

Algebraic Days of Gabon

ÉCOLE NORMALE SUPÉRIEURE

LIBREVILLE, GABON

DECEMBER 5-20, 2022

Coordinators

ARMANA Cécile, University of Franche-Comté, France

EZOME Tony, Université des Sciences et Techniques de Masuku, Franceville, Gabon

MAIRE Christian, University of Franche-Comté, France

OBAME Maurice, École Normale Supérieure, Libreville, Gabon



[website of the event](#)

The third edition of the ALGEBRAIC DAYS OF GABON will take place in École Normale Supérieure (ENS) in Libreville, Gabon, from December 5 to 20, 2022.

These days will consist of three activities:

- A **research school** on *Number Theory and Arithmetic Geometry* for master and PhD students, including students from École Normale Supérieure de Libreville as part of their initial training.
- A **one-day meeting on Women in Mathematics**, with a double perspective on research and teaching careers for women in mathematics.
- The **annual AFRIMath research conference** for 2022, organized by the node Number Theory and Information Theory. It will also include outreach presentations by a representant of the “Institut Pédagogique National du Gabon”, by Lara Thomas and Christian Maire in order to promote the profession of mathematics teacher towards pupils and young students in science.

	morning	afternoon
December 5		Research School
December 6		
December 7		
December 8		
December 9		
December 10	Women in Mathematics	
December 11		
December 12	Conference	
December 13		
December 14		
December 15		
December 16		
December 17		
December 18		
December 19		
December 20		

Research School

This school is intended for master and PhD students.

Although named research school, these courses are intended for students from École Normale Supérieure de Libreville and future teachers in mathematics, as part of their initial training and to help them gain sufficient perspective into the field they will be teaching.

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

The program consists of four courses:

- *Algebraic Number Theory* by Cécile Armana, University of Franche-Comté, France
- *Algebraic Geometry and Applications to Cryptography and Coding theory* by Tony Ezome, Université des Sciences et Techniques de Masuku, Gabon
- *The Geometry of Schemes* by Elisa Lorenzo Garcia, University of Neuchâtel, Switzerland
- *p-adic Fields and the Local-Global Principle* by Christian Maire, University of Franche-Comté, France

There will be also contributed talks of Maurice Obame, École Normale Supérieure, Libreville, Gabon.

There are also scheduled lecture sessions given by young researchers (YRL) on their work.

	9-10	10:30-11:30	2pm-3pm	3:30-4:30	4:45-5:30
December 5	Opening ceremony	TE	M. Obame		
December 6		M. Obame			
December 7	CA				YRL
December 8					YRL
December 9					YRL
December 15	CM	ELG			YRL
December 16					
December 17					
December 18					
December 19					

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.

The lectures will be accompanied by exercises sessions.

EZOME TONY

Algebraic Geometry and Applications to Cryptography and Coding theory

We will present:

- Affine and projective varieties,
- Elementary properties of curves,
- Riemann-Roch and Riemann-Hurwitz theorems,
- Algebraic curves of small genus,
- Basics on Cryptography and Coding Theory,
- Using algebraic curves for Cryptography and Coding.

The lectures will be accompanied by exercises sessions.

LORENZO GARCIA ELISA

The Geometry of Schemes

We will present:

- Affine schemes,
- Schemes,
- S -schemes,
- Reduce schemes,
- Arithmetic schemes,
- Projective schemes.

The lectures will be accompanied by many examples and exercises sessions.

MAIRE CHRISTIAN

p -adic Fields and the Local-Global Principle

We will present local/global aspects:

- p -adic valuation and completion of \mathbb{Q} ,
- analysis in \mathbb{Q}_p ,
- algebraic extensions of \mathbb{Q}_p ,
- Hilbert symbol, and Hasse-Minkowski Theorem.

Abstracts of the Young Research Lectures

BOUGOUENDJI LEBOUMA COPERNIC, Université des Sciences et Techniques de Masuku, Gabon

Finitude du groupe des classes d'idéaux.

L'objectif de cet exposé est d'introduire toutes les notions et les outils permettant de montrer que le groupe de classes d'un corps de nombres est fini.

