

Report on the COSPAR-IAU Capacity Building Workshop
on X-ray Astrophysics "X-Vision 2023"
Potchefstroom, South Africa - 6-17 February 2023

Carlos Gabriel - COSPAR



IAU I-HOW & COSPAR Capacity Building Workshop on X-Ray Astronomy

**X-VISION
2023**

X-Ray vision of the energetic universe

XMM-Newton, NICER, and NuSTAR

A joint Workshop for X-Ray Data analysis

6th - 17th February, 2023

North-West University (NWU)
Potchefstroom, South Africa

Topics

- + Black holes
- + Pulsars
- + Jets
- + Galaxy clusters
- + Ionized outflows

**Key Lecturers
and Project Leaders**

Dr. Keith Arnaud, NASA, GSFC, USA
Dr. Diego Altamirano, Univ. of Southampton, UK
Prof. Markus Boettcher, NWU, SA
Dr. Ignacio de la Calle, ESA/ESAC, Spain
Dr. Priyanka Chakraborty, Harvard-Smithsonian, USA
Dr. Carlos Gabriel, COSPAR, Germany
Dr. Matteo Guainazzi, ESA, The Netherlands
Mr. Aitor Ibarra, ESA/ESAC, Spain
Dr. Kristin K. Madsen, CRESST, GSFC, USA
Dr. Jermy Hare, NASA/GSFC, USA
Prof. Mariano Mendez, Univ. of Groningen
Dr. Dan Wilkins, KIPC, Stanford, USA
Dr. Arnab Sarkar, MIT-Kavli, Cambridge, USA
Dr. James Stiener, Harvard-Smithsonian, USA

Organizing committee

Prof. Markus Boettcher
Dr. Sunil Chandra
Prof. James Chibueze
Dr. Carlos Gabriel
Dr. Pranjupriya Goswami
Dr. Matteo Guainazzi
Prof. Mariano Mendez
Prof. Christo Venter

Register at:
<https://xvisionastro2023.github.io>

For further information please write to:
xrayvision2023@gmail.com



I – Introduction

The workshop took place at the North-West University (NWU) in Potchefstroom, South Africa, some 120 km west from Johannesburg, from 6 to 17 February 2023. The main international organisers were the IAU Hands-on-Workshops (I-HOW) Initiative and the COSPAR Panel for Capacity Building (PCB). For the first time they jointly organised a workshop, in a way which could constitute a model for future space astronomy events.

This workshop was also generously supported locally by the South African Gamma-ray Astronomy Programme (SA-GAMMA) and the North West University (NWU) Space Research Centre, and internationally by the National Aeronautics and Space Administration (NASA), the European Space Agency (ESA) and the Gordon and Betty Moore Foundation.

The workshop was proposed and organised locally by Dr. Sunil Chandra of the South African Astronomical Observatory (SAAO), Prof. Markus Böttcher, Prof. Christo Venter and Prof. James Chibueze, all from NWU.

The X-VISION2023 Capacity Building Workshop aimed to provide a platform for students and young researchers from developing countries, especially from the African region, to learn how to analyse X-ray data from the XMM-Newton, NICER and NuSTAR missions. The teams of experts included several renowned scientists from various fields. The practical sessions were led by the respective instrument team members. One of the objectives of this Workshop was to inspire and prepare young researchers to use future X-ray observing facilities such as XRISM, ATHENA, Arcus, etc.

Details of the workshop can be found on the Capacity Building Programme pages (<http://cosparhq.cnes.fr/Meetings/Workshops.htm>) and on the local website (<https://xvisionastro2023.github.io/>).

II – Participants

Out of 154 candidates, 34 participants (referred to as students) were selected to participate. However, in the final weeks, five students withdrew from the program. Luckily, three of them were replaced, resulting in a final count of 31 students. The majority of the students were from African countries, with 12 from South Africa, two each from Madagascar, Nigeria, Kenya, Uganda, and Egypt, and one each from Ethiopia, Algeria, Sudan, and Ghana. In addition, there were five students from India. Unfortunately, the program had to limit the number of participants to 31 due to the challenge of finding suitable replacements who could obtain visas for South Africa on short notice.

The geographical distribution of the students showed a strong regional diversification. The gender distribution showed a 45/55% female/male student ratio, which is quite typical considering the workshops previously organised in this region. The full list of students, with their affiliation and nationality, can be found in Appendix I.



Fig. 1: Participants and Lecturers of the I-HOW/COSPAR CB WS



Fig. 2: Participants and Lecturers- Excursion Day

III – Lecturers

Most of the speakers and supervisors were participating in such a CB workshop for the first time. However, three of us had participated in multiple workshops in the past, and two of the remote lecturers had attended previous COSPAR CB workshops as students.

Dr. Matteo Guainazzi from ESA/ESTEC was responsible for the scientific coordination of the workshop. He represented I-HOW in the organizing team as Prof. Mariano Méndez, the director of I-HOW (University of Groningen), was unable to attend the workshop in person. Dr. Guainazzi was part of the organizing team, which also included Dr. Sunil Chandra from SAAO and Prof. Mariano Méndez, and was led by Dr. Carlos Gabriel from COSPAR. All members of the organizing team acted as lecturers and supervisors at the workshop. The team brought together experts in various areas of astrophysics and from the three space missions to create a balanced program in X-ray astrophysics. The goal was to provide effective guidance to the students in their projects.

We were fortunate to have the selfless participation of several experts from various NASA institutes in the USA, including Dr. Kristin Knudsen-Madsen, Drs. Jeremy Hare, James Steiner, Dan Wilkins, and Javier Garcia. Additionally, Aitor Ibarra from ESA/ESAC and Prof. Tomaso Belloni from Italy contributed to the workshop. Remote lectures were given by Prof. Diego Altamirano and Dr. Effrain Gatuzz, who were former participants of previous COSPAR CB workshops as students and are currently based in European institutes. Unfortunately, Prof. Mariano Mendez from the Netherlands was unable to attend the workshop in person due to personal reasons, but still gave a lecture remotely. Similarly, Prof. Priyanka Chakraborty and Prof. Arnab Sarkar from the USA were unable to attend in person due to visa issues, but they also gave their talks remotely.

Local lecturers were Prof. Markus Böttcher, Prof. Christo Venter and Dr. Iurii Sushch, all NWU.

As part of our outreach efforts in astronomy, we frequently incorporate public lectures into our workshops. For the X-Vision 2023 workshop, we were fortunate to have Prof. David Buckley, a former director of the South African Astronomical Observatory (SAAO) and an outstanding student at a previous workshop in Durban, South Africa in 2004, give a presentation as part of the program. The lecture was open to the general public and was also broadcast and publicly announced by the NWU (see Fig. 3).

The possibility of including remote talks contributed to one of the highlights of the workshop: Professor Reinhard Genzel, recent Nobel laureate in Physics, generously gave a presentation on his scientific life, which is a good part of the history of modern astronomy (Fig. 4). The motivational importance and influence that such an event can have on the scientific life of young researchers is noteworthy (Fig. 5).

All presentations, both face-to-face and remote, were broadcast by Zoom, which also allowed them to be recorded. We consider this practice to be very valuable and worthy of being considered in the future.

The full list of lecturers is given in Appendix II.

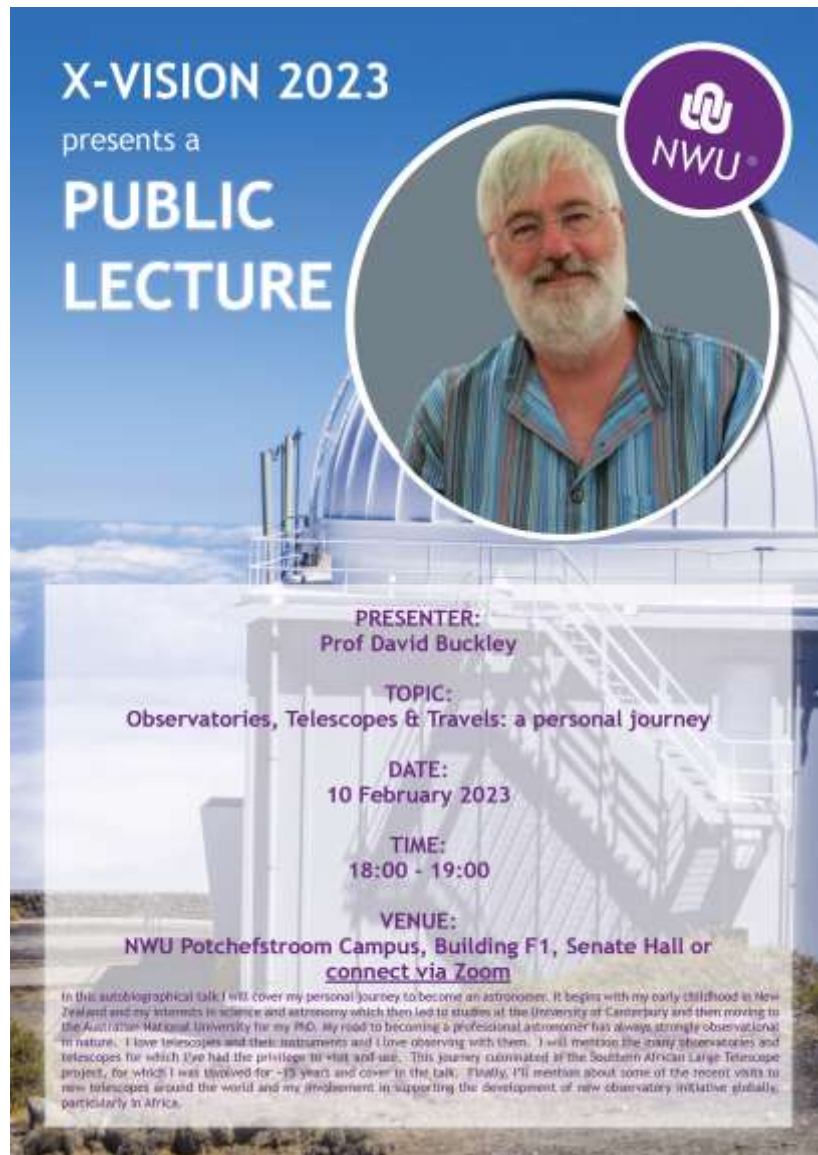


Fig. 3 – The public announcement of Prof. Buckley’s lecture


IV – Program


The workshop's program (Fig. 6) was designed to give students ample time to work on their projects, with 55% of the time dedicated to this endeavor. Lectures on science and data analysis software accounted for approximately 31% and 11% of the program, respectively. As in previous X-ray Astrophysics workshops, the lecturers also acted as project supervisors.

