XXXI IAU General Assembly Focus Meeting 10: Synergy of Small Telescopes and Large Surveys for Solar System and Exoplanetary Bodies Research

Post Meeting Report

by Anatoliy Ivantsov, chair of the Scientific Organising Committee

Introduction
The **Scientific Organising Committee** was comprised of the IAU members. Information about gender was retrieved from the IAU individual webpages.

No.	Name	SOC function	IAU membership	Country	Gender
1	Anatoliy Ivantsov	chair	yes	Belgium	male
2	William Thuillot	co-chair	yes	France	male
3	Marcelo Assafin	member	yes	Brazil	male
4	Zouhair Benkhaldoun	member	yes	Morocco	male
5	David Hobbs	member	yes	Sweden	male
7	Myung-Jim Kim	member	yes	Republic of Korea	male
8	Anna Marciniak	member	yes	Poland	female
9	Joseph Ryan Masiero	member	yes	USA	male
10	Bruno Merín Martin	member	yes	Spain	male
11	Megan Elizabeth Schwamb	member	yes	UK	female
12	Wang Na	member	yes	People's Republic of China	female

The gender balance female/male/non-specified is 3/9/0 (12 in total).
The female ratio to the total number is 25% which is greater than 22% over the entire IAU membership retrieved in January 2023, https://www.iau.org/administration/membership/individual/distribution/ .

The meeting **website** is kept updated at https://iaufm10.org.

The **coordinating division** is Division A Fundamental Astronomy.

The **number of participants is 48**, and the number of presented talks is 49.

The **number of representing countries is 27**. The list contains Australia, Belgium, Canada, Czech Republic, Finland, France, Germany, Hungary, Italy, Lithuania, Morocco, the Netherlands, the

People's Republic of China, the Republic of China, Republic of Korea, the Russian Federation, Spain, Sweden, Tadjikistan, Thailand, Turkey, Ukraine, United Arab Emirates, the United Kingdom, Uruguay, the USA, Uzbekistan.

There were **3 articles accepted for publication in the IAU Proceedings Series** (the first authors are Jean-Eudes Arlot, Alberto Cellino, Marco Micheli).

I. The final **Scientific Programme** with gender information is listed below.

August 4, 2022, KST					
Session Chairman: Anatoliy Ivantsov, room CH 106-107					
Slot	Category	Name, country	Talk Title	Timeline	Gender
FM 10-1	Invited	Hamed Valizadegan, the USA	ExoMiner: A Highly Effective Deep Learning Classifier to Mine Exoplanets	10:30+30 min	male
FM 10-1	Invited	Andrew Vanderburg (remote), the USA	Enhancing and Optimizing TESS's Scientific Output using Machine Learning	11:00+30 min	male
FM 10-1	Contrib.	Rob Wittenmyer, Australia	MINERVA-Australis: A Southern TESS follow-up machine	11:30+15 min	male
FM 10-1	Contrib.	Sebastián Zúñiga-Fernández (remote), Belgium	SPECULOOS: Hunting exoplanets of ultracool dwarfs with 1-meter ground-based telescopes network	11:45+15 min	male
Session Chairman: Anatoliy Ivantsov, room CH 106-107					
Slot	Category	Name, country	Talk Title	Timeline	Gender
FM 10-2	Invited	Jessie Christiansen (remote), the USA	Exoplanet Demographics: Exploring the Multiplicity of Planetary Systems	13:30+30 min	female

FM 10-2	Invited	Ernst De Mooij (remote), the United Kingdom	Characterising the atmospheres of exoplanets using high-resolution transmission spectroscopy	14:00+30 min	male
FM 10-2	Contrib.	William Welsh, the USA	Using Small Telescopes to Photometrically Determine the Masses of Tatooine Planets	14:30+15 min	male
FM 10-2	Contrib.	Zouhair Benkhaldoun (remote), Morocco	Small telescopes and big projects	14:45+15 min	male
Session Chairman: William Thuillot, room CH 106-107					
Slot	Category	Name, country	Talk Title	Timeline	Gender
FM 10-3	Invited	Siegfried Eggl, the USA	Solar System Science opportunities with the Vera C. Rubin Observatory Legacy Survey of Space and Time	15:15+25 min	male
FM 10-3	Invited	Federica Spoto (remote), the USA	The Gaia Follow Up Network: state of the art and future objectives	15:40+25 min	female
FM 10-3	Invited	Stephen Gwyn (remote), Canada	Recycling photons: The uses of archives in solar system searches	16:05+25 min	male
FM 10-3	Contrib.	Anatoliy Ivantsov, Belgium	Astrometric bias due to overlapping image profiles in the focal plane and its removal in the positions of near-Earth asteroids	16:30+15 min	male
August 9, 2022, KST					
Session Chairman: David Hobbs, room CH 106-107					
Slot	Category	Name, country	Talk Title	Timeline	Gender