CAMARA MOUSTAPHA, University Assane Seck of Ziguinchor, Sénégal

Points algébriques sur la septique de Fermat.

Notons F_7 la septique de Fermat, i.e., la courbe plane lisse de degré 7 d'équation projective

$$F_7 = \{(X, Y, Z) \in \mathbb{P}^2(\overline{\mathbb{Q}}) : X^7 + Y^7 + Z^7 = 0\}.$$

Nous donnons une description géométrique des points algébriques de degré au plus 14 sur \mathbb{Q} sur F_7 .

DJELLA JONATHAN, Université Assane Seck, Sénégal

Arithmetic functions and bad witnesses for a composite number.

The goal of this talk is to discuss two pseudo-prIMALITY tests: the Fermat test and the Galois test. These tests yield two arithmetic functions. For $n \geq 1$ an odd integer, the function $\mathbf{F}(n)$ gives the number of bad witnesses for the Fermat test, and the function $\mathbf{Gal}(n)$ gives the number of bad witnesses for the Galois test. We will see that the study of $F(n)$ and $\mathbf{Gal}(n)$ gives important informations about the reliability of both tests.

IBARA ROSLAN, Université Marien Ngouabi, République du Congo

Sur le groupe des classes de la clôture normale de $\mathbb{Q}(\sqrt[p]{n})$.

En théorie des nombres, le groupe de classes d'un corps de nombres K permet de mesurer la non principalité de l'anneau des entiers de K . C'est un groupe fini dont le nombre d'éléments est appelé le nombre de classes de K . En 1971, Taira Honda prouve que le nombre de classes de $\mathbb{Q}(\zeta_3, \sqrt[3]{n})$ est égal à h^2 ou $3h^2$ avec h le nombre de classes de $\mathbb{Q}(\sqrt[3]{n})$. Vers 2016, L.C. Washington propose une précision sur le résultat de Honda pour certaines valeurs de n . En 2020, René Schoof prouve l'énoncé de Washington dans un contexte plus général avec une étude de la structure galoisienne du groupe de classes de la clôture normale de $\mathbb{Q}(\sqrt[p]{n})$ pour p premier impair. Dans cet exposé, on présentera le résultat de René Schoof.

LOKOSSA ALDO SPERO, Université des Sciences et Techniques de Masuku, Gabon
Les corps de nombres de discriminant un entier d fixé.

L'objectif de cet exposé est d'introduire toutes les notions et les outils permettant de montrer que pour un entier d donné, il n'y a qu'un nombre fini de corps de nombres dont le discriminant est égal à d .

MIAYOKA BRICE, Université Marien Ngouabi, République du Congo
Méthodes des calculs de points rationnels sur les courbes algébriques de genre supérieur ou égal à 2.

Dans cet exposé nous présentons les méthodes de calculs des points rationnels sur les courbes algébriques genre au moins 2, nous nous spécialisons à la méthode du quotient et la méthode de Chabauty-Coleman.

PEKA MINGA SARIELLE, Université de Maroua, Cameroun
Elliptic curves and their isomorphisms.

Two elliptic curves can be transform into each other using rational functions and thus, these curves are said to be isomorphic. This isomorphism and its relation with the j -invariant of these curves will be studied over finite fields of characteristics 2, 3 and characteristic $\neq 2, 3$.

PONCHO-KOTEY EPHRAIM NII AMON, University of Ghana, Ghana
Advances made on the Function Field Sieve.

The function field Sieve is one of the efficient method in computing discrete logarithms especially in the field \mathbb{F}_q where $q = p^n$. The success of this algorithms relies on the number or linear relations with element from the factor base. It has been noticed that it is sometimes possible to find an automorphism which reduces the number of such linear relations and hence more efficient.

SANKARA KARIM, Université Nazi Boni, Burkina Faso
Some aspects of Class Field Theory.

In our talk, we first provide a detailed of main topics in algebraic number: algebraic number fields, rings of integers, Dedekind domain, ramification of primes, class group and Hilbert class field, which are fundamental notions of class field theory. We then develop the main concepts in class field theory, including valuations on a field, Frobenius automorphism and the Artin map, and also Artin reciprocity.

