

The 4th edition of the Algebraic Days of Gabon (ADG 2024)



Dates: March 4-16, 2024

Venue: École Normale Supérieure (ENS) Libreville, Gabon

Website: <https://indico.math.cnrs.fr/event/11410/>

Coordinators:

- Cécile Armana, University of Franche-Comté, France
Her professional webpage: <http://armana.perso.math.cnrs.fr/>
- Tony Ezome, École Normale Supérieure (ENS) Libreville, Gabon
His professional webpage: <https://sites.google.com/site/ezometony/home>
- Christian Maire, University of Franche-Comté, France
his professional webpage: <https://members.femto-st.fr/christian-maire/fr>
- Maurice Obame, École Normale Supérieure (ENS) Libreville, Gabon

Format: Starting with discussion sessions to exchange on mathematical background during the first two days, there will be advanced courses for PhD and Master students, problem sessions, outreach activities about the gender gap in science, activities for popularizing mathematics to the general public.

This mathematical event aims to promote a research activity in Number Theory and Arithmetic Geometry and Applications in Africa involving young researchers, mainly master and PhD students. In Subsaharan Africa, teaching on Arithmetic Geometry and Number Theory is at the basic step, and so research is in its early days. But the will and the human potential are there. Since 2021, we stabilize a group of young researchers (from Burkina Faso, Cameroon, Congo Brazzaville, Gabon, Ghana and Senegal) in order to implement a research team in number theory and arithmetic geometry in central Africa hosted at Ecole Normale

Supérieure in Libreville in Gabon. Indeed, a good mathematical education in Africa requires competitive research teams in African universities and institutes. More details concerning previous activities and this group of young researchers can be found on the webpages of the coordinators. However, the webpage of the 3rd edition of of the Algebraic Days of Gabon (ADG 2022) is <https://indico.math.cnrs.fr/event/8278/>

The detailed program of ADG 2024 is given in the following sections.

Themes and goals of ADG 2024: The fourth edition of the *Algebraic Days of Gabon* will take place at École Normale Supérieure (ENS) in Libreville, Gabon. It will consist of three main activities:

- (1) Two sessions of **Young Researcher Lectures (YRL)** for master and PhD students:
 - *The first session* will be intensive exchanges (under the supervision of two or three senior researchers) during the first two days of the meeting to let master and PhD students discuss and present mini-projects on topics identified in advance in the areas of Number Theory and Arithmetic Geometry. This will allow them to complete the needed background for the research school described below.
 - *The second session* will let students present their PhD work.
- (2) A **Research School in Number Theory and Arithmetic Geometry** with courses given by: Cécile Armana, Christian Maire, Martin Lüdtkke (University of Groningen, The Netherlands), Florian Luca (Wits University, South Africa), Amadou Bah (Columbia University, USA), and Tony Ezome.
- (3) **Outreach activities about the gender gap in Science** in the framework of the **International Women’s Day 2024**. Participants (mainly mathematicians, but also physicists, chemists, biologists and geologists) will present the key ideas about their research work, discuss the problems they are facing, organize round tables to raise awareness among young girls. From previous meetings and activities of the Gabonese women mathematicians, they will discuss solutions to reduce the gender gap in science.
- (4) **Activities for Popularizing Mathematics** in the framework of the **International Day of Mathematics IDM 2024**. We plan presentations for the general public (namely pupils from secondary school and young students in science in universities and high schools) as well as some activities to show/explain some applications of mathematics in real life. Actually, this will be a discovery day of research in number theory and arithmetic geometry for the general public.

Research School

This school is supported by <https://www.cimpa.info/> in the form of CIMPA courses. The program consists of six courses:

- *Fundamental Results of the Algebraic Theory of Numbers* by Cécile Armana, University of Franche-Comté, France;
- *The Theorem of Scholtz-Reichardt, and the shrinking process of Shafarevich* by Christian Maire, University of Franche-Comté, France;

- *Arithmetic Functions* by Florian Luca, Wits University, South Africa;
- *Fundamental groups in arithmetic and geometry* by Martin Lüdtkke, University of Groningen, The Netherlands;
- *Weil's proof of the Riemann hypothesis for curves over finite fields* by Amadou Bah, Columbia University, USA;
- *Intersection Theory for Surfaces and Applications* by Tony Ezome, École Normale Supérieure (ENS) in Libreville, Gabon.

