Report on the COSPAR Capacity Building Workshop "Coronal and Interplanetary Shocks: Data Analysis from SOHO, STEREO, SDO, Wind, and Ground-based Radio Data" in Samarkand, Uzbekistan - August 2024

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Nat Gopalswamy (GSFC, USA)

Carlos Gabriel (COSPAR, Germany)

I – Introduction

The COSPAR Capacity Building Workshop (CBW) “Coronal and Interplanetary Shocks: Data Analysis from SOHO, STEREO, SDO, Wind, and Ground-based Radio Data” (https://www.e-callisto.org/cospar2024/COSPAR2024workshopUzbekistan.html) was hosted by the Samarkand State University (SamSU) in Samarkand, Uzbekistan during August 19 - 30, 2024. The main objective of the COSPAR Capacity-Building Workshops is to encourage the scientific use of space data by scientists in developing countries. Accordingly, data on coronal mass ejections, type II radio bursts, and solar energetic particles available at the CDAW Data Center, NASA Goddard Space Flight Center were considered for training and analysis.

The CBW introduced data analyses of space-based white-light coronagraph observations and radio spectral observations from space and ground to study shocks driven by coronal mass ejections (CMEs). The CME images are from the ESA/NASA Solar and Heliospheric Observatory (SOHO) and NASA's Solar Terrestrial Relations Observatory (STEREO). Near-Sun manifestations of CMEs were obtained from NASA's Solar Dynamics Observatory (SDO). In the heliosphere, in-situ observations from NASA's Wind and Advanced Composition Explorer (ACE) missions were used to track CME flux ropes into the interplanetary medium. In addition, ground based radio data from the e-CALLISTO and RSTN networks were used for the studying near-Sun manifestation of CME-driven shocks inferred from type II radio bursts. In the

interplanetary medium, shocks are inferred from type II radio bursts at frequencies below ~16 MHz observed by Wind/WAVES and STEREO/WAVES instruments. Context information such as soft X-ray flares and solar energetic particle (SEP) events were obtained from NOAA's GOES missions.

In addition to the space and ground-based data, software tools were provided to the participants for analyzing the data. During the first week of the workshop, python software training was provided to the participants in addition to lectures covering topics from the Sun to Earth. The second week was dedicated to analyzing selected data sets. The workshop also included the installation of a radio telescope at SamSU to add radio data to the e-Callisto network .

This workshop enabled scientists and students in central Asian countries to analyze space- and ground-based data to investigate Earth-affecting solar transient phenomena.

II – Participants

A total of 38 participants (also known as students) were selected out of a total of 74 candidates. The distribution of the selected students according to region, background and nationality can be seen in Fig.1.

Most of the BSc and MSc students were local to Samarkand, their selection was consciously made as an effort to promote local space science activities, increasing the number of participants originally envisaged at low financial costs to the organisation.

As usual, all non-local students received full lodging during the two weeks and travel subvention (around 90% of the actual travel costs). Meals and coffee breaks as well as the costs of the excursion were covered for all the participants.

The geographical distribution of the students revealed a broad regional distribution. An even gender distribution was not forced, but arose naturally from the selection process, which did not take gender into account as a criterion. The full list of students including affiliation and nationality is given in

Appendix I. The geographical distribution of the students reveals a wide regional distribution. An even gender distribution was not enforced in the selection process, which did not take gender into account as a criterion, resulting in less than ⅓ of female participants, which is remarkably low compared to other workshops. A critical review of this point is needed for future events in this region. The full list of students, with their affiliation and nationality, can be found in the appendix.