As practiced for the first time in the workshop on Planetary Sciences in Antofagasta, Chile, in the previous month, all the presentations could be followed online via Zoom, and we also used it to record them. Presentations and recordings are available under <https://xvisionastro2023.github.io/programme.html>, one of the web pages of the workshop, for anyone to view. This innovative approach to delivering content provides a valuable resource for students and researchers in the field of astrophysics.

X-VISION 2023 presents a

PUBLIC LECTURE





Prof. Reinhard Genzel
NOBEL PRIZE LAUREATE
 Max Planck Institute for
 Extraterrestrial Physics, Garching

A 40-YEAR JOURNEY

Date:
 14 February 2023

Time:
 14:00 - 15:00

Venue:
 NWU Potchefstroom
 Campus, Building E5,
 Room G04 or connect
 via Zoom
 *Speaker will connect virtually.

More than one hundred years ago, Albert Einstein published his Theory of General Relativity (GR). One year later, Karl Schwarzschild solved the GR equations for a non-rotating, spherical mass distribution. If this mass is sufficiently compact, even light cannot escape from within the so-called event horizon, and there is a mass singularity at the centre. The theoretical concept of a "black hole" was born, and was refined in the next decades by work of Penrose, Wheeler, Kerr, Hawking and many others. First indirect evidence for the existence of such black holes in our Universe came from observations of compact X-ray binaries and distant luminous quasars. I will discuss the forty-year journey, which my colleagues and I have been undertaking to study the mass distribution in the Centre of our Milky Way from ever more precise, long-term studies of the motions of gas and stars as test particles of spacetime. These studies show the existence of a four-million-solar-mass object, which must be a single massive black hole, beyond any reasonable doubt.

Fig. 4 – The public announcement of Prof. Genzel’s lecture

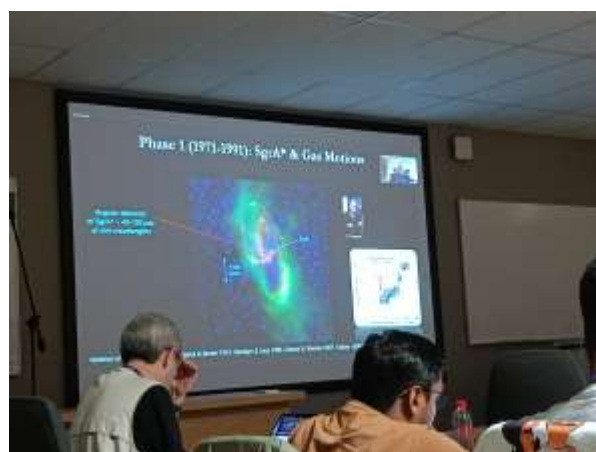


Fig. 5 – Following Prof. Genzel’s lecture in our venue

Day / Date	Arrival & Registration. Welcome reception in the evening											
Sun 05-Feb	9:00 - 10:00	10:00 - 11:00	11:15 - 12:15	13:15 - 14:15	14:15 - 15:15	15:15 - 16:15	16:30 - 17:30	17:30 - 18:30	18:30 - 20:00			
Mon 06-Feb	Opening Ceremony	X-ray detectors and telescopes Matteo Guainazzi	Data Reduction I - Introduction to LHEASOFT Sunil Chandra	The Missions I - XMM-Newton Instruments Calibration Status Carlos Gabriel	The Missions II - NICER Instruments and Calibration status Jeremy Hare	The Missions III - NUSTAR Instruments and Calibration Status Kristin Madsen	Computer Class Setting up SAS, and LHEASOFT	Computer Class Setting up SAS, and LHEASOFT	Computer Class Setting up SAS, and LHEASOFT			
Tue 07-Feb	Principles of X-ray Spectral Analysis Matteo Guainazzi	Data Reduction II - Introduction to SAS Altor Ibarra	Data Reduction III - Introduction to NICER software Jeremy Hare	Calibration Files in X-ray astronomy Carlos Gabriel	Data Red. IV - Introduction to NUSTAR software Kristin Madsen	Astrophysical particle accelerators Markus Boettcher	Computer Class	Computer Class	Computer Class			
Wed 08-Feb	Computer Class Project	Timing Analysis II - Design Algorithms James Steiner	Source detection Altor Ibarra	Cataclysmic Variables /Novae/White Dwarfs Jeremy Hare	Astrophysics and Databases - Pricat-Click+alor+... Kristin Madsen	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project			
Thu 09-Feb	AGNs I Dan Wilkins	Galactic Black Holes and Neutron Stars I James Steiner	X-ray Emission Mechanisms I Sunil Chandra	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project			
Fri 10-Feb	Stellar Neutron Stars Mariano Mendez	Timing Analysis I - Design Algorithms James Steiner	AGNs II Dan Wilkins	Galactic Black Holes and Neutron Stars II James Steiner	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project			
Sat 11-Feb	ISM Altor Ibarra	X-ray TeV synergies Lutz Sturich	Computer Class Project and mentors' meetings	Computer Class Project	Computer Class Project	X-ray Emission Mechanisms II Sunil Chandra	Galaxies, Quasars and Groups I Altor Ibarra	Galaxies, Quasars and Groups II Altor Ibarra	Computer Class Project (stop at 18:00)	Computer Class Project (stop at 18:00)	Observatories, Telescopes & Travels: a personal journey David Buckley	
Sun 12-Feb	Excursion to Planesberg National Park / Free Time											
Mon 13-Feb	Writing Proposals Kristin Madsen	Computer Class Project	Computer Class Project	Running SAS with Notebooks Altor Ibarra	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project			
Tue 14-Feb	Multi-wavelength observations of AGN Markus Boettcher	The COSPAR Capacity Building Initiative Carlos Gabriel	Computer Class Project	Computer Class Project	A 40 Year Journey prof. R. Genzel (15:00-16:30)	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project			
Wed 15-Feb	Basics of Scientific Presentation Dan Wilkins	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project			
Thu 16-Feb	Computer Class Project	Computer Class Project	Computer Class Project	Future Development of X-ray Astronomy Matteo Guainazzi	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project	Computer Class Project			
Fri 17-Feb	Project Presentations											

Scientific program of the X-VI SI ON 2023 Workshop
Version 1.8, 16 February 2023
Authors: Matteo Guainazzi & Sunil Chandra

Astrophysics	24 hours
Analysis tools	9 hours
Projects	43 hours
Others	2 hours

Refreshment break

Fig. 6 - The program

V - The projects

The students defined largely their projects themselves or together with their supervisors, who were assigned according to science topic and instrument (each student had two or three supervisors). The students could work individually or in pairs, but the presentations of the results at the end of the workshop were all done individually. A division was made to assign supervisors according to the chosen topics.

Except for three cases, all students worked on their projects using their own laptops. The desktops we had at our disposal (6) were fully prepared at the time of our arrival with all the needed software.

VI- Results

At the conclusion of the workshop, each student delivered a brief presentation summarizing their findings, with 7 minutes allotted for presentation and 3 minutes for discussion. For the most part, the students adhered to the predetermined time limits, although in some instances the discussion period had to be extended due to the enthusiastic response from the audience, which included students, lecturers, and assistants. The complete list of presentations can be found in Appendix III. Overall, the results were highly satisfactory, demonstrating that all participants had gained a solid understanding of the field work methodologies, and were generally capable of working with the data and tools associated with at least one of the missions involved, and in some cases, more than one. Upon returning to their respective institutions, many of the participants will be able to apply the knowledge they had gained during the workshop.

VII - Venue

The workshop was held in Potchefstroom, a university town near Johannesburg (120 kilometres west), in classrooms provided by the University. During the pre-workshop visit, a few months before the workshop, we managed to book a magnificent classroom with an integrated video system. Two weeks before the workshop, the university announced that, unfortunately, this room would not be available, as it was to be refurbished. Within a few days, the local organisers managed to replace it with two other rooms that had to be used alternately, as they were already partially booked.

Despite the fact that we were able to anticipate and remedy them using local generators, the recurring daily power outages were a significant issue. These outages proved to be particularly disruptive due to their impact on our internet and audio-visual systems. However, as time passed and we became more adept at resolving the disruptions quickly, these interruptions became less of a problem.

The same room was always used for presentations and project work. Due to booking problems, we used two different rooms on different days. Regrettably, the most frequently used room was also the least comfortable, particularly when it came to collaborative group work and fostering interaction between participants and supervisors.