These lectures will be accompanied by exercise sessions.

As mentioned previously, there will also be two sessions of **Young Researcher Lectures (YRL)** mainly by master and PhD students:

- *The first session* will be intensive exchanges (under the supervision of two or three senior researchers) during the first two days of the meeting to let master and PhD students discuss and present mini-projects on topics identified in advance (i.e during the previous edition ADG 2022). This will allow them to complete the needed background and follow the research school in the best conditions.
- *The second session* will close the meeting and let students present their PhD work.

Abstracts of the courses

ARMANA Cécile

Algebraic Number Theory

We will present global aspect:

- *Rings of integers, Dedekind rings*
- *Splitting of prime ideals (inertia degree, ramification), ideal class group and class number, case of Galois extensions (decomposition group, inertia group),*
- *Fundamental examples: number fields, quadratic fields, cyclotomic fields,*
- *Hilbert class field.*

MAIRE Christian

The Theorem of Scholtz-Reichardt, and the shrinking process of Shafarevich.

In this course we will show the following result:

Theorem. Let p be a prime number, and let G be a finite p -group. Then there exists a Galois extension K/Q such that $G = \text{Gal}(K/Q)$.

The course aims to give the key arguments, explain the difficulty for $p=2$, and the strategy of Shafarevich.

LUCA Florian

Arithmetic Functions

Average orders of arithmetic functions, maximal orders, normal orders, the Turan-Kubilius Theorem Introduction to probabilistic number theory, density of sets of integers. Smooth numbers, Applications: there are fewer pseudoprimes than primes. Sieves. Brun pure

sieve. Applications to twin primes. Results about primes in arithmetic progressions (Brun-Titchmarsh and Bombieri-Vinogradov). Carmichael numbers. Proof that there are infinitely many Carmichael numbers.

LÜDTKE Martin

Fundamental groups in arithmetic and geometry

We will roughly focus on the following topics:

- *Grothendieck's Galois theory,*
- *Covering spaces in topology,*
- *Galois categories,*
- *The étale fundamental group,*
- *The anabelian geometry.*

BAH Amadou

Weil's proof of the Riemann hypothesis for curves over finite fields

The content of the course is the following:

- *Cartier divisors and invertibles sheaves,*
- *Riemann-Roch Theorem for Curves and Surfaces, Hodge Index Theorem,*
- *Proof of Weil's Conjectures.*

EZOME Tony

Intersection Theory for Surfaces and Applications

The content of the course is the following:

- *Intersection Theory for surfaces,*
- *Computing discrete logarithms in finite extensions by using intersection theory,*
- *Improvements of the known algorithms.*

Also, there will be a talk on Artificial Intelligence (AI) by

Cyprien Tankeu,

Université Yaoundé 1, Cameroon.

Note that AI is expanding and is revolutionizing many aspects of our daily lives. This talk aims to present the links between AI and algebra.

Abstracts of the YRL

EBAYI ESSANGA Pierre, Université des Sciences et Techniques de Masuku, Gabon
Corps locaux, corps globaux, corps de fonctions algébriques

Dans cet exposé, nous allons définir les corps locaux, les corps globaux et les corps de fonctions algébriques. Ensuite nous présenterons quelques exemples classiques en décrivant leurs propriétés de base.

BOUGOUENDJI LÉBOUMA Copernic, Université des Sciences et Techniques de Masuku, Gabon

On the freeness of the Galois group of the maximal p -extension of some local and global fields.