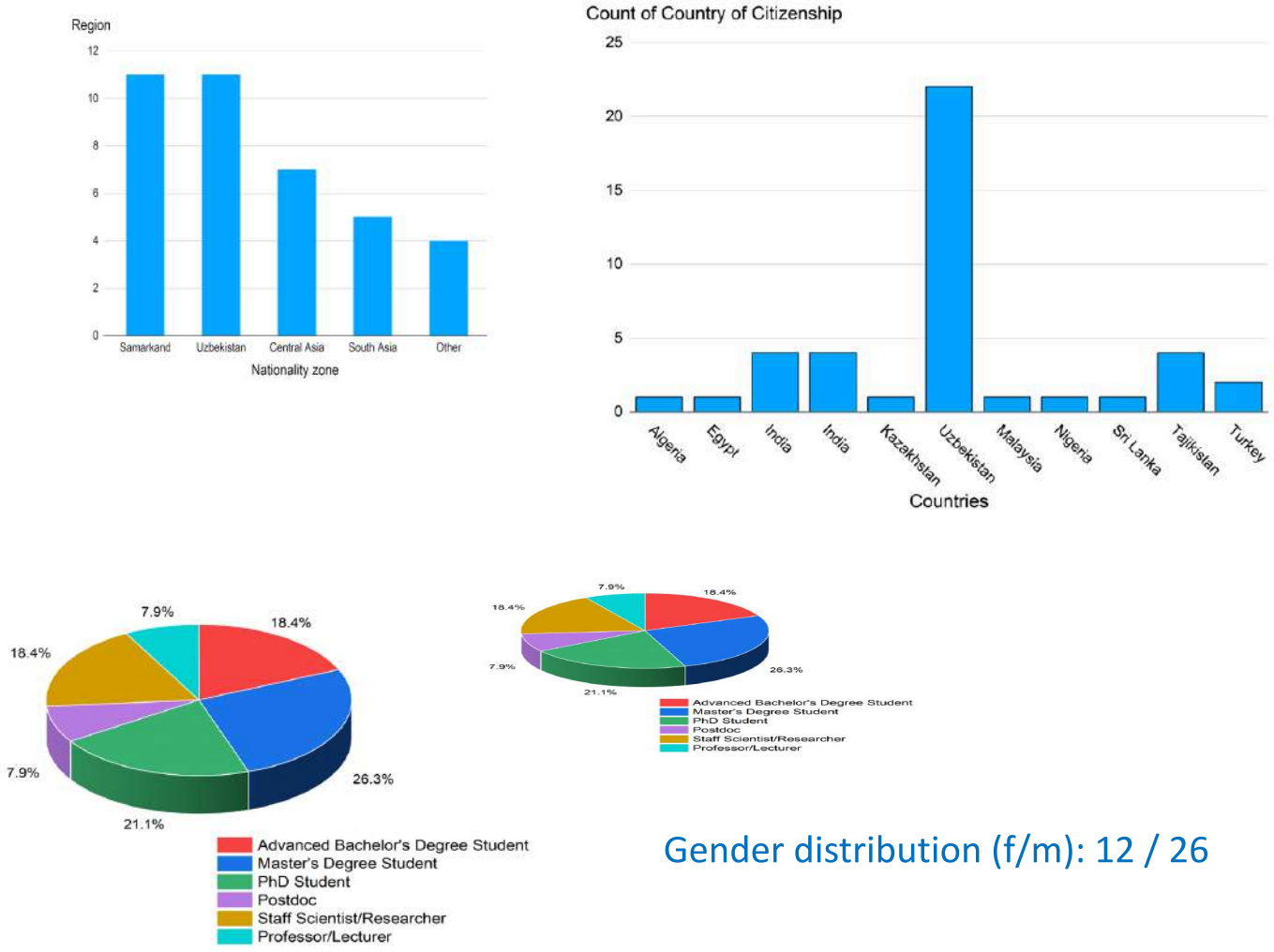


Fig. 1: Regional, national, background and gender distribution of participants

III – Lectures

Carlos Gabriel (Germany) introduced the COSPAR capacity building program and provided details on the COSPAR fellowship program to the participants of the workshop.

Nat Gopalswamy (USA) gave 3 lectures entitled “Overview of coronal and interplanetary shocks”, “Coronal mass ejections and radio bursts”, and “Solar eruptions and space weather”. He also held a hands-on session on “Using CME catalogs in the CDAW Data Center”.

Nandita Srivastava (India) gave 3 lectures on “Coronal Mass Ejections”, “CMEs and Space Weather”, and ”Ground Based Solar Observations.”

C. Kathiravan (India) gave two lectures: “Electromagnetic Wave emission from the Sun” and “Radio emission (GHz-kHz) from the Sun”.. In the hands-on session, he demonstrated how to plot the Gauribidanur radioheliograms, combining the X-ray, HMI, LASCO and radio images.

Pertti Makela (USA) gave two lectures entitled “Solar Energetic Particles” and “Particle Instruments” and held a hands-on session on “Velocity Dispersion Analysis”.

Wageesh Mishra (India) delivered two talks, one on the “Basics of the Sun and different processes in solar atmospheres”, and the other on “Mass loss from the Sun via CMEs and solar wind”. He also conducted a hands-on session on the “forward modeling of CMEs” using coronagraphic observations from multiple viewpoints.

Seiji Yashiro (USA) gave two lectures entitled “Online Resources for Space Weather Research” and “Flare – Coronal Mass Ejection Connection” and held a hands-on session on “CME Height-Time Measurements”.

Zavkiddin Mirtoshev (SamSU) gave a lecture on the solar cycle variation of the solar wind and coronal mass ejections.

Christian Monstein (Switzerland) covered the following topics on Python software:

- Plotting mathematical functions, histograms, and several common types of charts

- Reading data-files of different format such as: FITS, CDF, NetCDF (nc), HDF5, XLS, TXT and CSV

- Downloading and plotting light-curves from GOES-satellites

- Downloading and plotting dynamic spectra from STEREO satellites

- Combining dynamic spectra from CALLISTO together with STEREO in frequency space

- Overplotting of dynamic spectra from CALLISTO or RSTN with GOES-light-curves

- Curve fitting of manually generated data

- Generating plots in different formats such as: PNG, JPG, PDF, EPS etc.