FM 10-4	Invited	Ashish Mahabal, the USA	Searching Solar System and Exoplanetary Bodies the Data Science Way	10:30+30 min	male
FM 10-4	Invited	Jean-Eudes Arlot (remote), France	NAROO: a New Astrometric Reduction of Old Observations	11:00+30 min	male
FM 10-4	Contrib.	Teymoor Saifollahi, the Netherlands	Precovery and risk assessment of the hazardous Near-Earth Objects in large astronomical surveys	11:30+15 min	male
FM 10-4	Contrib.	Svitlana Kolomiyets, Ukraine	Data docking in meteor research	11:45+15 min	female
Session Chairman: Myung-Jin Kim, room CH 106-107					
Slot	Category	Name, country	Talk Title	Timeline	Gender
FM 10-5	Invited	Marco Micheli (remote), Italy	High precision astrometry of small solar system bodies	13:30+20 min	male
FM 10-5	Invited	Matthew Lehner, the USA	The Transneptunian Automated Occultation Survey – TAOS II	13:50+20 min	male
FM 10-5	Invited	Julia de León (remote), Spain	Understanding asteroids from their spectra. Asteroid taxonomies: benefits and limitations	14:10+20 min	female
FM 10-5	Contrib.	Ivan Slyusarev (remote), Ukraine	Search for M-type dominated asteroid families	14:30+15 min	male
FM 10-5	Contrib.	Said Hmiddouch, Belgium	Composition and activity of comets with TRAPPIST telescopes	14:45+15 min	male
Session Chairman: Myung-Jin Kim, room CH 106-107					
Slot	Category	Name, country	Talk Title	Timeline	Gender

FM 10-6	Invited	Josef Ďurech, Czech Republic	Asteroid photometry and its interpretation	15:15+20 min	male
FM 10-6	Invited	Eric MacLennan (remote), Finland	Significance of shapes and spins in the thermophysical modeling of asteroids	15:35+20 min	male
FM 10-6	Invited	Alberto Cellino (remote), Italy	Asteroid Polarimetry in the Gaia Era	15:55+20 min	male
FM 10-6	Contrib.	Hee-Jae Lee, Republic of Korea	Light curve survey of the asteroids with KMTNet	16:15+15 min	female
FM 10-6	Contrib.	Gulchehra Kokhirova, Tadjikistan	Synergy of Small Telescopes for Asteroid (6478) Gault Observations in Tajikistan and Slovakia	16:30+15 min	female

1. The distribution of the **invited and contributed talks** participants per country was Australia (1), Belgium (3), Canada (1), Czech Republic (1), Finland (1), France (1), Italy (2), Morocco (1), the Netherlands (1), Republic of Korea (1), Spain (1), Tadjikistan (1), Ukraine (2), the United Kingdom (1), the USA (8).
2. The gender distribution of female/male/non-specified for **invited** speakers was 3/11/0 (14 in total). The female/total ratio is 21% which is similar to 22% over the entire IAU membership retrieved in January 2023.
3. The gender distribution of female/male/non-specified for **contributed** speakers was 3/9/0 (12 in total). The female/total ratio is 25% which is higher than 22% over the entire IAU membership retrieved in January 2023.
4. In addition, there were presented 9 **e-Talks** and 10 **e-Posters**. The participants came from the People's Republic of China (1), Germany (1), Hungary (1), Lithuania (1), Morocco (1), Russian Federation (1), Sweden (1), Republic of China (1), Tadjikistan (1), Thailand (3), Turkey (1), the United Arab Emirates (2), the United Kingdom (2), Uruguay (1), Uzbekistan (1). Gender distribution female/male/non-specified for e-Talks and 10 e-Posters speakers was 7/12/0 (19 in total). The female/total ratio is 37% which is higher than 22% over the entire IAU membership retrieved in January 2023.

