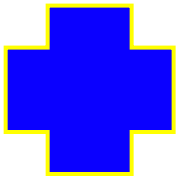
X-ray laboratory module: Lessons + Tutorials. I

Useful: review some AGN lessons

http://www.bo.astro.it/~vignali/Active_Galaxies/AA2021-22/

- AGN classification/demography/Unified scheme
- AGN evolution and AGN-galaxy coevolution
- Feedback in AGN (through winds),
- AGN X-ray spectral components
- Radio-jetted AGN (RL-AGN)

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



- X-ray surveys and AGN evolution
- AGN spectral energy distribution and AGN-galaxy coevolution
- AGN feedback: multi-wavelength indications and X-ray winds/outflows

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

X-ray laboratory module: Lessons + Tutorials. II

When and where

- Monday: 14−18 room L
- Tuesday: 14−18 room M
- Wednesday: 14−18 room L
- Thursday: 14−18 room L
- Friday: all day room M

Lessons

21.02.2022
- Introduction to the X-ray laboratory module: CV [30 min]
- X-ray surveys and AGN evolution: SM [60m]
- Fundamental parameters of X-ray telescopes and detectors: MD [60 min]

22.02.2022
- Pills of statistics: CV [45 min]
- AGN spectral energy distribution & AGN-galaxy co-evolution: LB [60m]
- Chandra tutorial: CV [120 min]

23.02.2022
- AGN feedback: multiwavelength indications and X-ray winds/outflows: EB [60m]
- XSPEC tutorial: CV [90 min]

24.02.2022
- Data analysis: **projects** [15-20 min each, total=90-120 min]

25.02.2022
- XMM-Newton tutorial: ET [120 min]
- Computer/login setup

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

X-ray lab data handling: Feb. 28 – March 11 (two weeks)

When and where

- Monday: 14–18 room L
- Tuesday: 14–18 room M
- Wednesday: 14–18 room L
- Thursday: 14–18 room L
- Friday: 9–11 room M (afternoon: optional, room M is available)

Final exams ("rules" at the end of this presentation): to be decided (at least one week after the end of data analysis)

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 (we will test this tomorrow and in the next few days): install the client ThinLinc (https: www.cendio.com/thinlinc/download) for remote connection (Linux/Windows/MacOS)

X-ray laboratory: groups and projects

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41 students

- ✓ 13 groups of 3 students
- ✓ 1 group of two students

Group number

X-ray laboratory: groups and projects

41 students: 13 groups of 3 students each + 1 of two

Test	Target	Goal	Data
1	Pictor A	Nucleus + Eastern Lobe	XMM
2	Pictor A	Jet + Hotspot	Chandra
3	PKS 1510-089	Nucleus/Jet/Knots High-energy variab.	Chandra (AGILE)
4	NGC 3783	Nucleus, two states	XMM
5	NGC 5135	Nucleus + SFG	Chandra/NuSTAR
6	CDF-S	Mosaic/catalog/ obscured AGN spectral analysis	Chandra

1. Each X-ray lab test consists of a mandatory and an optional part
2. 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 2022

February 21, 2022 to March 11, 2022
Europe/Rome timezone

https://indico.ict.inaf.it/event/1799/

- HOME
- TIMETABLE
- FRONTAL LESSONS
- TUTORIALS
- SOFTWARE
- USEFUL LINKS
- TEACHERS
- BIBLIOGRAPHY

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

In collaboration with the Department of Physics and Astronomy of the University of Bologna (DIFA), OAS-Bologna organizes combined seminars/laboratories, investigating a broad range of astronomical systems through detection and analysis of their X-ray emission and other radiation they emit.

The laboratory runs for three weeks (21 February-11 March 2022).

Lessons, Tutorials, Bibliography, useful Links

TIMETABLE

I week: Lessons + Tutorials + Data Analysis Projects

21.02: h 14-18

- **C. Vignali** Introduction to the X-ray laboratory module (30m)
- **S. Marchesi** X-ray surveys and AGN evolution (60m)
- **M. Dadina** Fundamental parameters of X-ray telescopes (60m)

22.02: h 14-18

- **C. Vignali** Pills of statistics (45m)
- **L. Barchiesi** AGN spectral energy distribution & AGN-galaxy co-evolution (60m)
- **C. Vignali** Tutorial Chandra (120m)

23.02: h 14-18

- **E. Bertola** AGN feedback: multi-wavelength indications and X-ray winds/outflows (60m)
- **C. Vignali** Tutorial XSPEC (90m)

24.02: h 14-18

- **all** Data analysis exercises (120m)

25.02: h 9-13; 14-18

- **E. Torresi** Tutorial XMM-Newton (120m)
- Computer/login setup

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

- X-ray module exam: powerpoint presentation, one per group, **one week after the end of the lab? To be decided**
- Evaluation: XX/30, to be 'merged' with the optical/radio (mm)
- Communication of the judgement + vote to the students at the end of the X-ray laboratory exams (so all students are encouraged to do their best to achieve a good result in the end)
- Students can either accept the final vote ('sum' of the three labs) or decide to go with an oral examination. In this optional case, previous votes are not considered anymore
- Evaluation based on content/presentation/commitment/language

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. III

RECAP

- Scientific problem and goals of the project
- Presentation of the source and its main properties
- Data available (having in mind the main properties of the adopted satellite/instrument)
- Data analysis (not a list of commands used in the analysis)
- Presentation of the results and discussion

Remember: each student should take part to the project (data analysis, discussion of the results, and final presentation)

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

Web page – Astrophysics Lab course

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

→ Didattica

→ 16297 – Laboratorio di Astrofisica – 10 cfu

Avvisi:
https://www.unibo.it/sitoweb/cristian.vignali/avvisi

Lessons/Tutorials:
Virtual Learning Environment +
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