Report on the Wams school on Introductory topics in Number Theory and Differential Geometry with a course on Dynamical Systems King Khalid University, Abha. Saudi Arabia June 16th- 23rd, 2019

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1 Preamble

This report covers two activities:

- **Visit by Francesco Pappalardi of the**
  Research group of Algebraic Structures and its Applications (ASA)
  King Abdulaziz University, Jeddah Saudi Arabia Kingdom (June 13th- 15th, 2019)
  `https://www.kau.edu.sa/home_ENGLISH.aspx`

- WAMS school on **Wams school on Introductory topics in Number Theory and Differential Geometry with a course on Dynamical Systems**,
  `http://www.rnta.eu/Abha2019/`
  King Khalid University, Abha. Saudi Arabia Kingdom (June 16th- 23rd, 2019)
  `https://www.kku.edu.sa/en/`

  More detailed information regarding every single item can be found in the appropriate web pages above. This report can be downloaded at
  `http://www.mat.uniroma3.it/users/pappa/missions/reports/2019_Abha_WAMS.pdf`

2 Visit to ASA - Jeddah

The visit was the result of an invitation by Professor Adel N. Alahmadi `<adelnife2@yahoo.com>` director of ASA. The invitation was suggested by Florian Luca, member of ASA. FL was aware of the visit of FP to Abha in occasion of the WAMS school and suggested a stop for a couple of days in Jeddah to discuss future cooperation with the members of ASA including the possibility of the organization of a WAMS or a CIMPA school at King Abdulaziz University.

FP gave a slides presentation about CIMPA outlining the history and way of functioning of CIMPA. He also informed Adel of the major problem encountered by the organizers of the CIMPA school in Abha (explained later in this report). Namely the fact that none of the non-Saudi participants in the WAMS school was given the entry VISA to Saudi Arabia. AA is quite confident that, in the event that a CIMPA/WAMS school takes place at King Abdulaziz University (KAU) in Jeddah, the entry VISA can be obtained. In fact AA is the KAU responsible for the office that deals with the VISA for all the visitors at KAU. So he knows all the aspects of the matter.

Of the presentation were presents: Florian Luca, Adel N. Alahmadi, Alaa Altassan (on the left in the photo below) and Hatoon Shoaib (on the right in the photo below), all members of ASA.

KAU has a nice campus with suitable infrastructures to host an international school. Furthermore, the important international airport of Jeddah and the central geographical position on the city would make of KAU an ideal location.

3 WAMS school at King Khalid University, Abha

The idea of this WAMS school is due to Dr. Abdalaziz Alanazi from University of Tabuk. During the CIMPA research school on Explicit Number Theory at the University of the Witwatersrand, Johannesburg, South Africa on January 8 - 19, 2018 he approached FL and FP with the proposal that originated this event. He is an Alumni of Wits and he was attending the CIMPA school as participant.

We accepted enthusiastically to join him in the enterprise. At the time the issue of accessibility to the school to Female participants was raised. Abdalaziz ensured that also woman would be able to attend. This turned out to be correct.

Soon after we discovered the difficulties that CIMPA has already encountered in Saudi Arabia in 2012 at Thuwal where a CIMPA research school in "Applied Mathematics on Uncertainty Quantification" was held. If fact we learned that during that school there were no international participants. At the time Abdalaziz was hoping that the problem would not present again.

After some discussions we selected the following speakers: Florian Luca, Cécile Armana, Paul Voutier and the three of us. Cécile and Paul had to cancel their participation after the school was approved.

Furthermore Abdalaziz proposed to hold the school at the University of Abha where the colleagues were interested in hosting the program. We were also asked to include a course in Differential Geometry and later, after the cancellation of Paul Voutier and the school was already approved, we were asked to include a course in Dynamical Systems.

The deadline for applications was on February 10, 2019 and the responses were communicated soon after February 15, 2019. We selected 21 foreign participants from the following countries:

	MALE	FEMALES
INDIA	2	0
EGYPT	4	5
IRAQ	3	1
PAKISTAN	1	0
SUDAN	0	1
MOROCCO	0	1
ALGERIA	1	2
totale	11	10

The process of granting a VISA is a difficult task in Saudi Arabia and we all underestimated the difficulties.