II. Scientific Highlights of FM10 Sessions on August 4, 2022

Invited talks FM10-1

1. **ExoMiner: A Highly Effective Deep Learning Classifier to Mine Exoplanets** by *Hamed Valizadegan:*
   - Machine classification makes possible to extend human expertise used for detecting exoplanets for large datasets of transit signals.

- ExoMiner allowed to increase validation of 301 new exoplanets, the total number of known exoplanets by 6.5%, from 4500 to 4800.

2. **Enhancing and Optimizing TESS's Scientific Output using Machine Learning** by *Andrew Vanderburg:*
   - The deep convolutional neural network classifier, Astronet, is currently being used in the TESS Quick Look Pipeline to produce the official TESS planet candidate catalog.
   - Radial velocity observations to confirm TESS planet candidates are often limited by astrophysical noise from stellar magnetic activity.

Contributed talks FM10-1:

3. **MINERVA-Australis: A Southern TESS follow-up machine** by *Rob Wittenmyer:*
   - MINERVA-Australis is the world's only fully dedicated set of 4 small telescopes each D=0.7m. Contributed to validation of 30 TESS planets (15%).
   - 85% of 600 TESS small planets still need follow-up.
   - Photometry and RV measurements can mitigate the stellar noise in RV due to stellar activity. It allows to detect smaller planets orbiting more active stars.

4. **SPECULOOS: Hunting exoplanets of ultracool dwarfs with 1-meter ground-based telescopes network** by *Sebastián Zúñiga-Fernández:*
   - Search for habitable Planets EClipsing ULtra-cOOl Stars aims to perform a transit search on the nearest (<40 pc) ultra-cool (<3000K) dwarf stars. The project is based on a network of 1m robotic telescopes (Cerro Paranal, Tenerife, San Pedro Martir).

Invited talks FM10-2:

5. **Exoplanet Demographics: Exploring the Multiplicity of Planetary Systems** by J*essie Christiansen:*
   - Multi-planets are common while the systems with a single planet (hot Jupiters) may be the exception.
   - There is a high level of intrasystem similarity using either planet radii or masses for observed multi-planet systems.

6. **Characterising the atmospheres of exoplanets using high-resolution transmission spectroscopy** by *Ernst De Mooij:*
   - There were discovered 8 stars (WASP-77A b, β Pictoris b, HD209458 b, HD189733 b, GJ1214, 55 Cancri e, KELT-9 b, MASCARA-2b) where transmission spectroscopy for studying planetary atmospheres is being analysed.
   - Spectrophotometry of GJ1214 allows to apply some atmospheric models that contains various mixtures of water and hydrogen.

Contributed talks FM10-2:

7. **Using Small Telescopes to Photometrically Determine the Masses of Tatooine Planets** by *William Welsh*:
   - Measuring eclipse timing variations is easy to do using small telescope follow-up for finding precession variation, and, thus, masses of exoplanets.

8. **Small telescopes and big projects** by *Zouhair Benkhaldoun*:
   - Scientific projects, instrumentation at Oukaimeden Observatory located in the High Atlas mountains in Morocco are described.

Invited talks FM10-3:

9. **Solar System Science opportunities with the Vera C. Rubin Observatory Legacy Survey of Space and Time** by *Siegfried Eggl:*
   - Small telescopes can contribute to the LSST science applied for variable or moving celestial sources, validation of sky brightness models.

10. **The Gaia Follow Up Network: state of the art and future objectives** by *Federica Spoto:*
    - Gaia alerts for Small Solar System Objects can be followed up using small telescopes. These measurements can be useful for linking observations and improving orbits.
    - The required astrometric accuracy is 60/70 mas.
    - By now, there were identified 5808 observations for 175 objects.