Given a field k , we first prove that the Galois group G_k of the maximal p -extension of k is a free pro- p group when k has characteristic p . Then we prove that G_k is also a free pro- p group when k is a p -infinite local field or a global field with the property that $k_{\mathfrak{p}}$ is p -infinite for all finite place \mathfrak{p} of k .

DRAME Ousmane, Université des Sciences et Techniques de Masuku, Gabon
Nombres normaux et théorie ergodique

Dans cet exposé, nous présentons les notions et propriétés de base en théorie ergodique et les nombres normaux

NGAISSOU Lhamma, Université de Bamenda, Cameroun
La correspondance de Galois-Grothendieck

Étant donné k un corps commutatif, L une extension galoisienne de k et $G = \text{Gal}(L/k)$. Il s'agit dans cet exposé de montrer qu'il y a une antiéquivalence entre la catégorie des k -algèbres finies diagonalisées par L et la catégorie des ensembles finis sur lesquels G opère.

KOUEMO Derille, École Normale Supérieure, Gabon
Herbrand quotient and its applications

The Herbrand quotient is an important invariant in Number Theory and Group Theory, providing valuable information about the structure of extensions of fields and Galois groups. In this talk, we will present the concept of Herbrand quotient, its fundamental properties as well as its applications.

CAMARA Moustapha, University Assane Seck of Ziguinchor, Sénégal
Points algébriques de petits degrés sur les courbes $\mathcal{C}_n : y^2 = x(x^2 - n^2)(x^2 - 4n^2)$

On s'intéresse à la détermination des points algébriques de degré au plus 3 sur \mathbb{Q} sur les courbes hyperelliptiques d'équations affines

$$\mathcal{C}_n : y^2 = x(x^2 - n^2)(x^2 - 4n^2),$$

avec $n \in \{1, 2, 3, q \text{ un nombre premier et } q \equiv 7 \pmod{24}\}$. Le résultat obtenu étend les travaux de Heiden, Evink et Evink, et al. qui ont donné l'ensemble des points \mathbb{Q} -rationnels sur les mêmes courbes.

DJELLA Jonathan, Université Assane Seck, Sénégal
Average number of bad witnesses of a composite number with respect to two pseudo-primality tests

The goal of this talk is to study the arithmetic mean of the number of bad witnesses of a composite number with respect to the Fermat test and the Galois test.

MIAAYOKA Brice, Université Marien Ngouabi, République du Congo
Rational points of some genus 3 curves from rank zero strategy

We describe an algorithm to compute the rational points of a genus 3 curve C/\mathbb{Q} which is a degree-2 cover of a genus 1 curve whose Jacobian has rank 0. We also presented an implementation of this algorithm in Magma. Then, we discuss some interesting examples, and we exhibit curves for which the number of rational points meets the Stoll's bound.

PONCHO-KOTÉY Ephraim Nii Amon, University of Ghana, Ghana
Computing Discrete Logarithms in the Multiplicative Group of Finite Fields

There have been a lot of algorithms to compute discrete logarithms in the multiplicative groups of finite fields. Most of the algorithms rely on principles from the Quadratic Sieve and Number Field sieve. We will explain how the underlying ideas may be exploited to compute discrete logarithms by using algebraic curves and surfaces.

IBARA NGIZA MFUMU Roslan, Université Marien Ngouabi, République du Congo
Corps gouvernant et théorie des $S - T$ genres T -ramifiées modérées, S -modifiées

Soit K un corps de nombres et soient T et S deux ensembles finis de places de K . Dans cet exposé, nous allons développer une approche de la théorie des $S - T$ genres pour une extension galoisienne L/K de corps de nombres en introduisant un corps gouvernant. Lorsque la restriction de chaque groupe d'inertie à l'abélianisation locale est annulé par un nombre premier fixe p , ce point de vue nous permet d'estimer le nombre de $S - T$ -genre de L/K à l'aide d'un sous-espace de l'extension gouvernante générée par certains Frobenius. Puis étant donné un corps de nombres K et un possible nombre de $S - T$ -genre g , nous dérivons des informations sur les plus petits idéaux premiers de K pour lesquels il existe une extension cyclique de degré p ramifiée uniquement en ces nombres premiers et ayant g comme nombre de $S - T$ -genre.