While the visas of all the speakers were granted in the due time, two weeks before the beginning of the school we learned that none of the selected international participants was granted the visa and, at that late stage, it was unlikely that they would receive it on time to participate in the school.

The result was that, as it happened in 2012 in Thuwal, no international participants were attending the school. Both the local organizer were extremely sorry for the development. It is clear that this was not under their control.

Nevertheless the atmosphere of the classroom was excellent and the lectures by speakers were delivered clearly. Various other aspects of the organization were excellent and the immense work of the local organizers, especially of Professor Ali Alkhaldi and his team, produced a successful event.

Although I do not have the precise numbers on the attendance to the school, I can say that, at different times, there were at least 14 women participants and about the same number of men participants.

The schedule

The schedule was proposed and approved by the scientific committee several months before the school and it was published in the web page:

	Sun 16	Mon 17	Tue 18	Wed 19	Thu 20	Sat 22	Sun 23
09:00-10:30	DS1	CO1	DG3	CO2	DE4	DE5	EC3
11:00-12:30	DE1	DG2	DS2	DG4	DS3	EC2	DG6
12:30-14:00	LUNCH						
14:00-15:30	DG1	DE2	EC1	DE3	CO3	DG5	DE6
16:00-18:00	TUTORIALS						

1. **(DG)** *Differential Geometry of Curves and surfaces*, Mohammad Shahid & Ali Alkhaldi
2. **(DE)** *Introduction to Diophantine Equations*, Florian Luca & Michel Waldschmidt
3. **(DS)** *Introduction to Dynamical Systems*, Gamal Mokhtar Mahmoud
4. **(CO)** *Introduction to Enumerative Combinatorics*, Abdulaziz Alanazi
5. **(EC)** *Introduction to Elliptic Curve*, Francesco Pappalardi

At our arrival in Abha, we were informed that the president of King Khalid University had changed the schedule lowering the amount of hours of lecture, removing one of the days of lecture and canceling the afternoon tutorials.

WAMS SUMMER SCHOOL
16 - 22 June 2019

Schedule

	Sun 16	Mon 17	Tue 18	Wed 19	Thu 20	Sat 22
08:30-09:15	DGI	DEI	EC	DEII	DEI	DEII
09:20-10:05	DEI	DGII	DG1	CO	DGII	DEI
10:05-10:20	Break					
10:20-11:05	EC	DS	DEI	DGI	CO	CO
11:10-11:55	DGII	EC	DEII	DS	DGI	DS
12:00-12:45	DS	DGI	DGII	EC	DEII	DGII

- ■ - Differential Geometry I (DGI), M. Shahid
- ■ - Differential Geometry II (DGII), V. Khan
- ■ - Introduction to Diophantine Equations I (DEI), F. Luca
- ■ - Introduction to Diophantine Equations II (DEII), M. Waldschmidt
- ■ - Introduction to Enumerative Combinatorics (CO), A. Alanazi
- ■ - Introduction to Elliptic Curve over finite fields (EC), F. Pappalardi
- ■ - Introduction to Dynamical System (DS), G. Mahmoud

4 The courses of the WAMS School

During the school 5 courses were held. The original programs of the courses were:

- **Differential Geometry of Curves and surfaces**, Ali Alkhaldi and Mohammad Hasan Shahid

  Curves in 3-dimensional Euclidean space E^3 Curves in 3-dimensional Minkowski space E_1^3 Curves in 4-dimensional Minkowski space E_1^4 Surfaces in 3-dimension Euclidean space E^3 Shape operator, curvature and new type of surfaces.

- **Introduction to Diophantine Equations**, Florian Luca & Michel Waldschmidt

  Classical Diophantine equations in two variables, their theory, relations with Diophantine Approximation and with Algebraic Number Theory linear equation Pell equation Thue equation elliptic, hyperelliptic,

superelliptic equations general equation, Siegel's finiteness theorem. Baker's method, effective results From effective to explicit: the Las-Vegas Principle Continued Fractions and Baker-Davenport Lemma Explicit solution of simultaneous Pell equations Explicit solutions of Thue equations. Elliptic curves, Mordell-Weil Theorem. Solving elliptic equations using elliptic logarithms.