11. **Recycling photons: The uses of archives in solar system searches** by *Stephen Gwyn:*
    - The Solar System Object Image Search (SSOIS) at the Canadian Astronomy Data Centre provides search for images of moving objects, allowing precoveries.
    - The user is provided with a list of images containing an object from a variety of telescopes. Initially created to search the CFHT MegaCam archive, SSOIS has been extended to other telescopes including Gemini, Subaru, HST, the ESO and NOAO telescopes, Pan-STARRS and a growing number of other archives.

Contributed talks FM10-3:

12. **Astrometric bias due to overlapping image profiles in the focal plane and its removal in the positions of near-Earth asteroids** by *Anatoliy Ivantsov:*
    - An astrometric bias appears due to position measurements of light sources with overlapping profiles. The image width can be determined by either direct measurements or fitting image profiles and is recommended to be reported to the IAU Minor Planet Center using the ADES format.
    - Astrometric positions of asteroids measured close to the stars are likely biased. These measurements are recommended to be down-weighted or eliminated from the orbit fitting process.

Scientific Highlights of FM10 Sessions on August 9, 2022

Invited talks FM10-4

13. **Searching Solar System and Exoplanetary Bodies the Data Science Way** by *Ashish Mahabal*:
    - Deep Learning with AStreaks developed for identifying moving asteroids, comets, artefacts.
    - Detecting Exoplanet candidates using TESS and deep learning.

14. **NAROO: a New Astrometric Reduction of Old Observations** by *Jean-Eudes Arlot*:
    - Digitization of photographic plates with high resolution produces large datasets that can be used for making new much accurate astrometric measurements for the past data.

Contributed talks FM10-4:

15. **Precovery and risk assessment of the hazardous Near-Earth Objects in large astronomical surveys** by *Teymoor Saifollahi*
    - Description of a pipeline PRECOVERY for extracting images with SSOIS, calculating ephemerides with HORIZONS, analysing (O−C) and identifying NEOs.
    - Doing precovery of NEOs. Using SSOIS, HORIZONS for precovery NEOs.

16. **Data docking in meteor research** by *Svitlana Kolomiyets*
    - This study is devoted to the experience of dockings in meteor studies. The pros and cons of data stitching in meteor studies was demonstrated.

Invited talks FM10-5:

17. **High precision astrometry of Small Solar System Bodies** by *Marco Micheli:*
    - Gaia catalogue allows to extract high-quality unbiased measurements of Solar System Bodies, and improve modeling of their orbits.
    - Synthetic tracking as a new astrometric technique that changed the way astrometric observations are scheduled and processed, and the hardware required for data acquisition and its analysis.

18. **The Transneptunian Automated Occultation Survey – TAOS II** by *Matthew Lehner:*
    - The Transneptunian Automated Occultation Survey (TAOS II) will aim to detect occultations of stars by small (1 km diameter) objects in the Kuiper Belt and beyond.
    - TAOS II will operate three 1.3 meter telescopes at the Observatorio Astronómico Nacional at San Pedro Mártir in Baja California, México. It's description, survey goals, prospects for collaboration are presented.

19. **Understanding asteroids from their spectra. Asteroid taxonomies: benefits and limitations** by *Julia de León:* Future advances are expected so far due to
    - Mean spectrophotometric spectra of 60,000 asteroids binned in 16 wavelengths from 0.35 μm to 1.06 μm published by Gaia DR3 (June 2022).
    - Classification of asteroids to be done using artificial neural networks and deep learning.

20. **Search for M-type dominated asteroid families** by *Ivan Slyusarev:*
    - There were found 6 M-type dominated asteroid families (Baptistina, Brasilia, Eria, Tina, San Marcello, 1993 FY12).
    - A new criterion is proposed for separation of M-type asteroids using “a* — albedo” plot. M-type asteroids are located in the plot within $-0.2 < a^* < 0.05$ and albedo $0.1 < p_V < 0.35$.

Contributed talks FM10-5:

21. **Composition and activity of comets with TRAPPIST telescopes** by *Said Hmiddouch:*

- TRAPPIST (for TRAnsiting Planets and PlanetesImals Small Telescope) is a set of two twin robotic telescopes with a diameter of 60 cm installed at La Silla ESO Observatory and the Oukaimeden Observatory (Morocco) in 2016.
- The telescopes were used for observing two comets C/2020 M3 (ATLAS) and C/2017 K2 (PANSTARRS) and deriving production rates for dust and different molecules with respect to OH and CN.