Women in Mathematics

The meeting on Women in Mathematics will take place on December 10, 2022.

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 Marthe Betoue Etoughe, ENS, Gabon and Cécile Armana, Université de Franche-Comté.

Women in Mathematics

Program

9:30-9:45 Welcome Session

9:50-10:10 NGNINGONE ISABELLE

Université des Sciences et Techniques de Masuku, Gabon

Presentation of the Gabonese Woman Mathematician Association
and my career as a mathematician

10:10-10:40 Coffee Break

10:40-11 OSSETE WINNIE

Université Marien Ngouabi, République du Congo

Presentation of the basic aspects of Tropical Geometry
and my young career as a mathematician

11:05-11:25 ROUGNANT MARINE

Université de Franche-Comté, France

11:30-11:55 OSSETE WINNIE MOUSSAVOU LYDIA

Lycée Raponda Walker de Port-Gentil, Gabon

Presentation of the devissages of groups
and my young career as a mathematician

12:00-1pm Round Tables

1-1:15 Conclusion

1:15-2 Lunch

AFRIMath Annual Conference

The annual AFRIMath research conference for 2022 is organized by the node Number Theory and Information Theory.

Although named research conference, there will be also four outreach presentations on December 14 afternoon by a representant of the “Institut Pédagogique National du Gabon”, Lara Thomas “*Danse tes mathématiques*” and Christian Maire “*Sur l’histoire du théorème de Fermat*”, in order to promote the profession of mathematics teacher towards pupils and young students in science.

Some lectures will be online.

	9-9:40	9:45-10:25	10:50 -11:30	11:35-12:15	2:15-2:55	3:00-3:40	4:00-4:40
Dec. 12	W. Ossete	D. Barry	A. Quéguiner	G. Massala	T. Ezome	C. Armana	
Dec. 13	C. Maire	E. Lorenzo	H. Soré	A. Boumanga	S. Nikiema	C. Tougma	O. Ogunfolu
Dec. 14	E. Fouotsa	J.Tindzogho	J. Bourgeois	Discussion	Representant of IPNG	L. Thomas	C. Maire

Abstracts of the lectures

ARMANA CÉCILE, Université de Franche-Comté, France

Sturm bounds for modular forms over function fields

Sturm bounds say how many successive Fourier coefficients are sufficient to determine a modular form of a given weight and level. I will present similar bounds for two types of modular forms over the rational function field $\mathbb{F}_q(t)$: Drinfeld modular forms and “Drinfeld-type” automorphic forms, and give an insight of their proofs. This is a joint work with Fu-Tsun Wei (National Tsing Hua University, Taiwan).

BARRY DEMBA, University of Bamako, Mali

Rationality of adjoint groups of type A.

Let F be a field of characteristic different from 2 and \mathbf{G} a connected linear algebraic group over F . Let X be the underlying variety of \mathbf{G} . The group \mathbf{G} is said to be F -stably rational if X is F -stably rational, that is, if there exist two affine spaces \mathbb{A}_F^n , \mathbb{A}_F^m and a birational map between $\mathbb{A}_F^m \times X$ and \mathbb{A}_F^n . In algebraic terms that means: let A be the F -algebra representing \mathbf{G} and $F(A)$ the field of fractions of A . The group \mathbf{G} is rational if and only if $F(A)$ is a purely transcendental extension of F . Using Merkurjev’s computation of the group of R -equivalence classes of adjoint classical groups and a construction of groups of type A from groups of type D, I will construct the first examples of groups of type ${}^2\mathbf{A}_n$ with $n \equiv 1 \pmod{4}$ ($n \geq 5$) that are not R -trivial, hence not rational (nor stably rational). This talk is based on a joint work with J-P. Tignol.

BOUMANGA BA ABDOULAYE, ArchiSec-IT, Gabon

Cryptographie et Sécurité de l’information sur le Web.