To compound matters, we encountered one day an unexpected power outage lasting several hours while using this room, which was already hampered by its peculiar electrical wiring.

The network bandwidth at both locations was quite good, sufficient for all participants to download programmes and data at peak times. Despite the hotel's internet connection being generally reliable, there were occasional power cuts that disrupted connectivity.

There were no additional rooms for small groups, nor a speaker's area that we could use when we were not actively presenting, supervising, or attending lectures.. This, which was foreseen in the initially booked configuration, could not be achieved in the replacement we were forced to make.



Fig. 7 - The lectures/data lab venue #1



Fig. 8 - The lectures/data lab venue #2



Fig. 9 - The lectures/data lab venues during power cuts

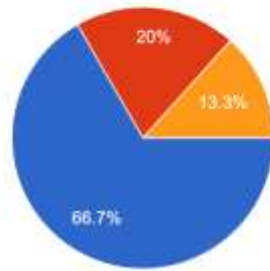
VIII - Lunch and Coffee Breaks

They were held in open areas adjacent to the main conference/project rooms used. The quality of the food was generally acceptable and both venues were not very comfortable, although the less used one (only 3 days) offered some tables and chairs. Vegetarian and vegan meals were included. In the final evaluation by the students, the venue for the workshop was considered good, although the internet in part and especially the food did not convince everyone.



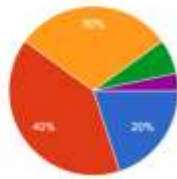
Fig. 10 - Lunch / Coffee Breaks area

The NWU was a good place to hold this workshop
30 responses

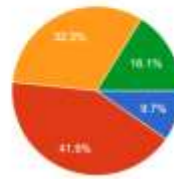


- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not applicable

The internet connection at the NWU was acceptable
30 responses



The lunch at the NWU was good
31 responses



- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not applicable

Fig. 11 – NWU Evaluation

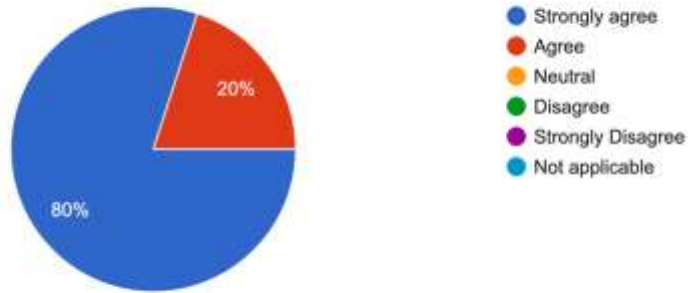
IX – The Accommodation

The decision to schedule the workshop in February, as opposed to the original January timeframe, was largely due to the availability of the NWU Sports Village, a hotel affiliated with NWU. Situated a mere 500 meters from the university campus, this facility offered exceptional accommodations, including both single and double rooms, making it an ideal choice for housing both students and teachers for the two-week duration of the workshop. The Sports Village also provided a restaurant for communal dinners and recreational areas where participants could socialize and engage in sports activities. Despite the persistent rain that accompanied us throughout our stay, the Sports Village exceeded our expectations, although we regretted that the swimming pool could hardly be used due to the inclement weather.

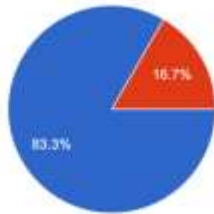


Fig. 12 – The NWU Sports Village

Generally, the accommodation environment was good
30 responses



The room at the NWU Sports Centre was good
30 responses



The internet connection in the hotel was acceptable
29 responses

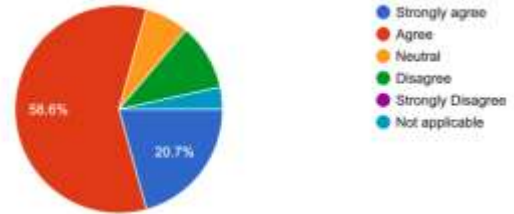
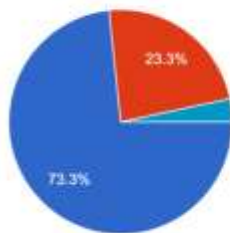


Fig. 13 – The NWU Sports Village Evaluation

X - The Sports Village restaurant

We dined at this place, buffet style. The meals were excellent, including vegetarian and vegan alternatives. There were two modes, most of the time we could use the terrace for dining, set up for our exclusive use, sometimes we dined in the large dining room, which was also the one used for a very good breakfast, including the preparation of eggs and omelettes. We even had a special wine tasting evening there.

The breakfast at the NWU Sports Centre was good
30 responses



The supper at the NWU Sports Centre was good
30 responses

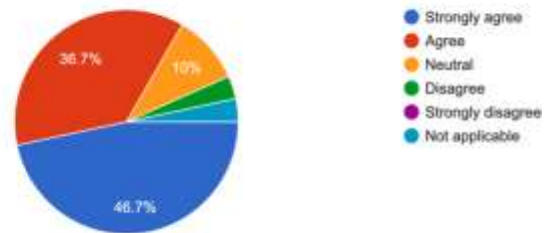


Fig. 14 – The NWU Sports Village meals evaluation

XI – The excursion

The excursion on the Sunday in between was surely a memorable one for all participants. We went in a very comfortable bus to the Pilanesberg Nature Park, about 180 km from Potchefstroom. The park is home to the Big 5, but given the time we had at our disposal especially in the midday hours we could not hope to see most of them. We did see

elephants and white rhinos in large numbers, zebras, giraffes, antelopes, and even hippos in and out of the water. The open jeep ride to observe animals in their natural habitat was great fun. The excursion concluded with a visit to a man-made beach at the resort attached to the park.



Fig. 15 - Driving through Pilanesberg



Fig. 16 - Wild animals we have seen during our game drive

We were back at the Sports Village at 20:30 in time for dinner.

The excursion on Sunday was good

30 responses

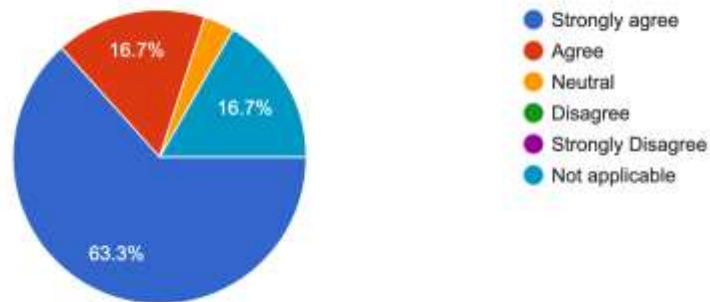


Fig. 17 - Evaluation of the excursion in the week-end

XII - Reception and Gala Dinner

The hospitality of our hosts was present on many occasions. Two exceptional ones were the ice-breaking reception on the first evening of our stay, in the university's botanical garden, and the other was the gala dinner, at the Crista Galli venue, a feast hall with a memorable meal, some live music (thanks to a piano brought in for the occasion and occasional pianists and singers from various continents) as well as lots of dancing (from Spanish ballads to African music, including a collective performance of impromptu Indian dancers, the Bollywood Capacity Building Performance Ballet, joined by dancers from three different continents. ..)



Fig. 18 - Impressions of the gala dinner

XIII - General evaluation

As anticipated in several points, we have prepared and distributed among the students an evaluation sheet (Ap. IV), in order to obtain feedback on the different aspects of the workshop, obtaining all 31 evaluation sheets answered (100% !). A first analysis of the results has been carried out. In general terms, the results do not differ much from those obtained in previous X-ray astrophysics CB workshops. As always, with regard to local elements (place, food) opinions differ partly, as is to be expected due to the very different conditions.

The level of satisfaction with financial support is similar to the former workshop in Chile in January 2023 (Fig. 19). The general increase in workshop-related costs, especially flight costs, has forced us to reduce the percentage of subsidised travel expenses. In the past, this percentage ranged from 70% to 80% of the price of an economy ticket. This time we have been forced to reduce it to an average of 55%. This, together with the rising cost of flights in general, and the economic situation in a large number of African countries with very weak currencies, has led to a low level of student satisfaction (and also to an increase in students' efforts to cover these costs themselves). In my opinion a general increase of the maximum amount for an individual workshop is absolutely necessary. Although we have never cancelled a workshop due to exceeding the maximum amount, the existence of this limit often necessitates measures such as reduced subsidies.

General - The financial support I got was sufficient
30 responses

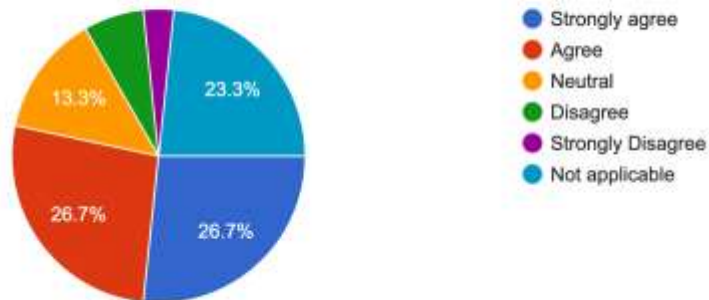


Fig. 19- Evaluation of the financial support (travel subsidy)

There is a very high level of satisfaction with the workshop in general, also with the lecturers and supervisors (Fig. 20). The hard work done by the latter in helping with data reduction and analysis is especially rewarded with more than 96% agreement (of which more than 70% is "strong").