Javier Bussons (Spain) gave a lecture entitled "eCallisto New Generation (eCallistoNG)" with emphasis on the current status of, and immediate opportunities within, this international net-work of ground-based instruments.

IV – Program

From the program (Fig.2) it can be seen that this workshop was structured approximately 25% of the time dedicated to tutorial lectures, 25% to hands-on activities (python software training) and 50% to analyzing selected data sets. During the first week of the workshop, python software training was provided to the participants in addition to lectures covering topics from the Sun to Earth. During the second week of the workshop, the lecturers served as mentors to groups of 6 participants each. Each group analyzed observations of two solar eruptions associated with type II radio bursts and presented their results at the conclusion of the workshop.

Schedule:
Week 1

Time	Monday Aug 19	Tuesday Aug 20	Wednesday Aug 21	Thursday Aug 22	Friday Aug. 23	Saturday Aug 24	Sunday Aug 25
0830-1030	Inauguration Gopalswamy 0 Mishra 1	Kathiravan 1,2	Srivastava 1,2	Gopalswamy 1,2	Monstein 9	Yashiro 2	Field trip
1030-1100	Break	Break	Break	Break	Break	Break	Field trip
1100-1230	Monstein 1,2	Mishra 2	Makela 1	Makela 2	Yashiro 1	Discussion	Field trip
1230-1300	Lunch	Lunch	Lunch	Lunch	Lunch	Lunch	Field trip
1300-1530	Mishra_ho	Monstein 3,4	Srivastava_ho	Monstein 7,8	Yashiro_ho	Data intro	Field trip
1530-1600	Break	Break	Break	Break	Break	Break	Field trip
1600-1800	Gopalswamy_ho	Kathiravan_ho	Monstein 5,6	Gopalswamy_ho	Makela_ho	Callisto installation/demo	Field trip

Week 2

Time	Monday Aug 26	Tuesday Aug 27	Wednesday Aug 28	Thursday Aug 29	Friday Aug. 30	Saturday Aug 31	Sunday Sep 01
0830-1030	Group assignment	Reports	Reports	Reports	Final Reports	Departures	
1030-1100	Break	Break	Break	Break	Break	Departures	
1100-1230	Event analysis	Event analysis	Event analysis	Event analysis	Closing	Departures	
1230-1300	Lunch	Lunch	Lunch	Lunch	Lunch	Departures	
1300-1500	Event analysis	Event analysis	Event analysis	Event analysis	Departures	Departures	
1500-1530	Break	Break	Break	Break	Departures	Departures	
1530-1700	Event analysis	Event analysis	Event analysis	Event analysis	Departures	Departures	

Fig.2: The program

VII – The projects

The projects were in principle, as in many former occasions in solar physics workshops, defined by the participants prior to the workshop. During the second week of the workshop, the lecturers served as mentors to groups of 6 participants each. Each group analyzed observations of two solar eruptions associated with type II radio bursts and presented their results at the conclusion of the workshop.

VIII – Results

Team Kathiravan (Pavlataliev, Pulatov , Rashidov , Khaled, Sharipov, and Yovgochev) analyzed the 2024 September 7 event that had a CME and a type II radio burst with split band. They used the split-band technique for the type II burst and estimated the magnetic field variation as a function of radial height. It gave us B = 12.5 r-5.5 (Gauss). The Alfven speed varies as VA = 811.2 r-1.9 (km/s).

Team Makela (Agarwal, Prakash, Ikhlef, Khudayberdiev, Juraev, Muminova) analyzed two events: 2015 November 5 and 2023 April 21 eruptions. During the first event, a well-defined split band type II burst was observed. From the split-nad technique, they found the magnetic field strength declining from 1.3 G to 0.8 G in the heliocentric distance range 1.5 to 1.7 solar radii. During the second event, the shock speed derived from the drift rate of the metric type II burst was smaller than that of the CME in the coronagraph FOV, probably due to the slow acceleration of the CME.

Team Gopalswamy (Mirtoshev, Bakhriddinov, Shokirov, Ergashev, Sayfiyev, Safarov, Liyanage) analyzed the 2012 December 5 event with a fast-drifting and a regular drifting type II bursts. The fast drifting burst was found to be due to the passage of the shock across a coronal type II burst. The regular type II had split-band feature indicating a coronal magnetic field of 0.75 G at a distance of 1.4 solar radii. They also analyzed the 2023 May 4 eruption that had an extensive set of radio bursts including a third harmonic component in the type II burst The team discovered another CME from the same region that was not listed in the catalog.

Team Yashiro (Bokhari, Özcan, Erol, Rahmatulloeva, Nazarova, Mirkamalov) analyzed the 2023 July 15 and August 10 eruptions. In the July event, they found that the shock speed derived from the metric type II burst decreased with time, indicating that the CME acceleration ended before the type II burst. On the other hand, the shock speed derived from the metric type II burst increased from ~450 km/s to ~680 km/s in the August event. The final speed was found to be consistent with the CME shock speed (757 km/s).They

concluded that the CME acceleration/deceleration timing is consistent with the standard (CSHKP) flare-CME model.

