Barcelona-Boston-Tokyo number theory seminar in memory of Fumiyuki Momose

21-23 May of 2012, Barcelona

Oragnizers:

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Joan-C. Lario   Tsutomu Sekiguchi

Contents

1 A trilingual preface

Benvolguts col·legues,

Jo no conec molt de la vida de **Fumiyuki Momose**. Però sé completament del cert per quines raons un dia vaig decidir impulsar l'organització d'aquesta trobada en honor seu. I això és el que us vull explicar ara.

Vaig conèixer Fumiyuki Momose l'any 1993 a **Boston**. Jo estava fent una estada al departament de matemàtiques de la Universitat de Harvard. Després d'uns quants mesos em van demanar d'intervenir en el seminari de Teoria de Nombres que es reunia setmanalment cada dimecres a la tarda. Em va semblar que el més natural que podia fer era explicar el que havia estat fent durant tot aquell temps en aquell ambient tan formidable.

Quan vaig acabar la meva xerrada, hi va haver un torn d'intervencions, totes elles positives i suggerents, especialment una del Noam Elkies. Quan ja sortíem tots de la sala on fèiem el seminari, se'm va apropar en Fumiyuki Momose, que feia temps que també s'estava pel departament, però fins al moment no havíem tingut l'oportunitat de conèixer-nos.

Les seves primeres paraules van ser: "Això que has explicat ho vaig fer fa 7 anys i està publicat. Vine amb mi que et convido a sopar". Quina sorpresa!!! La seva reacció positiva i oberta contrastava molt fortament amb el que jo estava habituat. En lloc d'enuig per part seva, vaig copsar alegria i comprensió.

Fumiyuki Momose va anar més lluny. Allò passava un mes de juny, poc abans del primer anunci d'Andrew Wiles de la demostració del Darrer Teorema de Fermat. Tres mesos després, ja de tornada als nostres respectius països, vaig rebre un email de Momose convidant-me a passar un any a la seva universitat de Chuo a **Tokyo**. Vaig passar-hi 3 mesos, i Momose va fer que allí em sentís com a casa.

Des d'aquella ocasió, vam mantenir una molt bona relació amb diverses anades i vingudes entre Barcelona i Tokyo per estades curtes, tant per part meva com per part seva.

Finalment, Momose havia decidit de venir a fer una estada llarga sabàtica a **Barcelona**. Tots els preparatius estaven a punt, ja teníem el seu allotjament preparat. I llavors va arribar la malaltia i es va haver de suspendre l'estada a Barcelona.

Puc dir amb tota sinceritat que aquella manera seva de reaccionar davant la meva xerrada en aquell seminari va provocar un canvi en la meva manera de veure les coses, d'entendre la ciència i la vida. Durant molt de temps jo m'havia estat preguntant que era el més important en Teoria de Nombres, si bé la teoria o bé els nombres. Gràcies a Momose ara sé la resposta. El més important en Teoria de Nombres som les persones.

Joan-C. Lario,
10 d'abril de 2012, Barcelona.

拝啓、皆様

私は百瀬文之氏がどのような人生を歩んだかは知りません。しかし、私はなぜある日、私自身が彼に敬意を表してこのような講演を企画することに至ったか理解することができます。本日はそのことについて、私がこの場でみなさんにお話したいと思います。

それはまだ私がハーバード大学で数学を学んでいた１９９３年のことでした。当時、私は毎週水曜日の午後に開かれる数論のセミナーに参加させてもらっていました。私にとってその真剣な雰囲気の中で出来た事と言いえば私が普段研究している内容を説明するくらいでした。

私が話を終えたとき、前向きで考え深い質問やコメントをNoam Elkies氏をはじめとする方々からいくつか頂きました。私たちがセミナールームから出たとき、百瀬文之氏が私のところにやってきました。ちょうどその頃彼もハーバードを訪れていましたが、それまで私たちは直接会う機会がありませんでした。

彼が最初に私にかけた言葉が："あなたが言ったことは、もう７年前に私が発表しました。"私が大変驚いたことに、彼の前向きでオープンな態度は私が慣れていた昔の彼とは異なるものでした。怒りを感じる代わりに、私は喜びを感じ、理解することができました。

百瀬氏はさらに言いました。先ほど私が言った１９９３年６月の出来事は、Andrew Wiles氏の初の発表の少し前の事でした．三ヶ月後にお互い帰国いしたのちに、私は彼から東京にあり、彼のいる中央大学に1年間来ないかというお誘いを頂きました。私は中央大学で３ヶ月過ごし、彼のおかげでまるで故郷のようにいるような素晴らしい生活を過ごすことができました。

その頃より、私たちはバルセロナと東京をお互いが行き来し、親密な関係を築いております。

ついに百瀬氏が長期休暇のためにバルセロナにくる事を決心されました。彼の宿泊先など、滞在中に必要な準備は全て整っています。しかし、彼が病にかかってしまったことでバルセロナでの滞在は中止にせざるを得なくなってしまいました。

私が率直に思う事は、１９９３年のセミナーで話をさせて頂いた時、彼の態度が私のものの見方や、科学や人生に対する見方を変えてくれました。私は長い間、数論のなかで理論と数字のどちらがより大切な要素であるのか考えてきましたが、百瀬氏のおかげで、その答えはそのどちらでもなく、最も大切な要素は人々なのであると分かりました。

Joan-C. Lario.