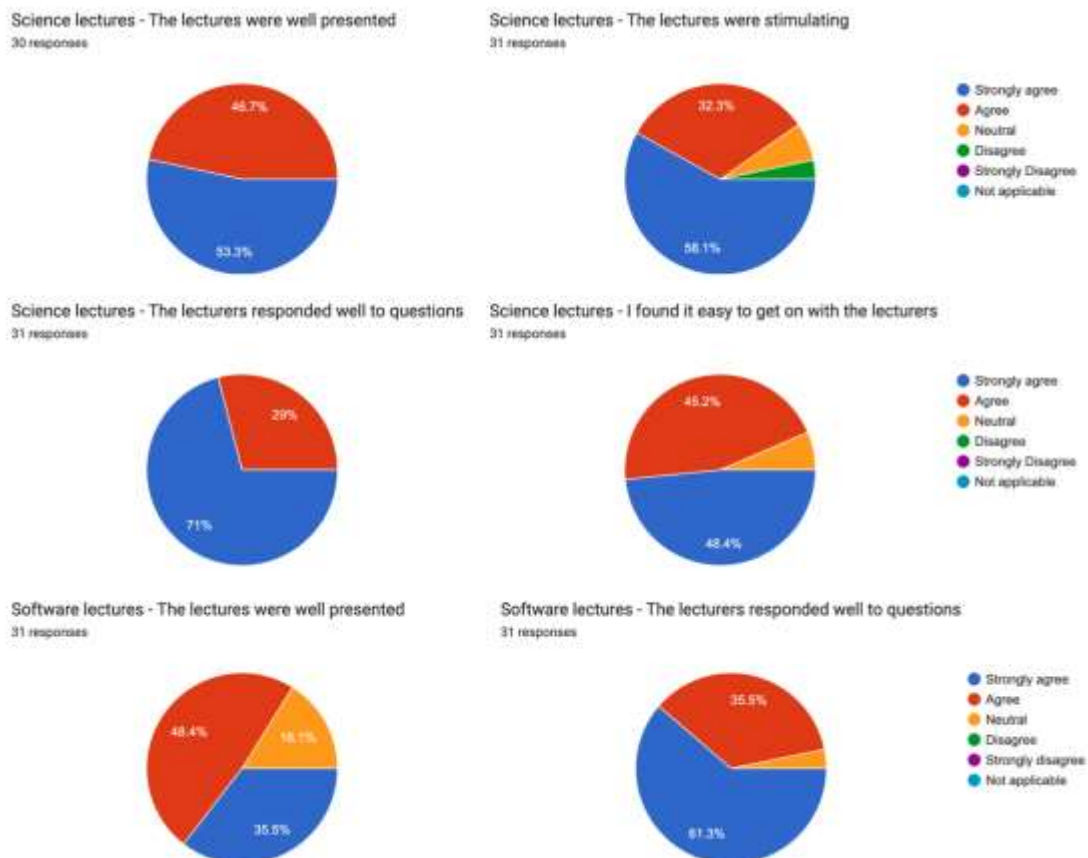


Fig. 20- Evaluation of project supervisors

This is by no means surprising, given the high level of assistance to project work that could be provided at this workshop. All the teachers present in the second half of the course (10), plus the three who helped remotely, formed a group of supervisors covering

all areas and especially all the instruments and dedicated software needed for the projects.

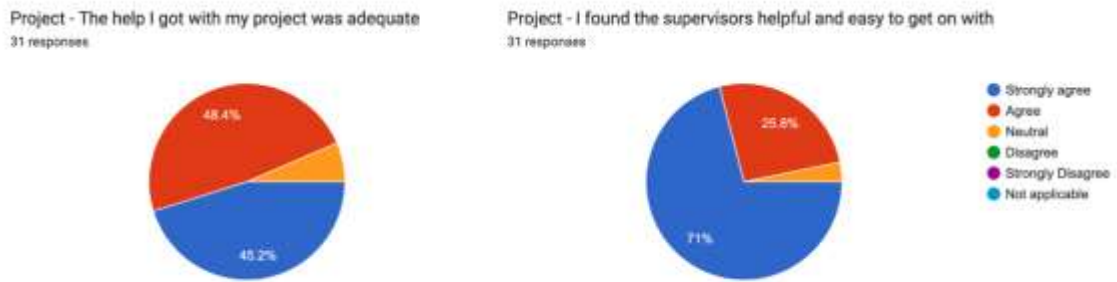
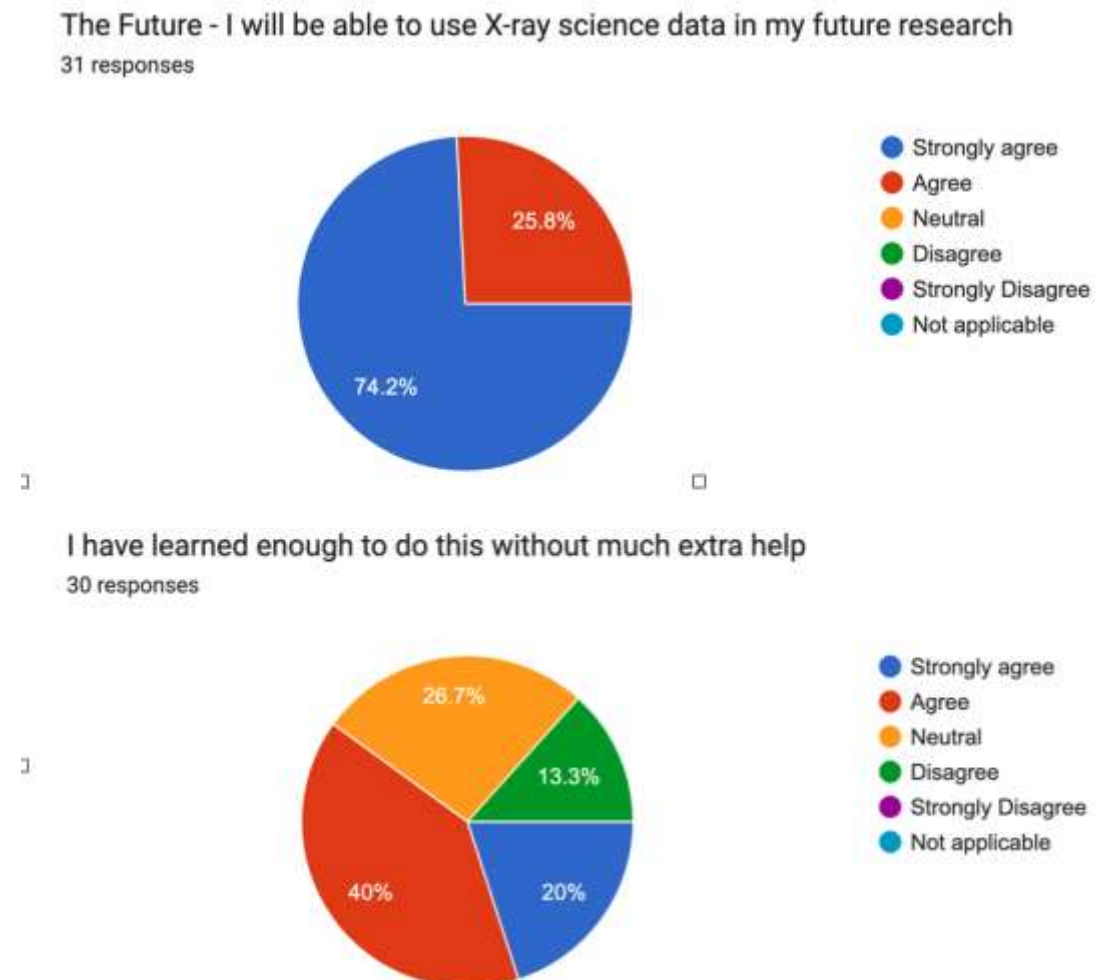


Fig. 21- Evaluation of project supervisors

A large majority of participants believe they will be able to use X-ray science data in their future research, demonstrating a high level of confidence, and more than half believe they will be able to do so without much additional help (Figs. 22).



Figs. 22- Evaluation: Usage of X-ray astrophysics science data in the future

Unanimously, and probably with the highest rates ever achieved in the answer to this typical question in our evaluation, the students feel that they have benefited significantly from their attendance at the workshop (see figure 23). This very high level of satisfaction

does not differ qualitatively from previous workshops though, which is always very comforting for us, organisers, lecturers and supervisors.

I have benefitted significantly from attending the workshop

31 responses

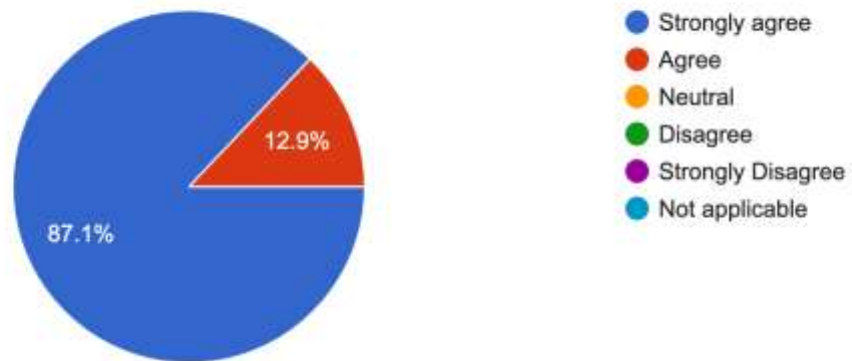


Fig. 23- Evaluation of benefit of participation

The whole evaluation, including the written comments to individual aspects can be seen in Appendix IV. Despite the excellent marks obtained in the evaluation, we found some comments regarding the way data reduction and analysis is taught that lead us to consider possible changes in the future. One of our new lecturers also produced a document with proposals for changes in the method of teaching, which has become a basis for discussion among the lecturers for future events. There will always be room for improvement. The use of new analysis techniques, e.g. based on the use of Jupyter Notebooks, are welcome as elements that can accelerate the teaching process.