Team Srivastava (Seifullina, Boltatoshova, Fayzullaeva, P. Srivastava, Arjun, Farhod) analyzed the 2023 April 24 and 2024 July 4 eruptions. The April 2023 type II burst had three harmonics and was associated with a partial halo CME. The team determined the average speed and initial propagation direction, which indicate that the CME was not a major space weather event. The July 2024 event was also associated with a partial halo. not directed towards the Earth. The harmonic band of the type II burst was more prominent, and hence was used for the drift-rate analysis.

Team Mishra (Yunusov, Karshiboev, Joseph, Rustam, Aktam, Parmanova) analyzed the 2023 June 12 and May 9 events. In the June event, the team found that the shock formation height from the empirical model and direct observations from STEREO/EUVI are roughly the same, around 1.26 solar radii. They also found the ambient averaged magnetic field from different models (Newkirk, Saito, Leblanc) agree with one another and show a decreasing trend with height. In the May event, they found a slightly larger difference in shock formation heights between the empirical formula and observations; estimated magnetic fields were similar using various models. The team noted CME-CME interaction in the coronagraph field of view and suggested further investigation.

IX – Venue

The workshop took place in a conference room of the Institute of Engineering Physics, Samarkand State University. The excellent condition of the conference room in all aspects of audio-visual, transmission and recording of presentations fully satisfied the requirements. The conference room in the university was big enough to hold the workshop comfortably, and provided enough space for the lecturers to work separately from the students during the classes. There was enough space also for the practical part of the workshop using computers.

X – Breakfast, Lunch, Dinner and Coffee Breaks

Breakfast, lunch and dinner were offered at the university cafeteria next to the student accommodation. Coffee breaks were held twice a day, in the morning and afternoon, in the cafeteria adjacent to the conference room of the Institute of Engineering Physics, which included sweets, local delicacies, dried and fresh fruits.

XI – Lodging

Students and teachers stayed in the SamSU international student hostel and the university hotel. Students were accommodated in shared double rooms and teachers were accommodated in single rooms. The conditions in the university hotel and the international student hostel were very good. The university park and many entertainment venues were nearby for students to enjoy their free time.

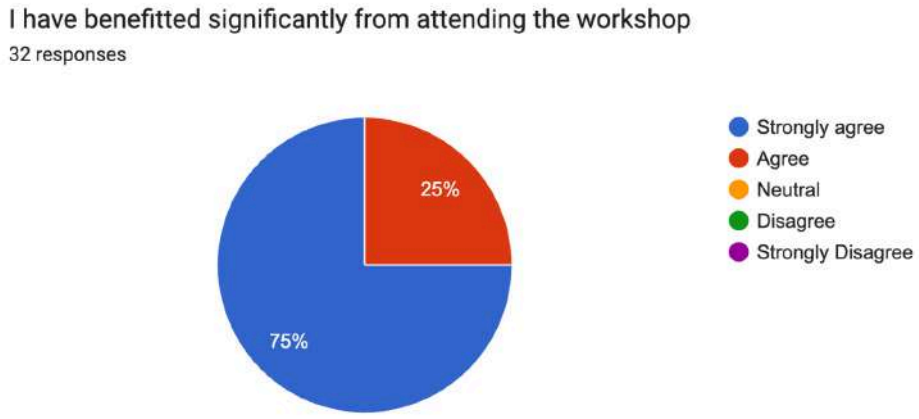
XII – The excursion

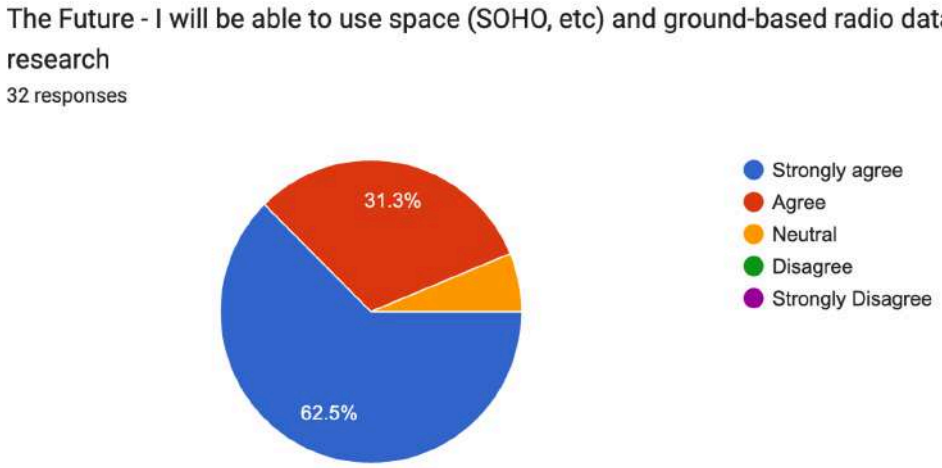
On the Saturday in between we had an excursion for all participants, including the lecturers, to a Kitab International Latitude Station in Kashkadarya region (https://en.wikipedia.org/wiki/International_Latitude_Service), located about 100 km from Samarkand city. Kitab city is located on the international parallel (39 degrees 08 minutes) and therefore the International Latitude Station was built. There we got acquainted with the old Bamberg Zenith telescope brought from Germany and the clocks used to measure time. Also, we got acquainted with DORIS which tracks satellites at the observatory and “KIT3” GNSS station, which is part of the IGS network. During that day we also visited Ak-Saray Palace in Shahrisabz (https://en.wikipedia.org/wiki/Ak-Saray_Palace), birth place of king Amir Timur.