La démocratisation du réseau Internet a entraîné le développement d’applications indispensables pour l’activité humaine, on peut citer : la recherche scientifique, le commerce électronique, les réseaux sociaux, les échanges de mails, et bien d’autres encore. Toutes ces activités constituent aujourd’hui le Web, l’application d’Internet la plus puissante qui ait été créée, aussi bien que l’Internet lui doit sa popularité. La quasi-totalité du trafic sur le réseau internet s’effectue via le web. Étant donné l’importance et la sensibilité de l’information échangée sur le web, il est devenu indispensable de sécuriser l’infrastructure web. La Cryptographie s’est avérée depuis bien longtemps l’outil idéal pour sécuriser cette infrastructure Web. Depuis lors, de nombreux outils ou techniques cryptographiques ont été mis en place afin de répondre aux différents objectifs de la sécurité de l’information sur le web. Dans cet exposé nous allons d’abord pouvoir appréhender le fonctionnement de l’infrastructure web et ensuite comprendre comment la cryptographie est mise en œuvre pour assurer la sécurité de l’information sur le Web, tout en précisant leurs enjeux majeurs pour un gouvernement ou une organisation.

EZOME TONY, Université des Sciences et Techniques de Masuku, Gabon

On Finite field Arithmetic

In this talk, we are concerned with the complexity of the multiplication of two elements of a finite field extension $\mathbf{F}_{q^n}/\mathbf{F}_q$ given by their coordinates in a basis of \mathbf{F}_{q^n} over \mathbf{F}_q . We explain how to control this complexity in a normal basis of $\mathbf{F}_{q^n}/\mathbf{F}_q$ by using the arithmetic and geometry of algebraic curves. This is a joint work with Jean-Marc Couveignes.

FOUOTSA EMMANUEL, University of Bamenda, Cameroon

x -Superoptimal Pairings on Elliptic Curves with Embedding Degrees 13 and 19

We present a new variant of pairing suitable for the elliptic curves of embedding degrees 13 and 19. We develop methods and construct algorithms to efficiently evaluate and avoid heavy exponentiations that affect the efficiency of the superoptimal pairing on these curves leading to the definition of x -superoptimal pairing which is faster than the optimal ate pairing previously computed on these curves.

LORENZO GARCIA ELISA, University of Neuchâtel, Switzerland

Lower bounds on the maximal number of rational points on curves over finite fields

For a long time people have been interested in finding and constructing curves with many points. For genus 1 and genus 2 curves, we know how to construct curves over any finite field of defect less than 1 or 3 (respectively), i.e. with a number of points at distance at most 1 or 3 to the upper bound given by the Hasse-Weil-Serre bound. The case of genus 3 is still open after more than 40 years of research. In this talk I will take a different approach based on the random matrix theory of Katz-Sarnak to prove the existence for all $\epsilon > 0$ of curves of genus g over \mathbb{F}_q with more than $1 + q + (2g - \epsilon)\sqrt{q}$ points for q big enough. I will also discuss some explicit constructions as well as some consequences to the Serre obstruction problem (an asymmetric behaviour of the distribution of the trace of the Frobenius for curves of genus 3).

This is a joint work with J. Bergström, E. Howe and C. Ritzenthaler.

MAIRE CHRISTIAN, Université de Franche-Comté, France

On the root discriminant of a number field

The root discriminant rd_K of a number K is the normalization of the absolute of its discriminant. This talk aims to present classical properties of rd_K (such as low bounds), but also recent results.

MASSALA MBOYI GILLES YOWEL, Electromagnetic Application Technology Lab, Jeju National University, South Korea

Information Theory Application: Data Compression Based on Huffman Coding

Data compression is the process of encoding information using fewer bits than the original representation. In the computer science field, this operation has several advantages such as better management of storage capacity, speed up file transfer, network bandwidth optimization, etc. Data compression is achieved through a set of algorithms provided by information theory. The well-known Huffman code is commonly used for lossless data compression. It involves compressing data to reduce its size without losing any of the original information details. The purpose of this presentation is to highlight the theoretical concepts tied to Huffman coding and show some software used daily based on this algorithm.