I would like to thank first of all Dr. Matteo Guainazzi (ESA), the scientific lead of the workshop, who together with Dr. Sunil Chandra, chairman of the local organising committee, were the main scientific inspiration for it. The LOC did a fantastic job. For the tremendous work and dedication my thanks (also on behalf of I-HOW and COSPAR) to all the speakers and supervisors. Thanks also to the institutions that have contributed substantially to the workshop: the North-West University Potchefstroom, the SA-GAMMA Programme, the South African Astronomical Observatory, the Gordon and Betty Moore Foundation, NASA, ESA, the Kavli Institute for Particle Astrophysics and Cosmology, as well as the African Astronomical Society. For the support also to the three main scientific missions: XMM-Newton from ESA and NuStar and NICER from NASA. Finally, my thanks to Prof. Mariano Méndez, director of the IAU I-HOW project, with which the PCB collaborated in partnership in the organisation of this event, in the hope that we can continue to work together.

Carlos Gabriel – Chairman of X-Vision 2023
COSPAR Panel on Capacity Building – Chairman

Appendix I - List of participants

#	Given Name	Surname	Country	Gender
1	Alemiye Mamo	Yacob	Ethiopia	Male
2	Bosco	Oruru	Uganda	Male
3	Dickson	Okello	Uganda	Male
4	Brian	Bichang'a	Kenya	Male
5	Dakalo Gerold	Phuravhathu	South Africa	Male
6	Daniel	Egbo	South Africa	Male
7	Elizabeth	Kamau	South Africa	Female
8	Emmanuel	Proven-Adzri	Ghana	Male
9	Fatma	Shaban	Egypt	Female
10	Gloria	Raharimbolamena	Madagascar	Female
11	Helene	Szegedi	South Africa	Female
12	Hozayfa Ahmed Braima	Ibrahim	Sudan	Male
13	Janie	du Preez	South Africa	Female
14	Joleen	Barnard	South Africa	Female
15	Kabelo	Kesebonye	South Africa	Male
16	Kavita	Kumari	India	Female
17	Keegan	Trehaeven	South Africa	Male
18	Kinjal	Roy	India	Male
19	Kyle	Solomons	South Africa	Male
20	Lalenthra	Fisher	South Africa	Female
21	Malu	Sudha	India	Female
22	Mona Molham	Elhalaby	Egypt	Female
23	Nancy Julianna	Tovolahy	Madagascar	Female
24	Ogochukwu Uzoamaka	Chibueze	South Africa	Female
25	Ramanshu Prabhakar	Singh	India	Male
26	Siham	Kalli	Algeria	Female
27	Simon	de Wet	South Africa	Male
28	Sneha Nedhath	Divakaran	India	Female
29	Spenser	Madzime	South Africa	Male
30	Thabiso Owen	Machipi	South Africa	Male
31	Thuto	Ndlovu	South Africa	Male

Appendix II - Lecturers / Supervisors

Given Name	Surname	Affiliation	Country
Aitor	Ibarra	ESA	Spain
Amab	Sarkar	MIT, USA	USA
Carlos	Gabriel	COSPAR	Germany
Christo	Venter	NWU, Potchefstroom	South Africa
Dan	Wilkins	Stanford, USA	USA
David	Buckley	SAAO, Cape Town	South Africa
Diego	Altamirano	University of Southampton, UK	UK
Iurii	Sushch	NWU, Potchefstroom	South Africa
James	Steiner	SAO, Harvard, USA	USA
Javier	García	CalTech, USA	USA
Jeremy	Hare	GSFC/NASA	USA
Kristin	Madsen	UMBC/NASA, USA	USA
Mariano	Méndez	University of Groningen,	the Netherlands
Markus	Boettcher	NWU, Potchefstroom	South Africa
Matteo	Guainazzi	ESA, Netherlands	the Netherlands
Priyanka	Chakraborty	SAO, Harvard, USA	USA
Sunil	Chandra	SAAO, Cape Town	South Africa
Tomaso	Belloni	INAF Brera, Italy	Italy
Effrain	Gatuzz	Max-Planck-Institut	Germany

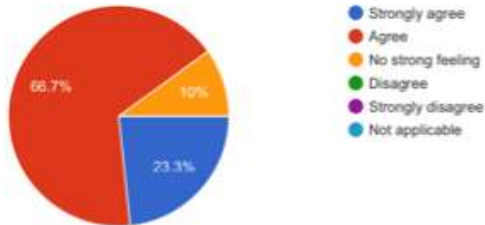
App. III – Projects

#	Surname	Project	Main mentor(s)
1	Yacob	"A study of spectra properties of high mass X-Ray Binary LMC X-1 using NuSTAR observation"	Steiner, Garcia
2	Oruru	"Modeling the X-ray Spectrum of MCG-5-23-6 from NuSTAR Data"	Madsen
3	Okello	"The accretion disk temperature of the black-hole X-ray binary MAXI J1535 – 571 from NICER observation of 2017"	Steiner, Belloni/Altamirano
4	Bichang'a	"Absorption mechanisms of the AGN in Henize 2-10"	Wilkins
5	Phuravhathu	"X-ray Spectrum Analysis of 3C 120"	Wilkins
6	Egbo	"X-ray Spectral Analysis of the PSR B1259-63 Gamma-Ray Binary System at different orbital phase"	Steiner, Belloni/Altamirano
7	Kamau	"The correlation between the flux and photon index of 32C73"	Madsen
8	Proven-Adzri	"NuSTAR observation of GX 339-4, a black hole binary system"	Hare
9	Shaban	"Mkn421 and Mkn335 spectral variability using Nustar data"	Hare
10	Raharimbolamena	"X-ray emission from Pictor A core and hotspot"	Chandra
11	Szegedi	"Supersoft X-ray variability visible during the 2021 eruption of nova RS Ophiuchi"	Ibarra, Garcia
12	Ibrahim	"Using X-ray emissions from galaxy clusters as cosmological probes"	Guainazzi
13	du Preez	"Determining the dynamical state of the galaxy cluster Abell 2667"	Chandra
14	Barnard	"Examining the X-ray spectral variability of MCG-6-15-30 using NuSTAR"	Madsen
15	Kesebonye	"The study of the Abell 2744 cluster properties using the XMM-Newton X-ray telescope"	Guainazzi
16	Kumari	"The possible accretion disk-Corona connection in Narrow-line Seyfert 1 galaxy NGC 4051"	Wilkins
17	Trehaeven	"Turbulent plasma velocities in ACO 1795"	Guainazzi
18	Roy	"Evolution of iron fluorescence emission from SWIFT J0243.6 +6124"	Guainazzi, Garcia
19	Solomons	"A spectral and timing study of the X-ray binary MAXI J1535+517 utilizing NICER observations"	Steiner, Garcia
20	Fisher	"Orbitally Resolved Spectroscopy and Timing of LMC P3"	Hare, Belloni/Altamirano
21	Sudha	"NuSTAR observation of GX 339-4, a black hole binary system"	Hare
22	Elhalaby	"Impact of accurate background subtraction on sample of galaxy clusters at redshift > 0.3"	Guainazzi
23	Tovolahy	"Understanding ABDor with XMM-Newton in the X-ray band"	Gabriel, Ibarra
24	Chibueze	"XMM-Newton vie of NGC 3783"	Ibarra, Gabriel
25	Singh	"Spectral and timing alalysis of GX 339-4 and GRS 1915+105"	Hare
26	Kalli	"Reflection spectral modeling of Ark 564"	Wilkins
27	de Wet	"A TDE and a GRB as seen by XMM-Newton, NICER and NuSTAR"	Chandra, Gabriel
28	Divakaran	"Probing the geometry of the high-mass X-ray binary Vela X-1"	Madsen, Garcia
29	Madzime	"The detection of pulsed X-ray emission from AR Scorpii"	Gabriel, Ibarra
30	Machipi	"X-ray analysis of SN 1987A using NuSTAR and XMM-Newton"	Ibarra
31	Ndlovu	"The Spectroscopic Study of Cygnus X-1 Binary System"	Steiner, Belloni/Altamirano

Appendix IV – Full results from the evaluation form

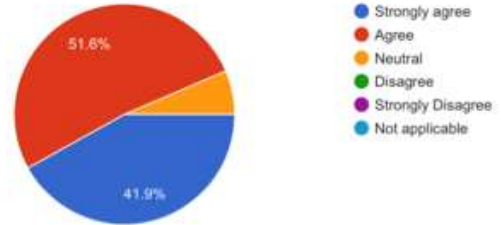
General - The website told me all I needed to know about the workshop

30 responses



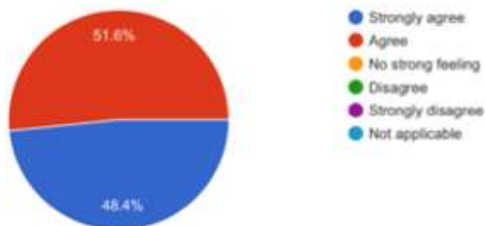
General - Applications were efficiently handled

31 responses



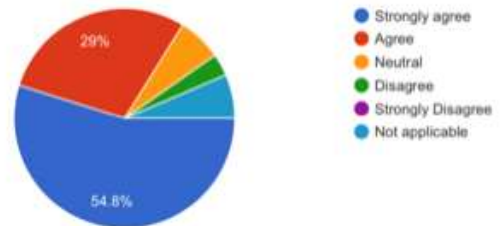
General - The application form was easy to fill in

31 responses



General - I had time enough to make my travel arrangements

31 responses



General - Comments?