We also visited the ancient historical places in Samarkand city on Saturday, such as Ulugh Beg Observatory, Registan square, Amir Temur Mausoleum, Bibi Khanym Mausoleum, Shakhi Zinda Necropolis.

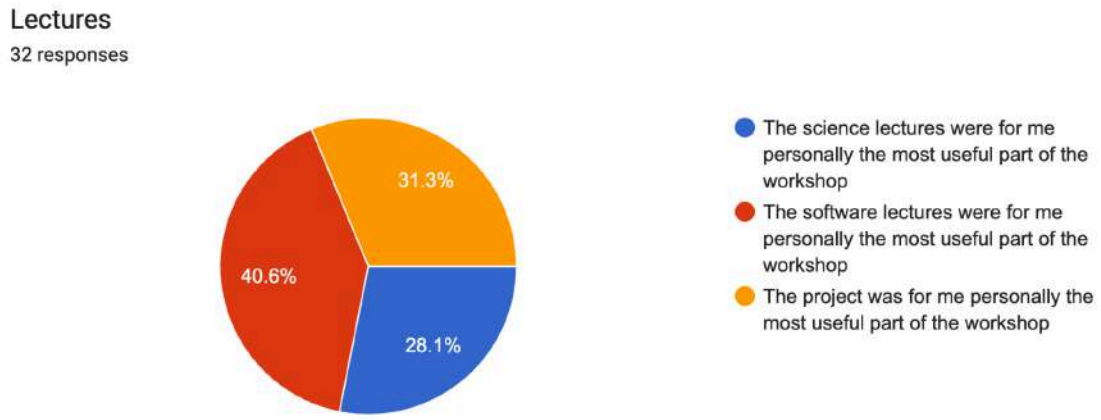
XIII - General evaluation

The usual event evaluation questionnaire that we asked participants to critically complete was answered by 32 of them (84%). As always, the answers have to be analysed in detail, which is beyond the scope of this report, for an overall understanding. But a quick evaluation shows a high level of satisfaction, including a 100% positive response to the question on personal benefit, as well as more than 90% positive to the question on the ability to work on future research with data of the kind handled at the workshop.

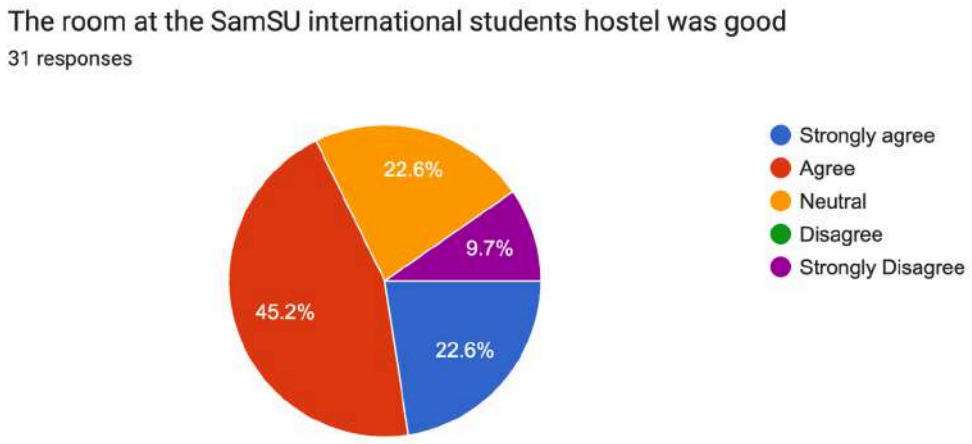




Theoretical lectures, software lectures and project hours are evaluated very similarly in terms of their importance, all very positively.

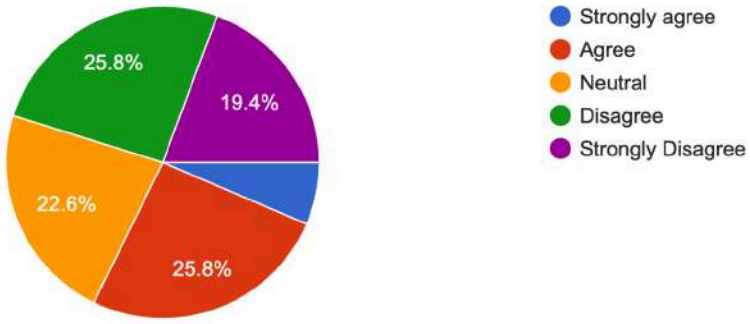


There is a lower level of satisfaction regarding the hotel where we stayed and especially the level of internet in part of the hotel. On the other hand, there is a very positive majority opinion about Samarkand University as a venue for this event.