Invited talks FM10-6:

22. **Asteroid photometry and its interpretation** by *Josef Ďurech:*
    - Inversion of asteroid photometry is based usually on a convex form assumption asteroids. Detailed non-convex models with surface features can be reconstructed when disk-integrated photometry is combined with disk-resolved data.
    - Accuracy of photometry data has to be sufficient for applying the comprehensive models.
    - The comprehensive models get benefit from combination of various independent data, e.g. photometric and thermal infrared data for getting size and thermophysical parameters. Sometimes it is possible to interpret changes in the linear rotational model as the YORP effect.

23. **Significance of shapes and spins in the thermophysical modeling of asteroids** by *Eric MacLennan:*
    - Application of thermophysical models (TPM) as analysis tools for the interpretation of thermal IR observations in the studies of asteroid surfaces.
    - TPM analysis techniques that do not rely on a priori shape and spin information.

24. **Asteroid Polarimetry in the Gaia Era** by *Alberto Cellino*
    - Polarimetric data are useful to identify dynamical family interlopers.
    - A possible relation between albedo and the slope of the linear portion of the phase-brightness curve is discussed. If the hypothesis is valid, one can derive the albedo of many thousands of asteroids from Gaia observations, even without knowing the absolute magnitude.

Contributed talks FM10-6:

25. **Light curve survey of the asteroids with KMTNet** by *Hee-Jae Lee:*
    - The Korea Microlensing Telescope Network (KMTNet) consists of D=1.6 m telescopes. An ecliptic plane survey with 25 min cadences has begun in the second half of 2019 provided photometric data for 40,000 asteroids per year. 3,000 of those have got confirmation of their rotational periods.
    - A statistical analysis of spins and shapes is provided.

26. **Synergy of Small Telescopes for Asteroid (6478) Gault Observations in Tajikistan and Slovakia** by *Gulchehra Kokhirova:*
    - Quasi-synchronous observations of the asteroid (6478) Gault at two different telescopes confirmed signs of its cometary activity.

General Conclusions to the talks presented:

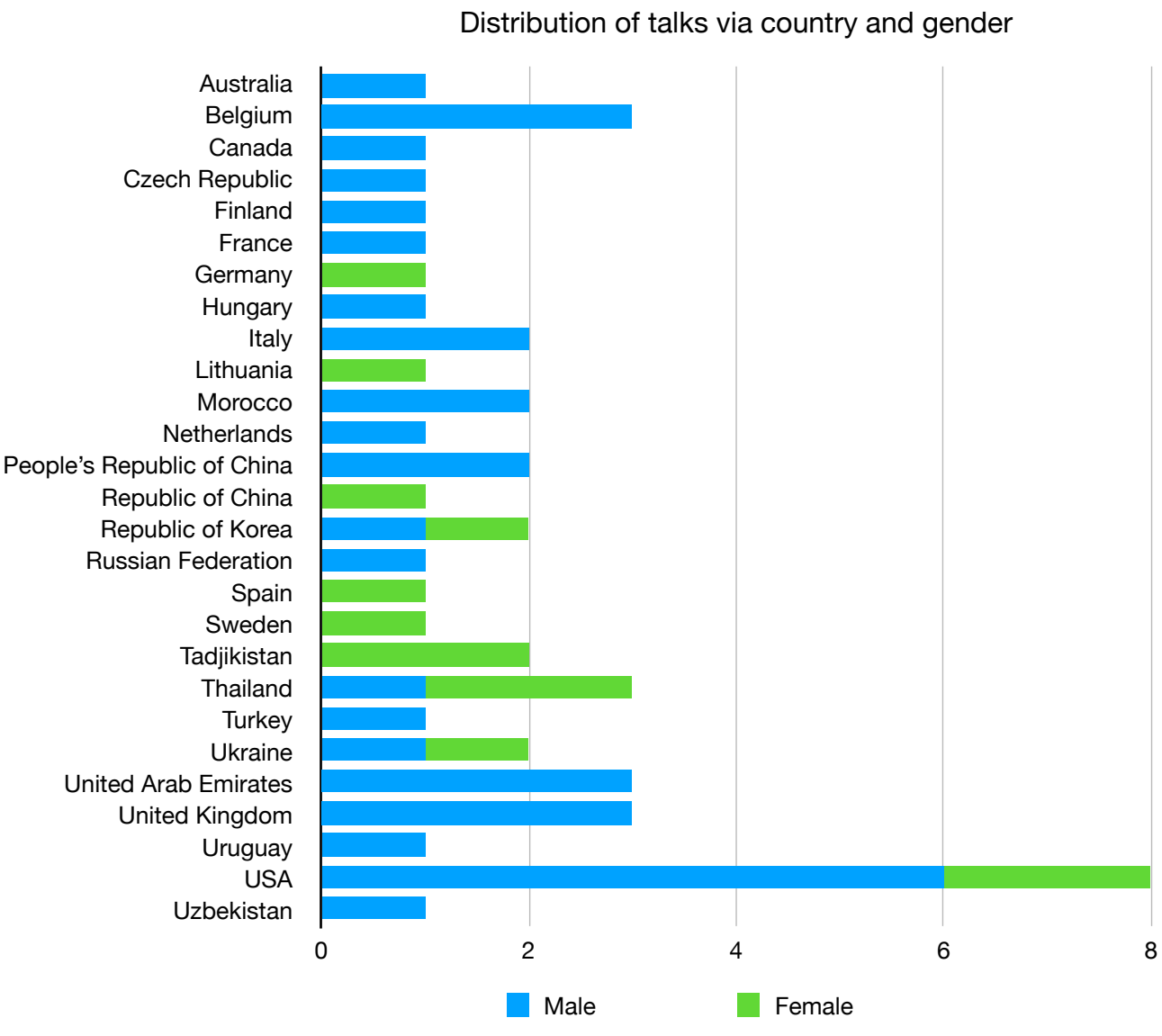
1. Machine and deep learning are used frequently in the classification and detection of exoplanets using large sets of parameters and data.

2. While large surveys produce homogeneous data over a greater area of sky, small telescopes can be suitable instruments for the follow-up of various objects suspected in either variability or motion.
3. While there are plenty of possibilities for calibration of small telescope measurements, the Gaia data releases provide the most accurate ones, and, thus, are highly recommended.
4. There are observational programmes for small telescopes that are open for collaboration today (Gaia Follow-Up network, LSST contribution programme, and other observational networks).

III. List of participants and their contributions

No.	Title	Name	Country	Talk	Gender
1	Dr.	Alberto Cellino	Italy	Invited Talk	male
2	Prof.	Alisher S. Hojaev	Uzbekistan	e-Poster	male
3	Dr.	Anatoliy Ivantsov	Belgium	Contributed Talk	male
4	Mr.	Anton Pomazan	China	e-Talk	male
5	Prof.	Andrew Vanderburg	United States of America	Invited Talk	male
7	Dr.	Ashish Mahabal	United States of America	Invited Talk	male
8	Mr.	Bifeng Guo	China	e-Talk	male
9	Dr.	Eamonn Kerins	United Kingdom	e-Talk	male
10	Dr.	Eliana Maritza Amazo-Gomez	Germany	e-Poster	female
11	Dr.	Eric MacLennan	Finland	Invited Talk	male
12	Dr.	Ernst De Mooij	United Kingdom	Invited Talk	male
13	Dr.	Federica Spoto	United States of America	Invited Talk	female
14	Mr.	Filipp Romanov	Russian Federation	e-Poster	male
15	Ms.	Gayathri Viswanath	Sweden	e-Poster	female
16	Prof.	Gonzalo Tancredi	Uruguay	e-Poster	male
17	Prof.	Grazina Tautvaisiene	Lithuania	e-Talk	female
18	Dr.	Gulchehra Kokhirova	Tadjikistan	e-Poster	female
19	Dr.	Gulchehra Kokhirova	Tadjikistan	Contributed Talk	female
20	Dr.	Hamed Valizadegan	United States of America	Invited Talk	male
21	Dr.	Hee-Jae Lee	Republic of Korea	Contributed Talk	female
22	Prof.	Ilias Fernini	United Arab Emirates	e-Talk	male
23	Dr.	Ivan Slyusarev	Ukraine	Contributed Talk	male
24	Dr.	Jean-Eudes Arlot	France	Invited Talk	male
25	Dr.	Jessie Christiansen	United States of America	Invited Talk	female
26	Dr.	Josef Durech	Czech Republic	Invited Talk	male
27	Dr.	Julia De Leon	Spain	Invited Talk	female
28	Dr.	Marco Micheli	Italy	Invited Talk	male
29	Dr.	Matthew Lehner	United States of America	Invited Talk	male
30	Mr.	Mohammad Odeh	United Arab Emirates	e-Talk	male
31	Mr.	Mohammad Talafha	United Arab Emirates	e-Talk	male
32	Mr.	Mourad Ghachoui	Morocco	e-Talk	male
33	Ms.	Napaporn A-thano	Taiwan	e-Talk	female
34	Dr.	Ozgur Basturk	Turkey	e-Talk	male