11 responses

I had delay for getting my visa, and I really appreciate the help and availability from loc

Financial support should cover at least a return air ticket.

The workshop is intensive and need some time for participants at least one day to get proper rest.

Allocation of mentors could done considering the level of knowledge of participants

Thanks to the organisers for creating a great learning and socialising environment. The conglomerate of experts and enthusiastic students was quite vital for the kind of work we were able to do. Great effort from LOC was made to ensure our comfort and for that I am truly appreciative. Thanks to the hands on help on software installation and research analysis.

When I applied for this workshop, I was thinking that my chance for being selected was small because I am not based in the African continent even if I am originally from an African country. But thank you so much for given me the opportunity to attend this workshop. I learned a lot of things, I managed to extract products and do fitting. During my presentation I got a good feedback. So to summarise, I am happy, I enjoyed it, this workshop has been really useful for me.

It would be better if everyone has the same education on doing data reduction on XMM-Newton or NICER or NuSTAR. Apart from that, all good. All mentors and organizers helped us as much as they could.

The administration leading to the workshop was very good. The communication of all relevant information (accommodation, transport etc) was timely, clear and consistent.

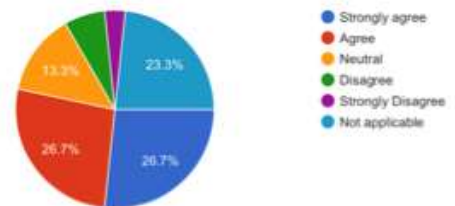
Inclusion of the Chandra telescope would have been nice, especially for those that require high spatial resolution.

It would be more useful if we got planned tutorial instead of projects, so confused students got into work with the group easily.

The workshop was greater than my previous expectations and it was the best astrophysics event I have ever attend, in terms of astrophysics topics diversity and the way of trashing and the interaction between the professors and students.

General - The financial support I got was sufficient

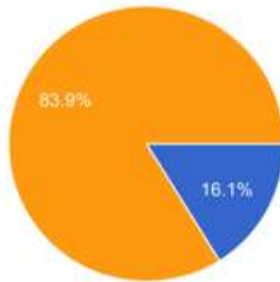
30 responses



Science lectures - Time



31 responses

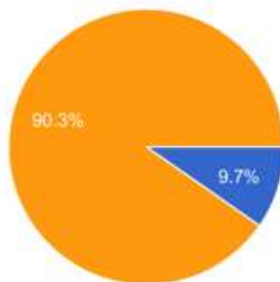


- The time spent on the lectures was too long
- The time spent on the lectures was too short
- The time spent on the lectures was just right

Science lectures - Level



31 responses

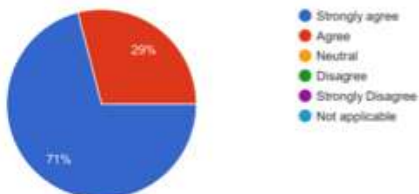


- The lectures were at too high a level
- The lectures were at too low a level
- The level of these lectures was just right

Science lectures - The lecturers responded well to questions



31 responses

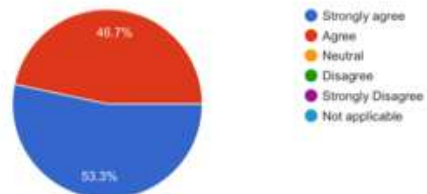


- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not applicable

Science lectures - The lectures were well presented



30 responses

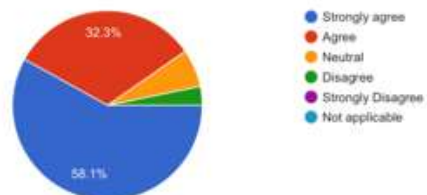


- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not applicable

Science lectures - The lectures were stimulating



31 responses

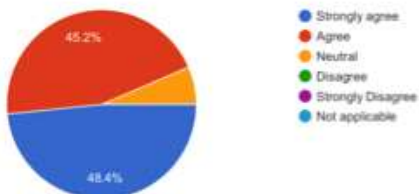


- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not applicable

Science lectures - I found it easy to get on with the lecturers



31 responses

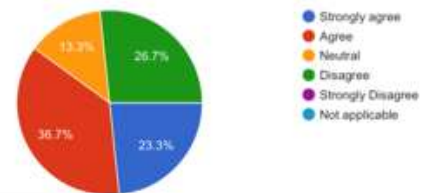


- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not applicable

Science lectures - The lecture room was comfortable



30 responses



- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not applicable

Science lectures - Comments? Were there any topics you would have found especially useful?

16 responses

E% was a better room than F1

The AGN topic and the Timing analysis topics were very useful for me

Lectures focusing on NS and BH XRBs were very useful. And the techniques of spectro-timing studies were discussed splendidly.

Lectures on statistics and AGNs were really beneficial for me and others were exciting too.

Not really. The coverage was okay.

Scientific proposal writing and scientific presentations it adds additional skill beside the lecture. I found them very useful.

I enjoyed the lectures and have been referring to them for my project.

I would have found more information about keV-TeV correlation (and other multi-wavelength) useful.

I think all lectures were very useful as I want to be part of the X-ray community and this workshop is my start-up on this interesting domain. All lectures around black hole (XRBs, AGNs,...) captivated me.

All the lectures were quite outstanding and insightful but would also recommend multi-wavelength lectures where the relationship(s) between all the wavelengths is considered and taught. We had lectures on x-rays and gamma rays, incorporating optical and radio and others would also be nice.

I prefer to have lectures from foundations to higher level.

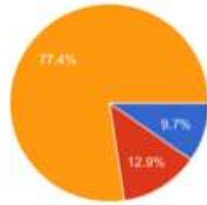
I would have found the science lectures more impactful in the second week after having some interaction with the software and data.

The galaxy clusters lectures and AGN. In general all the topics was very useful for me and I have learned new things better than any workshop.

I would have prefer the lecturers to give a step by step lecture on data reduction and analysis for each instrument before we start with projects. A single example for each instrument will be enough.

Software lectures - Time

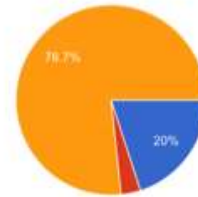
31 responses



- The time spent on these lectures was too long
- The time spent on these lectures was too short
- The time spent on these lectures was just right

Software lectures - Level

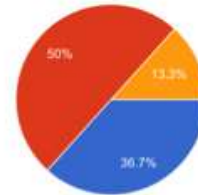
30 responses



- The lectures were at too high a level
- The lectures were at too low a level
- The level of these lectures was just right

Software lectures - The lectures were intelligible

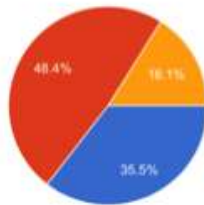
30 responses



- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not applicable

Software lectures - The lectures were well presented

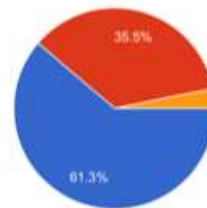
31 responses



- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not applicable

Software lectures - The lecturers responded well to questions

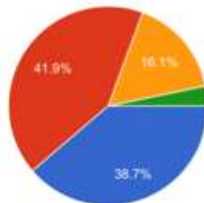
31 responses



- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree
- Not applicable

Software lectures - The lectures were stimulating

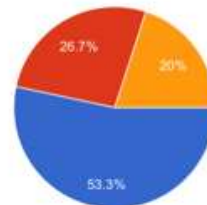
31 responses



- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not applicable

Software lectures - I found it easy get on with the lecturers

30 responses



- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly Disagree
- Not applicable

Software lectures - Comments

12 responses

There might be a different way to present the software lectures that are accessible for most people.

A quick hands-on session would be good to grasp the data reduction procedure instead of lectures.

An example tutorial would be necessary before going on a case by case basis.

I appreciated the NuSTAR video made by Xavier and shared to the students. I also recommend for SAS and XMM-Newton similar video should be done. It will help for self tutoring and to get familiar with the software easily.

Allocation of mentors could be done considering the level of knowledge of participants

It would have been useful to have the lecture slides available (and other relevant resources/tips) from the beginning of the workshop (or before) to allow us to run into issues sooner and resolve them sooner for smoother transition into doing the science and analysis sooner rather than ending up spending a lot of time on software issues.

I would have preferred the software lectures as a hands-on.