The internet connection in the hotel out of working hours was acceptable

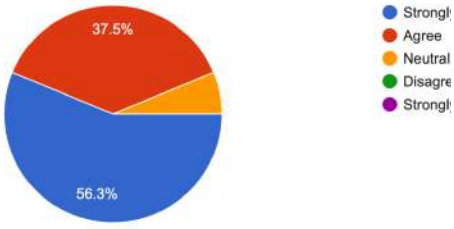
31 responses



On the other hand, there is a high degree of satisfaction with the lecturers, very similar in all three categories, science, software and project.

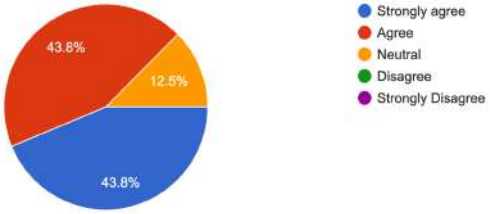
Science lectures - The lectures were well presented

32 responses



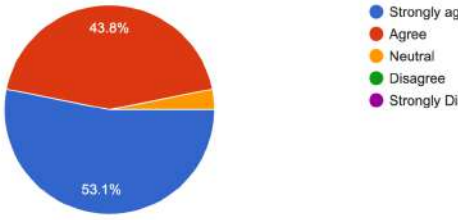
Science lectures - The lectures were stimulating

32 responses



Science lectures - The lecturers responded well to questions

32 responses



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

32 responses

Appendix I – List of participants

No	First name	Last name	Affiliation	Country	Gender
1.	Rabah	IKHLEF	CRAAG	Algeria	Male
2.	Safinaz	Khaled	NRIAG	Egypt	Female
3.	Joseph-Judah	Abraham-Alowonle	Egypt-Japan University of Science and Technology	Egypt (Nigeria)	Male
4.	Anjali	Agarwal	IIA	India	Female
5.	Priyank	Srivastava	University of Lucknow	India	Male
6.	Vijayalakshmi	Prakash	Arul Anandar College	India	Female
7.	K R	Arjun	IISER Mohali	India	Male
8.	Botakoz	Seifullina	Institute of Ionosphere	Kazakhstan	Female
9.	Nurul Husna	Mohammad Bokhari	MARA Technology University	Malaysia	Female
10.	Sahan	Liyanage	University of Colombo	Sri Lanka	Male
11.	Zamira	Nazarova	Institute of Astrophysics	Tajikistan	Female
12.	Farkhodjon	Shokiriyen	Institute of Astrophysics	Tajikistan	Male
13.	Firuza	Rahmatulloeva	Institute of Astrophysics	Tajikistan	Female
14.	Abduljalol	Safarov	Tajik National University	Tajikistan	Male
15.	Zeynep	Erol	Istanbul University	Turkey	Female
16.	Muhammet	Özcan	Istanbul University	Turkey	Male
17.	Abdurakhmon	Nosirov	Ulugh Beg Astronomical Institute (UBAI)	Uzbekistan	Male
18.	Odil	Yunusov	National University of Uzbekistan (NUU)	Uzbekistan	Male
19.	Khurshid	Karshiboev	NUU	Uzbekistan	Male
20.	Munisa	Boltatoshova	NUU	Uzbekistan	Female
21.	Pakhlavon	Yovkochev	NUU	Uzbekistan	Male
22.	Mamatjon	Xudayberdiyev	NUU	Uzbekistan	Male

23.	Yodgorbek	Rajabov	UBAI	Uzbekistan	Male
24.	Bolkinjon	Juraev	UBAI	Uzbekistan	Male
25.	Aktam	Hafizov	UBAI	Uzbekistan	Male
26.	Akbar	Davlataliev	UBAI	Uzbekistan	Male
27.	Mekhrinisa	Parmanova	UBAI	Uzbekistan	Female
28.	Rustam	Tojiyev	UBAI	Uzbekistan	Male
29.	Mirabbos	Mirkamalov	USTC / Samarkand State University (SamSU)	China/ Uzbekistan	Male
30.	Khusniddin	Rashidov	SamSU	Uzbekistan	Male
31.	Mukarram	Fayzullaeva	SamSU	Uzbekistan	Female
32.	Diyorbek	Pulatov	SamSU	Uzbekistan	Male
33.	Sherzod	Sayfiyev	SamSU	Uzbekistan	Male
34.	Rustam	Sharipov	SamSU	Uzbekistan	Male
35.	Bobosher	Bakhriddinov	SamSU	Uzbekistan	Male
36.	Salokhiddin	Ergashev	SamSU	Uzbekistan	Male
37.	Farkhodjon	Khamrakulov	SamSU	Uzbekistan	Male
38.	Malokhat	Muminova	SamSU	Uzbekistan	Female