SANKARA Karim, Université Nazi Boni, Burkina Faso
On Hilbert's Class Field Tower Problem.

In this talk, we first recall Golod-Shafarevich inequality which establishes a criterion for a pro- p -group to be infinite. After presenting the class field tower problem, we will apply Golod-Shafarevich to the problem via Galois group of maximal unramified pro- p -group extension. We will obtain a criterion for a number field k to have infinite class field tower. We end our talk by giving an explicit example of a number field satisfying this criterion.

Programme

	9-10	10:30-11:30	2pm-3pm	3:30-4:30	4:45-5:45
March 4	Opening Ceremony	Young Researcher Lectures (1st part)	Young Researcher Lectures (1st part)	Young Researcher Lectures (1st part)	Young Researcher Lectures (1st part)
March 5	Young Researcher Lectures (1st part)	Young Researcher Lectures (1st part)	Young Researcher Lectures (1st part)	Young Researcher Lectures (1st part)	Young Researcher Lectures (1st part)
March 6	Lüdtke	Bah	Lüdtke	Bah	Exercise Session
March 7	Lüdtke	Ezome	Lüdtke	Tankeu	Exercise Session
March 8	Bah	Ezome	Lüdtke	Bah	Exercise Session
March 9	Activities for Women in Science	Activities for Women in Science	Activities for Women in Science	Activities for Women in Science	
March 11	Luca	Ezome	Armana	Young Researcher Lectures (2nd part)	Exercise Session
March 12	Luca	Armana	Ezome	Young Researcher Lectures (2nd part)	Young Researcher Lectures (2nd part)
March 13	Maire	Luca	Maire	Exercise Session	Armana
March 14	Luca	Maire	Ezome	Maire	Armana
March 15	Maire	Armana	Luca	Exercise Session	Closing Ceremony
March 16	Pi Day – IDM 2024 Popularizing Math	Pi Day – IDM 2024 Popularizing Math	Pi Day – IDM 2024 Popularizing Math	Pi Day – IDM 2024 Popularizing Math	

International Women's Day 2024

There will be outreach activities about the gender gap in Science in the framework of the International Women's Day 2024. Participants (mainly mathematicians, but also physicists, chemists, biologists and geologists) will present the key ideas about their research work, discuss the problems they are facing, organize round tables to raise awareness among young girls. From previous meetings and activities of the Gabonese women mathematicians, they will discuss solutions to reduce the gender gap in science.

The meeting on Women in Mathematics will take place on March 9, 2024. It will consist of :

- presentations and testimonies given by participants;
- round-tables to discuss the problem of gender gap in mathematics, raise awareness among girls and boys / women and men, share insights and discuss solutions. We will adopt a double perspective on research and teaching careers for women in mathematics.

This meeting will be organized jointly with the Association des femmes mathématiciennes du Gabon, which is the local branch of the [African Women in Mathematics Association](#). The Chair Women of the talks will be Liliane Ogowet from ENS (Gabon) and Isabelle Ngningone Eya from USTM (Gabon).

Program of activities in the framework of the International Women's Day 2024

9:30 - 9:45	Welcome Session
9:50 - 10:05	NGNINGONE Isabelle <i>Université des Sciences et Techniques de Masuku, Gabon</i> Presentation of Gabonese Woman Mathematicans and my career as a mathematician
10:05 - 10:35	Coffee Break
10:40 - 10:55	MOUSSAMBI Hermance <i>Ecole Normale Supérieure, Gabon</i> Presentation of Gabonese Woman Physicists and my career as a Physicist
11:00 - 11:15	NTSAME AFFANE Armelle <i>Ecole Normale Supérieure, Gabon</i> Presentation of Gabonese Woman biologists and my career as a biologist
11:20 - 11:35	AKOUME NDONG Claude <i>CES Nelson MANDELA, Gabon</i> My young career as a mathematician
11:40 - 11:55	DJIERI Marthe <i>Ecole Normale Supérieure, Gabon</i> My research activity and some testamonies from my career as a Chemist
12:00 - 12:15	MEKUI Adriana <i>Institut Supérieur de Technologie, Gabon</i> My research activity and some testamonies from my career as a mathematician
12:15-13:15	Educational workshops
13:15-14:15	Lunch
14:15-15:15	Round Tables