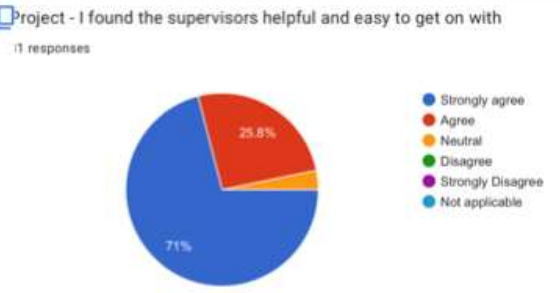
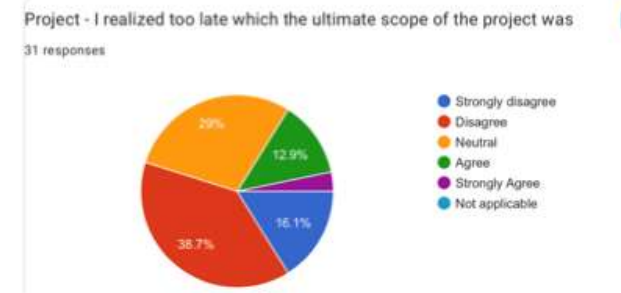
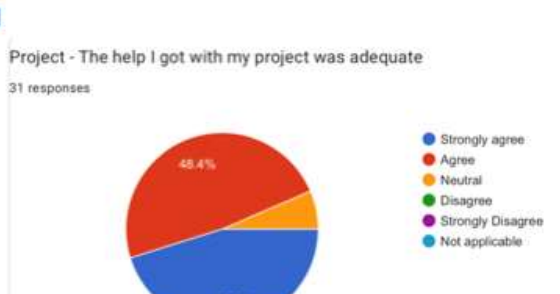
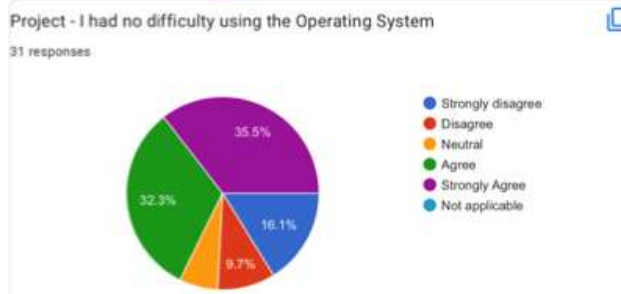
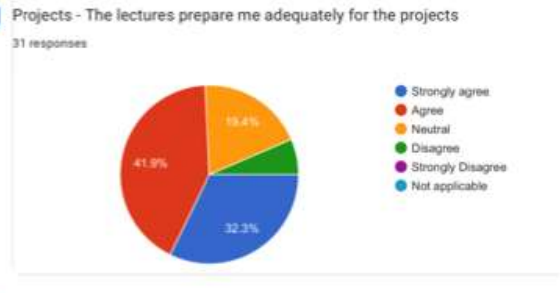
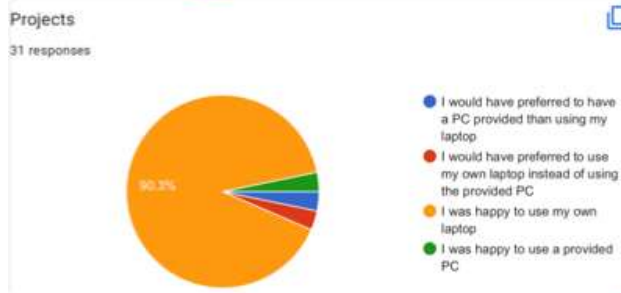
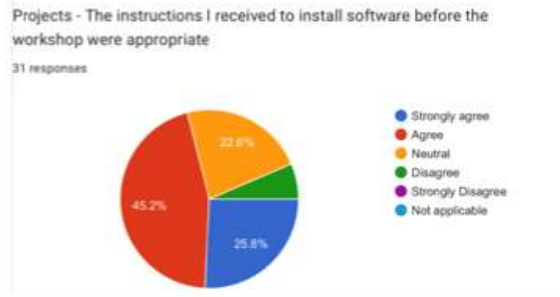
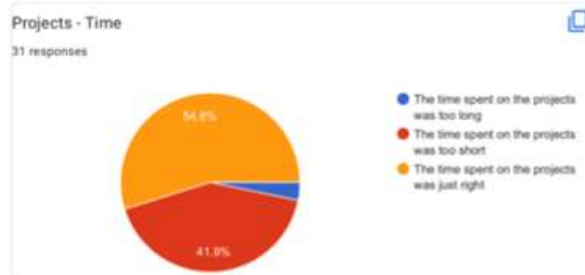
It would be easier to get the slides earlier or right after the lecture because not all participants would remember each command line and website link to bring us to the online documentation. But in general, the lectures were clear and well presented.

The lectures were cool but not enough

I would like to give a shout out to Aitor for being a great person and teacher. His passion when assisting us with analysis software issues was contagious.

It goes into details theoretically, we need to get into these details on the hands on session, so we the information connected in an easier way.

It was very useful and understandable.



Projects – Comments

16 responses

Project time should be increased because it is the most exciting part of the workshop for me.

The project was good except the shortage of time to accomplish all the task on the specified period.

Its a very good initiative though the scope could have been communicated to participants prior to their travel

The initial tutorial on how to install the software was not detailed, making it difficult to install the software, but the updated installation instructions were ideal. The time allocated for projects with mentors was perfect, however, I think it would have been useful to have time allocated to work on projects individually (~6 hours, split into 2 or 3 sessions) in the same venue as the peers (or in our rooms) to learn more from each other and build a collaborative energy. I have learnt a lot from my more experienced peers in pockets of time.

It's a learning curve for me as I peek into X-ray astronomy. I can agree I have achieved a beginner level for the Xray software stack. However, I will still research better on how to choose models for specific spectra and object types.

The first week was very challenging for me as I was not familiar with the software or any x-ray data reduction and analysis. Some participants already managed to extract products (spectrum, light curve, image) on the first 3 or 4 days but for me it took a time because I was not really sure about all the steps I should do so I was a bit stressed and I was feeling a bit bad to myself. Also, the online documentation for data analysis was too vast so we could get lost easily without any clear instructions (at this time the slides were not available), participants were not at the same level and I considered myself as a low level. I tried to deal with that for few days but thanks to my mentor to his understanding and try to help me a lot on explaining every single things. I get used to it after, I just needed some guidance to start with.

I do not have enough time for myself to recap what i have learned every day. We need more time...

I would like to thank Matteo for being a great mentor and teacher during my project. He was always happy to assist and gave indepth descriptions on the analysis, that helped me to understand X-ray data analysis. Thank you Matteo and may God bless you.

LOCs had already a lot of work pressure. It would have been better if they had been given less number of mentees, that can be easily helped.

The project mentors were absolutely helpful likewise other lecturers. I really liked how welcoming both the mentors and non-mentors were to all the students. They attended to everyone like their mentees and answered all questions accordingly.

I am slightly disappointed that I didn't have enough time to master all 3 missions (only XMM-Newton). However, enough information was shared for each mission that I will be able to work on their data on my own and know where to find support.

I was too specific, relating the project with my research and ended up doing nothing, then start with well know source to make sure I got a result.

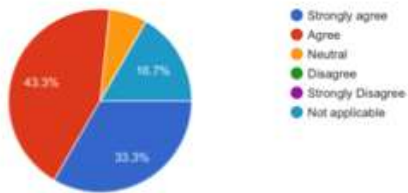
Perhaps project time could have been shifted in such a way that each day, project time would only come after lecture time, instead of being spliced in between.

Working on this project with Matteo has provided me new knowledge and skills and more comfortable working with software in addition to the confidence couragie and motivation to work on the new direction of this research, for first time I feel that I can do more and I can achieve what I want.

I would have prefer the lecturers to give a step by step lecture on data reduction and analysis for each instrument before we start with projects. A single example for each instrument will be enough.

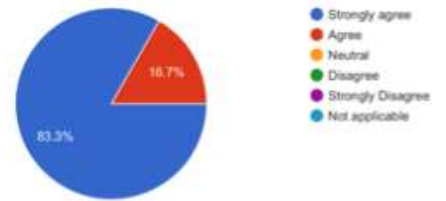
Accommodation and Venue - The flight to Johannesburg was efficiently done

30 responses



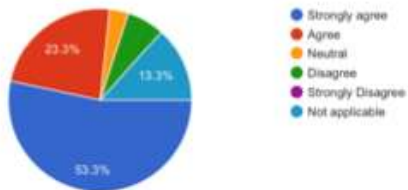
The room at the NWU Sports Centre was good

30 responses



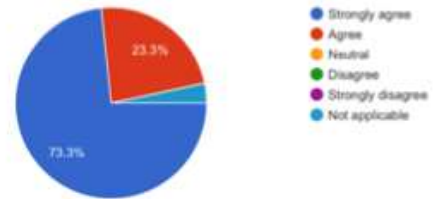
The local transport to Potchefstroom was efficiently arranged

30 responses



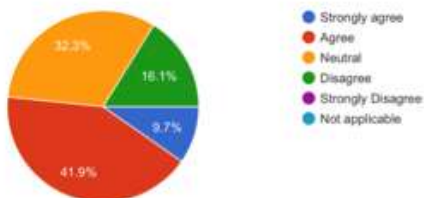
The breakfast at the NWU Sports Centre was good

30 responses



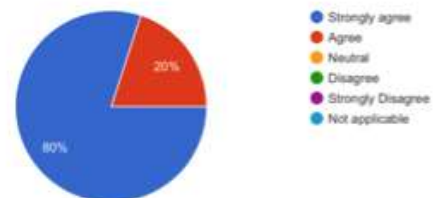
The lunch at the NWU was good

11 responses



Generally, the accommodation environment was good

30 responses



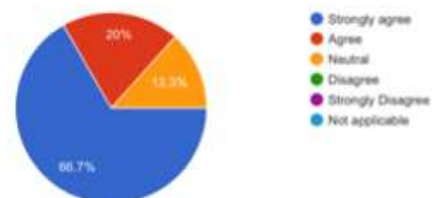
The supper at the NWU Sports Centre was good

10 responses



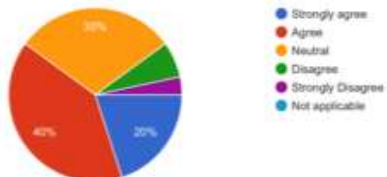
The NWU was a good place to hold this workshop

30 responses



The internet connection at the NWU was acceptable

30 responses



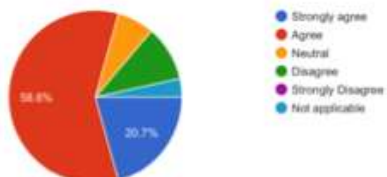
The excursion on Sunday was good

30 responses



The internet connection in the hotel was acceptable

29 responses



Comments on Accommodation and Venue

12 responses

Dinner at

Sharing it's not easy. It's hard to work at night or early in the morning while other person is sleeping

The only inconvenient was to not having shuttle to the university during all rainy days

Okay

Very good

The accommodation is awesome. I do prefer the second venue used from Monday February 13 to Wednesday February 15.