Appendix II – Lecturers / Supervisors

Dr. Nat Gopalswamy	GFSC, NASA, USA	Scientific leader/ Supervisor
Dr. Zavkiddin Mirtoshev	Samarkand State University, Uzbekistan	Lecturer / Local organiser
Dr. Nandita Srivastava	Udaipur Solar Observatory, Physical Research Laboratory, India	Lecturer/supervisor
Dr. Seiji Yashiro	Catholic University of America, USA	Lecturer/supervisor
Dr. Carlos Gabriel	COSPAR, Germany	Lecturer/COSPAR organiser
Dr. Pertti Makela	Catholic University of America, USA	Lecturer/supervisor
Dr. Chidambaram Kathiravan	Indian Institute of Astrophysics, India	Lecturer/supervisor
Dr. Wageesh Mishra	Indian Institute of Astrophysics, India	Lecturer/supervisor
Dr. Christian Monstein	ETH Zürich, Switzerland	Lecturer/supervisor
Dr. Javier Bussons Gordo	University of Alcalá, Spain	Lecturer/supervisor

Appendix V – Photos

1 – Workshop group photo

2 - Welcome speeches. Inauguration

Samarqand davlat universiteti
Axborot xizmati
Rustam_Ibragimovich_Xolmurodov
SamDUeduuzz
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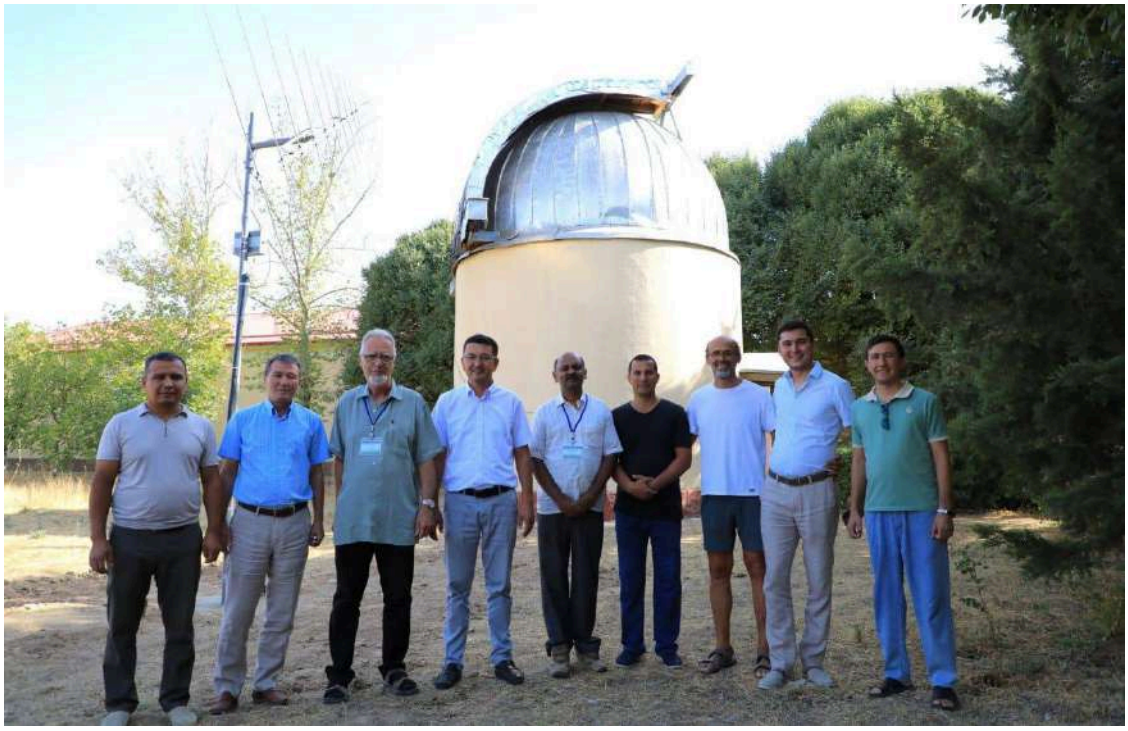
3 – Lectures going on

4 – Group photo in front of SamSU



5 – Visiting the Nuclear Physics and Astronomy Laboratoty of SamSU. Introducing e-CALLISTO

6 – Hands-on and Python lectures

7 – Dinner time – with Nat, Seiji, Pertti and Carlos

8 – Lunch time – In the first table, Seiji, Pertti; the next tables are participants