NIKIEMA SALIFOU, Université de Ouahigouya, Burkina Faso

Hauteur des puissances d'un polynôme à coefficients entiers

La mesure de Mahler est multiplicative. Ainsi, pour tout polynôme à coefficients entiers P et tout entier positif n , on a $\mathbb{M}(P^n) = \mathbb{M}(P)^n$. La hauteur d'un polynôme à coefficients entiers ne possède pas cette propriété et le problème de la relation entre la hauteur d'un polynôme et de ses puissances se pose. Nous proposons de présenter deux conjectures qui résolvent le problème ainsi que des éléments de preuves de ces conjectures pour certaines classes de polynômes.

OGUNFOLU OLUSOLA, University of Ibadan, Nigeria

Counting Subgroups and Chains of Subgroups of a presentation group

A natural equivalent relation on the subgroup lattice associated with counting number of chains of subgroups of the group is used to obtain fuzzy subgroups of the presentation group.

OSSETE WINNIE, Université Marien Ngouabi, République du Congo

Calcul tropical et Cryptographie : Le Protocole de Stickel

Soient G un groupe public fini non abélien et $a, b \in G$ deux éléments publics tel que $ab \neq b$. Le protocole d'échange de clé se déroule comme suit :

Soient N et M les ordres respectifs de a et b

1. Alice choisit de deux nombres naturels aléatoires $n < N$, $m < M$ envoie $u = a^n b^m$ à Bob.

2. Bob choisit de deux nombres naturels aléatoires $r < N$, $s < M$ envoie $v = a^r b^s$ à Bob.
3. Alice calcule $K_A = a^n v b^m = a^{n+r} b^{m+s}$.
4. Bob calcule $K_B = a^r u b^s = a^{n+r} b^{m+s}$.

Ainsi, Alice et Bob se retrouvent avec le même élément de groupe $K_A = K_B$ qui peut servir de clé secrète partagée.

Notons cependant que pour que ce protocole fonctionne, G peut être un semi groupe. Le but de cet exposé est de présenter la version tropicale de ce protocole en utilisant l'analogue du calcul matriciel dans le monde tropical. À noter qu'il s'agit d'un exposé de vulgarisation des Mathématiques Tropicales.

QUEGUINER-MATHIEU ANNE, Université Paris 13, France

Quadratic forms, algebraic groups and motivic equivalence

Two quadratic forms are called motivic equivalent if the corresponding projective quadrics have isomorphic motives. Vishik gave a purely algebraic characterization of motivic equivalence. His result shows that the motif of a quadric encodes splitting properties of the underlying quadratic form. In this talk, we will explain how this extends to algebraic groups.

SORÉ HERMANN, Nazi Boni University, Burkina Faso

On a Quillen adjunction between the categories of differential graded and simplicial coalgebras.

We prove that the normalization functor of the Dold-Kan correspondence does not induce a Quillen equivalence between Goerss' model category of simplicial coalgebras and Getzler-Goerss' model category of differential graded coalgebras.

TOUGMA CHARLES WEND-WAOGA, Université Thomas Sankara, Burkina Faso

On real biquadratic Pólya fields.

Let K be a number field. The Pólya field concept is used to know when the module of integer-valued polynomials over the ring of integers \mathcal{O}_K of K has a regular basis. The complex biquadratic Pólya fields were characterized by Zantema which formalized the Pólya's property on numbers fields, while the study of real fields is not complete. However one can prove that there are at most five ramified prime numbers in such fields. The aim of our talk is to present the results on fields with at most three ramified prime numbers. They provide natural generalizations of recent works on the subject. In particular, they allow us to identify some fields omitted on related questions in the literature. On the other hand, these results are related to some diophantine equations studied by Dirichlet for which, we present new extensions.

TINDZOGHO JULES, Université des Sciences et Techniques de Masuku, Gabon
Anneaux de Lie rangés et la question de classification.

Groups of finite Morley rank are objects of a category of groups that generalize that of algebraic groups over an algebraically closed field. Cherlin-Zilber Conjecture states that the infinite and simple ones are algebraic. Since its formulation, works on finite Morley rank structures have been focused on groups so that less is known about rings with finite Morley rank. In this talk we present some results and questions that could be treated in the immediate future.

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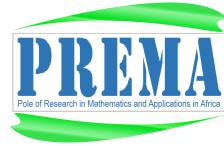
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- CIMPA, Centre International de Mathématiques Pures et Appliquées, France
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