International Day of Mathematics IDM 2024

There will be activities for popularizing mathematics, namely. outreach presentations for the general public (namely pupils from secondary school and young students in science in universities and high schools) as well as some activities to show/explain some applications of mathematics in real life.

Actually, this will be a discovery day of research in number theory and arithmetic geometry. We plan educational workshops around some mathematical topics, for instance an interesting game which links the Euler's totient function and the Brussels sprouts.

Program of activities in the framework of the π -Day IDM 2024

8:30 - 9:00	Welcome Session <i>Pupils, students, Teachers, Organizers, Administrative staff form ENS, People form the Minsitry of Higher Education People from the Ministry of Education (Primary and Secondary)</i>
9:00 - 9:30	Open ceremony
9:30 - 10:00	Presentation of the program to pupils and students
10:00 - 10:30	MAIRE Christian <i>University of Franche-Comté, France</i> Outreach presentation for popularizing mathematics
10:30 - 11:10	Talks by two PhD students
11:15 - 12:00	ONDZAGHE Yann <i>Société Gabonaise des Braseries du Gabon (SOBRAGA), Gabon</i> An illustration of the concrete use of mathematics in real life
12:00 - 13:30	Lunch
13:30 - 15:00	Educational workshops for pupils and students
15:00 - 16:00	Contest for pupils on the decimal digits of the real number π
16:00-16:30	Awards ceremony and family photo

Participants

- We have 11 senior researchers from Africa, Europe and USA (among them 6 lecturers of the research school);
- We selected 6 young researchers (Master and PhD students) from Subsaharan Africa (Burkina Faso, Cameroon, Congo, Ghana and Senegal) in order to implement a research team in arithmetic geometry;
- We also welcome local young researchers (Master and PhD Gabonese students) from Ecole Normale Supérieure and University of Masuku who are interested in the topics of this meeting.

Selection process: Lecturers have been selected for their availability, their expertise on the topics of this meeting as well as to ensure a fair representation of underrepresented groups in the mathematical community: women mathematicians, African mathematicians, and the intersection of these two communities. The group of 6 young researchers have been also selected with these criteria. Local participants have been also selected with the same criteria.

List of participants

ADILANGOYE Verdi, Ecole Normale Supérieure, Gabon
adilangoyebrandon@gmail.com

AKOUME NDONG Claude, CES Nelson MANDELA, Gabon

ANDAMI OVONO Armel, Ecole Normale Supérieure, Gabon
andami2016@gmail.com

ARMANA Cécile, Université de Franche-Comté, France
cecile.armana@univ-fcomte.fr

ATOUTH Levi, Ecole Normale Supérieure, Gabon

BAH Amadou, Columbia University, USA
ab5316@columbia.edu

BETOUE ETOUGHE Marthe, Ecole Normale Supérieure, Gabon
betouemarthe66@gmail.com

BOUGOUENDJI LEBOUMA Copernic, Université des Sciences et Techniques de Masuku, Gabon
copernicbougouendji12@gmail.com

BOUMANGA BA Abdoulaye, ArchiSec-IT, Gabon
boumangapro@gmail.com

CAMARA Moustapha, University Assane Seck of Ziguinchor, Sénégal
m.camara5367@zig.univ.sn

DJELLA LEGNONGO Johnathan, Université Assane Seck, Sénégal
johndjella@gmail.com

DJIERI Marthe, Ecole Normale Supérieure, Gabon

DRAME Ousmane, Université des Sciences et Techniques de Masuku, Gabon

EBAYI ESSANGA Pierre, Université des Sciences et Techniques de Masuku, Gabon
ebayiesspierre@gmail.com