9 - Party time for students and lecturers

10 – Students working on their projects

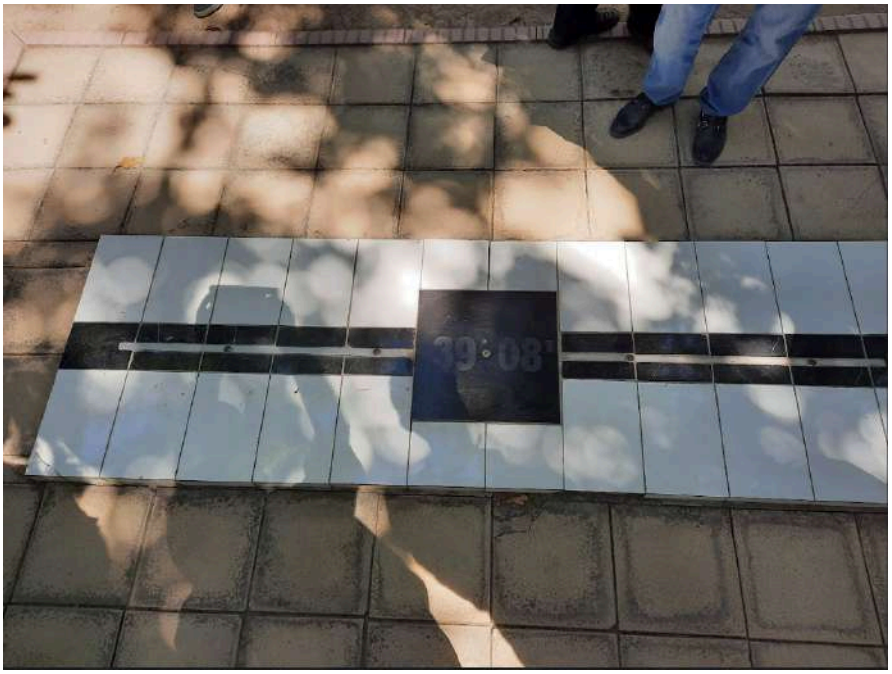
11 – Student group final day presentations

12 - Awarding of lecturers by the organizer

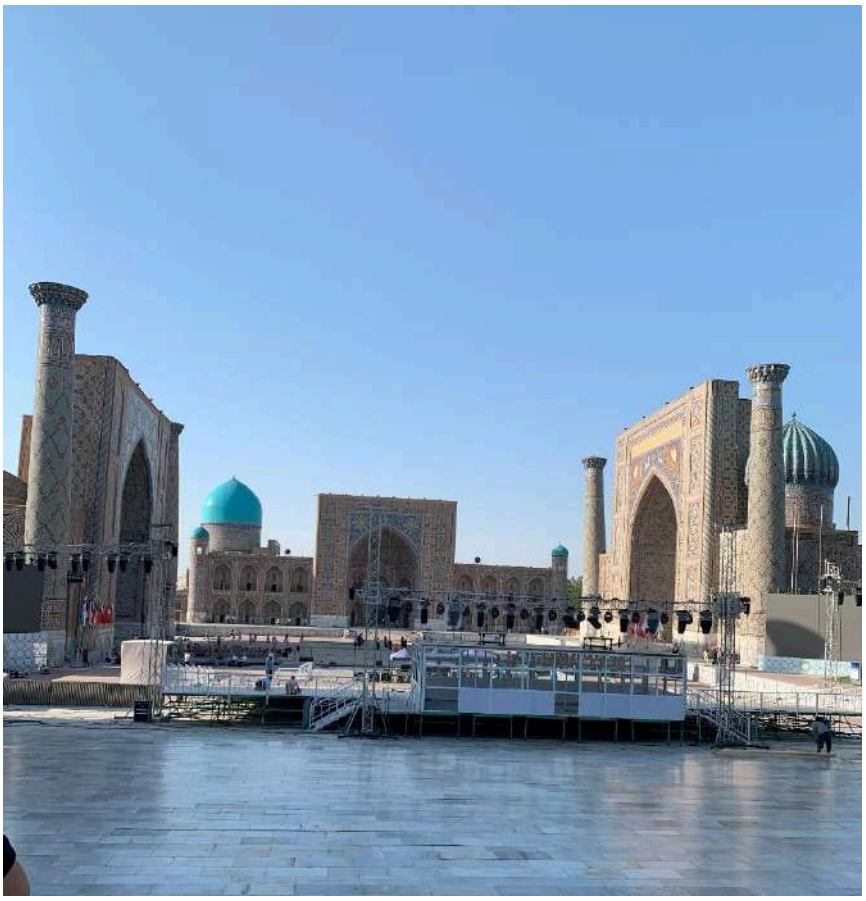
13 - Awarding participants with certificates

14 – Visit to Gur-e-Amir mausoleum

15 – Visit to Ak-Saray Palace in Shahrisabz, birth place of king Amir Timur.



16 – Visiting Kitab International Latitude Station



17 – Visiting Registan Square

18 – Visiting Ulugh Beg Observatory and Shakhi Zinda Necropolis