- **Introduction to Dynamical Systems**, Gamal Mokhtar Mahmoud

  Introduction to Differential Equations and Dynamical Systems Introduction to Chaos Local Bifurcations Averaging and other Perturbation methods Fixed points and their stability (e.g. real and complex Lorenz systems)

- **Introduction to Enumerative Combinatorics**, Abdulaziz Alanazi

  Permutations and binomial coefficients Inclusion and exclusion formula. Linear recurrences. The Fibonacci sequence Catalan numbers Generating functions Partitions Euler's generating function for partitions pentagonal formula.

- **Introduction to Elliptic Curve over finite fields**, Francesco Pappalardi

  Weierstrass Equations, The Group Law, The j-Invariant, Elliptic Curves in Characteristic 2, Endomorphisms, Singular Curves, Elliptic Curves mod n. Torsion points: Division Polynomials, The Weil Pairing. The Frobenius Endomorphism, Determining the Group Order, Schoof's Algorithm, Supersingular Curves.

  Exercise Sessions were in the original program but they were not held.

Security issues

Abha is a safe destination. However, the proximity of Abha to the Yemen border make of it a target. On June 17th there was an attack with no consequences at Abha airport.

`https://www.aljazeera.com/news/2019/06/yemen-houthis-claim-attack-saudi-arabia-abha-airport-190617012821518.html`

Later on June 23$^{\text{rd}}$ there was a second attack on Abha airport.

`https://www.aljazeera.com/news/2019/06/killed-wounded-attack-saudi-airport-190623193747842.html`

None of the events had any effect on the WAMS school.

The budget

The costs of the school were entirely covered by King Khaled University. All local expenses and all travel expenses for speakers were paid directly by the local organization.

In the original budget the amount of 4.000Euro allocated by CIMPA should have been spent exclusively to cover the travel expenses of international participant. The denial of the entry VISA and the consequent absence of them, resulted in the fact that nothing was spent by CIMPA. The entire budget from CIMPA is therefore unspent.

5 Followups and Final recommendations

It is of course unfortunate that the school was not accessible to international participants and the fact that this happened for the second time and for the second event ever organized in Saudi Arabia is even more remarkable. Nevertheless, we would like to stress one more time that the local organizers Abdalaziz Alanazi and Ali Alkhaldi made their best to avoid this defect.

We strongly believe that, due to its geographic region, due to the particular organization of the Saudi academic system where the majority of professors are foreigner, mostly originally from countries in regions of

crucial interest for CIMPA (Egypt, Morocco, Pakistan, India, Algeria, ...) it is very important CIMPA continues its activities in Saudi Arabia. In particular Shaban Aly (originally from Egypt), Khaled AL-Homam (originally from Yemen) and Akram Ali (originally from India) are all member of the Department of Mathematics of King Khalid University and collaborated actively to the organization of the WAMS school. Shaban Aly has also expressed a serious interest in organizing and EMA school in Applied Mathematics in Egypt next year.

Abdalaziz Alanazi, Ali Alkhaldi and also Adel N. Alahmadi are example devoted, dynamic and reliable young mathematicians. The type of researcher that deserve support and trust for future activities.

Abdalaziz and Ali are considering the possibility to organize another school next summer which will not be under the umbrella of CIMPA. This would be a new challenge that could finally succeed in bringing foreign participants in Saudi Arabia. We believe the their efforts should be morally supported by CIMPA.

Regarding the attendance of women, we were surprised at the enthusiasm of the women applicants at the possibility to attend the Abha WAMS school. One of the female applicant that was not selected was willing to participate in the school at her own expenses.

In conclusion, we believe that our Saudi colleagues should be encouraged to apply to other CIMPA/WAMS schools in the future. They should be assisted and stimulated to solve the problem of entry visa to international participants.

Rome July 2nd, 2019 Francesco Pappalardi   Paris July 2nd, 2019 Michel Waldschmidt