The accommodation and the venue are quite far away to each other but in general it is always nice to do a walk.

The accommodation and Venue is good except I do not have enough soap 😊 .

The accommodation and food at the sports village was good but the lunch served on campus was not so good.

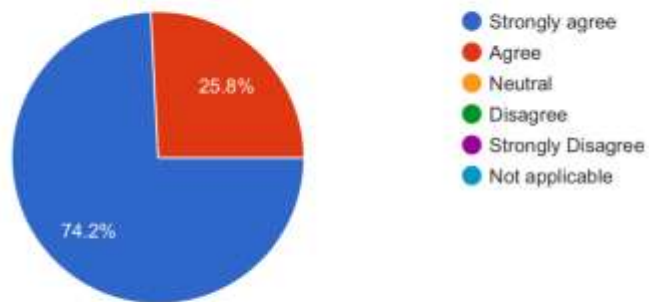
The internet at the accommodation was not sufficient to download big datasets necessary for the projects.

I wish place gives a south African vibes more than this Venue, however it was comfortable and clean

The accommodation was very good and the sport village are enjoyable and fancy place for me - the venue was also good expect the chairs was fixed, and it was acceptable in general.

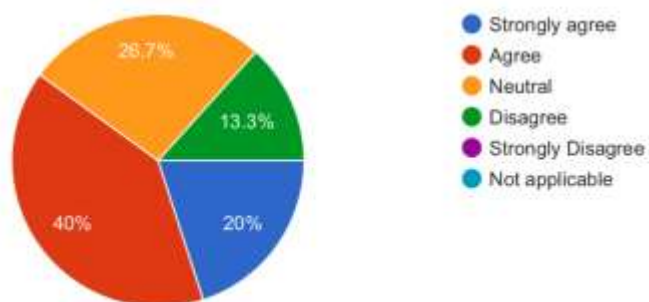
The Future - I will be able to use X-ray science data in my future research

31 responses



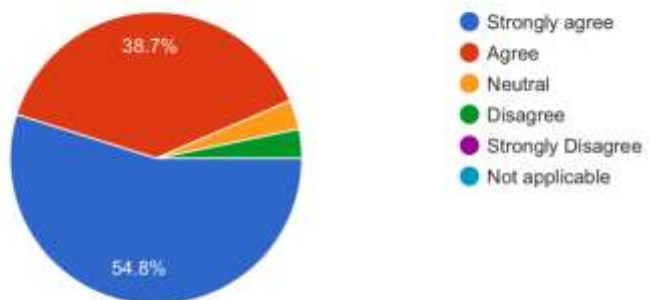
I have learned enough to do this without much extra help

30 responses



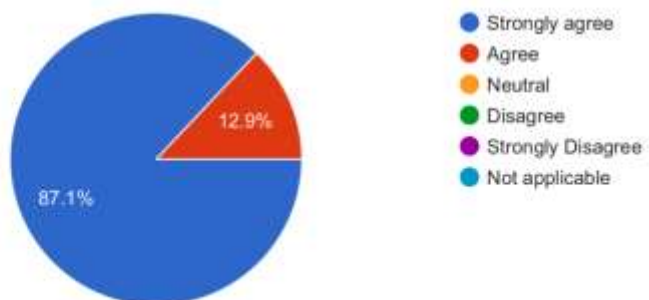
If I have problems, I know where to go for help

31 responses



I have benefitted significantly from attending the workshop

31 responses



General comments (on anything whatever to do with the workshop)

20 responses

This is probably the best workshop I have attended, due to the hands-on nature and having a lot of time to engage with the instructors

I would be happy to have the lecturers respond to our emails if we have problem about a project in the future. Most times, after a workshop, you send an email to lecturers and they are too busy and don't respond to you.

I don't recommend sharing room

I am thankful for being selected and for the financially supported , I learned a lot, and I met very interesting people. I especially appreciate the loc efforts to make things going smoothly.

According to my personal view, hands-on session on a common data set would have been better instead of having so many lectures on how to reduce data from different missions. In that way everyone could have learnt the basics of data reduction from all the missions, XMM-Newton, NuSTAR and NICER. So, while starting the project on any datasets they don't need to spend more time on data reduction and do more advance work. Moreover, keeping lectures in between the 'computer classes' break the continuity of the project work.

It was a privilege to be considered for the workshop.

The workshop is very good and I would thank and appreciate the lectures and organizers for their assistance whenever we need help.

Thanks to all the funding agencies that made this great workshop possible

I would have liked another day in the program where there was free time at the end of the day such as 14 February. A suggestion to alleviate the time constraints would be to have parallel sessions of recorded lectures that could be made available afterwards, in case participants were interested in both. I do understand accommodating for differences in time zones, but I found it was disruptive when there was lectures slotted in between project time. I did feel under-prepared for the workshop, limiting my ability to maximally take advantage of the expertise of the mentors. It might have been helpful to have done a tutorial analysis at home, before starting the workshop. Overall, it was an excellent and challenging experience that I will never forget.

Thanks to the organisers for pulling this off. I have learnt a lot and hope to continue with the knowledge I have gained. However, I'll suggest that the organisers should consider having a hands-on section for different groups say stellar and extragalactic group to enable participants work with a common data and thereafter, each participant can spin off to their own data.

It would be useful if all participants are considered as the same levels. Maybe before working on the project everyone should do a small exercise together, i.e. there is one lecturer who lead and everyone just do the same thing, like a computer lab. It is just a suggestion but everything is already fine. It is the best workshop I've never attended so far. Thanks.

Place local students in the same accommodation venue as the outsatition students. The program/schedule was long and not conducive; can the program include all the working

cultures of all participants (like reducing long attendance hours and reserving weekends for relaxing and fun activities).

I wish I have learned all data from all instruments(Xmm-Newton, NICER, NuSTAR) like the others but unfortunately I couldn't. Next time, it would be great for all participants to learn it together from one slide by one of the mentor, step by step (from the beginning until the end of one data from all instruments) and then have a different topic as a homework for participants. And please arrange that the participants have time for personal research at home. I was running out of time for myself to recap and to apply what I have learned. Thank you for every effort you make to help the young African and Indian citizens enrolled in Astrophysics and Astronomy using x-ray space telescope. I will make your efforts useful for the next generation of astrononers and astronomy. God bless us!

The workshop was great, I thank the organizers for taking the time to plan and coordinate this for us students and researchers. I would also like to extend my gratitude to the funders for their generosity in supporting this workshop. I have a few comments for improvement which I hope the organizers will find useful: 1. I think it would have been good to have all the participants lodged at the sports village. I think the local students would have also benefited from the extra time to network with the mentors during dinner and breakfast. Those moments are just as important as the classes/projects time. 2. The program was fully packed. We did not have time to tend to personal matters, even on weekends. Ending the program at 16.30 would have made a positive difference. I believe that some free time would have allowed for more social and cultural exchange between participants and the local community. The relationships formed at such events are just as important as the science learned. 3. Sunil did a stellar job coordinating the workshop, but I was often surprised by how he spoke to or addressed the students, the volunteering postdocs and the AV technicians. I thought that the way he spoke to non-senior people was often rude and inconsiderate. Judging from my personal experience with him and what I heard from fellow students. I understand that he may have been stressed by planning and running the workshop, but I think that is no excuse to be harsh to other people. I hope that he will improve on that going forward.

I'm working on multi-wavelength study of few blazars and intend to use XMM-Newton for some of my analysis. I also found out that some of my sources have not been observed by XMM-Newton, I'm working towards writing a proposal for them to be observed due to its large effective area.

This was the best workshop that I've ever attended. It was a privilege to learn from experts from various fields (missions and science) and I appreciated that all facets regarding X-ray astrophysics, missions, instruments, data, software, and analysis were covered. The mentors were very helpful, gave constructive and insightful advise and were invested in the students' success. The organizers, teachers and mentors created a positive, fun and inclusive environment where everyone was respected and free to be themselves. This workshop opened new doors for me and I'm excited about new opportunities and research in X-ray astronomy.

Please upload the lecture videos ASAP.

I would have liked there to be an interactive step by step session of analysis with a source (s) / mission chosen and all the students taken through the analysis steps, learning why certain steps are taken, the way to choose and tweak models and then the interpretation of data.

(This was done in the lectures but before any interaction with the software and data therefore it was difficult to piece it all together). I believe this would've made understanding the content of the lectures, how to go about the project and the overall understanding much better.

The environment was very supportive and the colleges (Spencer) and the LOC (Pranjupryia - Anton) and postdocs (Roukaya, Sree), they were very nice and helpful and friendly with me. Carlos is very nice Matteo Somehow the interaction between some students was not very strong maybe due to the differences of culture or maybe the colors or shyness.

I'm grateful that the organizers gave me the opportunity.