EYIMI MINTO'O Paul, Ecole Normale Supérieure, Gabon
azakpau@hotmail.fr

EZOME Tony, Ecole Normale Supérieure, Gabon
tony.ezome@gmail.com

IBARA NGIZA MFUMU Roslan, Université Marien Ngouabi, République du Congo
roslancello7@gmail.com

IGOUBE Geordan, Ecole Normale Supérieure, Gabon
igouweg@gmail.com

KOUEMO Derille,, Ecole Normale Supérieure, Gabon
derille@aims.ac.za

LUCA Florian, Wits University, South Africa
florian.luca@wits.ac.za

LÜDTKE Martin, University of Groningen, The Netherlands
m.w.ludtke@rug.nl

MAIRE Christian, Université de Franche-Comté, France
christian.maire@univ-fcomte.fr

MALEGHI Mozer, Ecole Normale Supérieure, Gabon
maleghim@gmail.com

MAYOMBO Bill, Ecole Normale Supérieure, Gabon

MEKUI Adriana, Institut Supérieur de Technologie, Gabon

MIAYOKA Brice, Université Marien Nguabi, République du Congo
bricemiayoka@gmail.com

MIHINDOU Seguy Parcely, Lycée Célestin Moukodoum Itah de Pana, Gabon
c.guybizon@gmail.com

MIWANZA MOUSSADJI Aide Nadine, Ecole Normale Supérieure, Gabon
bouroboujeanroger@gmail.com

MOUSSAMBI Hermance, Ecole Normale Supérieure, Gabon

MOUSSAVOU Lydia, Lycée Raponda Walker de Port-Gentil, Gabon
moussavoulydia945@gmail.com

MVE Geriel, Ecole Normale Supérieure, Gabon
mveverilgeriel@gmail.com

OLANGHAMBO NDOBARI Nathanaël, Ecole Normale Supérieure, Gabon
nathanaellanghambondobari68@gmail.com

NDIAYE Ibrahima, Ecole Normale Supérieure, Gabon
ibrahimalatgrandn@gmail.com

NDONG MEGOME, Ecole Normale Supérieure, Gabon

NGNINGONE Isabelle, Université des Sciences et Techniques de Masuku, Gabon
neyi94@yahoo.fr

NGAISSOU Lhamma, University of Bamenda, Cameroon
lhammangaissouant@gmail.com

NANG Philibert, Ecole Normale Supérieure, Gabon
nang@ihes.fr

NTOSSUI OSSIMA Michel, Ecole Normale Supérieure, Gabon

NTSAME AFFANE Armelle, Ecole Normale Supérieure, Gabon

NZE wilfried, Ecole Normale Supérieure, Gabon

OBAME NGUEMA Maurice Saint Clair, Ecole Normale Supérieure, Gabon
obamemaurice77@yahoo.com

ONDZAGHE Yann Axel, Société des Brasseries du Gabon (SOBRAGA)

OLOUNGA Stéphane, Ecole Normale Supérieure, Gabon

PAMBO BELLO Kowir, Ecole Normale Supérieure, Gabon
kpambobello@gmail.com

PONCHO-KOTÉY Ephraim Nii Amon, University of Ghana, Ghana
Ephraim.poncho@aims.ac.rw

SANKARA Karim, Université Nazi Boni, Burkina Faso
sankara86@yahoo.fr

SEDJRO Cédric, Université des Sciences et Techniques de Masuku, Gabon

TANKEU Cyprien, Université de Yaoundé 1, Cameroon
cyprien.tankeu@facsciences-uy1.cm

TOUKOUROU Bouraïma, Ecole Normale Supérieure, Gabon

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- [University of Groningen](#), The Netherlands;
- [Université des Sciences et Techniques de Masuku \(USTM\)](#), Gabon;
- [École Normale Supérieure \(ENS\)](#), Gabon;