35	Ms.	Patcharawee Munsaket	Thailand	e-Poster	female
36	Prof.	Rob Wittenmyer	Australia	Contributed Talk	male
37	Mr.	Ronnakrit Rattanamala	Thailand	e-Poster	male
38	Mr.	Said Hmiddouch	Belgium	Contributed Talk	male
39	Dr.	Sebastián Zúñiga-Fernández	Belgium	Contributed Talk	male
40	Dr.	Siegfried Eggl	United States of America	Invited Talk	male
41	Dr.	Stephen Gwyn	Canada	Invited Talk	male
42	Dr.	Svitlana Kolomiyets	Ukraine	Contributed Talk	female
43	Dr.	Teymoor Saifollahi	Netherlands	Contributed Talk	male
44	Ms.	Thammasorn Padjaroen	Thailand	e-Poster	female
45	Dr.	Tim Lichtenberg	United Kingdom	e-Talk	male
46	Prof.	William Welsh	United States of America	Contributed Talk	male
47	Mr.	Yeonho Choi	Republic of Korea	e-Poster	male
48	Dr.	Zoltán Garai	Hungary	e-Poster	male
49	Prof.	Zouhair Benkhaldoun	Morocco	Contributed Talk	male



IV. List of recipients of IAU grants, stating the amount received, country and gender

There were two IAU grants as the registration fee waiver allocated to Jessie Christensen (the USA, female) and Alberto Cellino (Italy, male). One fee discount proposed by the LOC was allocated to Ashish Mahabal (the USA, male). The SOC was not communicated with respect to other IAU grants allocated to the FM10 participants.

V. Executive Summary:

1. The FM10 meeting was held successfully. In total, there were 49 talks communicated within two days of the meeting. There were no changes to the final scientific programme, every invited and contributed speaker has given his or her talk on time and was asked to follow the schedule.
2. The scientific programme was developed in a way as to consider both priorities satisfied, the professional level and gender of every participant. Preselection of invited and contributed talks was done following internal voting and ranking organized among the SOC members for every abstract submitted. The gender of the participants was considered every time, however, there was difficulty in discovering this information through either the IAU personal webpages or an Internet search. It will simplify further work if gender information is provided to the SOC.
3. The session chairs have been chosen among four SOC members who arrived at the IAU General Assembly (Anatoliy Ivantsov, William Thuillot, David Hobbs, Myung-Jin Kim, all are males). The choice of chairmen taken made the session management process robust with respect to possible instabilities in the Internet connection.
4. All invited and contributed speakers were suggested to submit manuscripts following their talks. One of the reasons for the low number (3) of manuscripts submitted is the small number of pages (50) reserved per each Focus Meeting (the reason was communicated by the participants). In the case of the even distribution of pages among the invited speakers only, we have 50/14=3.5 pages per talk for FM10. The number of pages is insufficient for such manuscripts.
5. Scientific Highlights of the FM10 were presented by Anatoliy Ivantsov at the Division A meeting on August 8, 2022.