Dear Colleagues,

I do not know much about **Fumiyuki Momose**'s life. But what I know are the true reasons why one day I decided to promote the organization of this seminar in his honor. And that is what I would like to tell you now.

I met Fumiyuki Momose in 1993 in **Boston**. That year I was doing a stay at the Mathematics Department of the Harvard University. After a few months there I was asked to give a talk in the Number Theory Seminar that meets weekly every Wednesday afternoon. It seemed to me that the more natural thing to do was to explain what I had been doing during my stay in that formidable atmosphere.

When I finished my talk, there were a number of questions and comments. They were all positive and suggestive, especially one by Noam Elkies. When we went out of the room of the seminar, Fumiyuki Momose approached to me. At that time he was also visiting the department but so far we had not have any opportunity to meet.

His first words were: "I did what you have told 7 years ago and it is already published. Come with me to have dinner." That was a surprise to me! His positive and open reaction strongly contrasted with what I was used to. Instead of getting angry on his part, I saw joy and understanding.

Fumiyuki Momose went even further. What I just told you happened in June 1993, shortly before the first announcement of Andrew Wiles of a proof of Fermat's Last Theorem. Three months later, back into our respective countries, I received an email where Momose invited me to spend a year at the Chuo University in **Tokyo**. I spent 3 months there, and I felt at home thanks to Momose.

Since that time, we had a very good relationship with various comings and goings between Barcelona and Tokyo for short stays, for his and my part.

Finally, Momose had decided to come for a long sabbatical year in **Barcelona**. All preparations were ready; his accommodation was already set. And then he received the news about his illness and we had to abort his stay in Barcelona.

With no doubt his reaction to my talk in 1993 led to a deep change in the way I see things now, and in the way I understand science and life. For a long time, I had been wondering what is more important in number theory, either the theory or the numbers. Thanks to Momose, now I know the answer. The most important in number theory is the people.

Joan-C. Lario.

2 Conference building

The talks will take place at *Facultat de Matemàtiques i Estadística* of *Universitat Politècnica de Catalunya*. The address of the building is

C/ Pau Gargallo, 5
08028 Barcelona.

The building is within a walking distance from *Torre Girona Residence Hall*. To come from the *Residence of researchers* in *La Rambla* (or from Downtown, in general) take the metro green line (line 3) and stop at *Palau Reial*. Coming from Dowtown takes around 25 minutes.

The room of the talks will be *Sala d'actes*. The way from the entrance of the building to the room of the talks will be appropriately indicated with signs.

3 Schedule

9:00-9:30	Registration		
9:30-10:20	P. Parent	A. Tamagawa	K.S. Kedlaya
10:30-11:00	Coffee break		
11:00-11:50	K. Arai	T. Sekiguchi	M. Shimura
12:00-12:50	K. Murty*	V. Rotger	A.V. Sutherland
13:00-15:00	Lunch		
15:00-15:50	K. Hashimoto	M. Masdeu	T. Iijima
16:00-16:15	Coffee break		
16:20-16:50	X. Ros	C. Castaño-Bernard	J. Fernàndez*
17:00-17:30	C. Vera		F. Bars

19:00-20:00	Sagrada Família
20:30-22:30	Conference dinner

4 Talks

Keisuke Arai
Title: Algebraic points on Shimura curves of $\Gamma_0(p)$-type.
Abstract: We classify the characters associated to algebraic points on Shimura curves of $\Gamma_0(p)$-type, and over number fields (not only quadratic fields but also fields of higher degree) we show that there are few points on such a Shimura curve for every sufficiently large prime number p. This is an analogue of the study of rational points or points over quadratic fields on the modular curve $X_0(p)$ by Mazur and Momose.

Francesc Bars
Title: Momose and bielliptic modular curves.
Abstract: A non-singular projective curve C of genus ≥ 2 is named bielliptic if it admits a degree two map to an elliptic curve. Bielliptic curves over a number field have arithmetical interest because they have a non-finite number of quadratic points over some number field. The speaker began the work to list all the modular curves $X_0(N)$ which are bielliptic, and this work was extended for

other classical modular curves as $X_1(N)$ $X(N)$,... by corean mathematicians. The work of Momose on the group of automorphism for the above classical modular curves helps to complete the list of which classical modular curves are bielliptic. In the talk we will explain the main ideas and results to obtain the exact list of classical modular curves which are bielliptic and we will emphatize the points where we use the work of Momose on automorphisms groups on modular curves.

Carlos Castaño-Bernard
Title: On the Heegner index of an elliptic curve over $\mathbb{Q}$.
Abstract: In this talk we discuss an approach to study the refined version of the conjecture of Birch and Swinnerton-Dyer for E of rank one over $\mathbb{Q}$. Our approach is based on a result of Gross, Kohnen and Zagier that says that this conjecture is essentially equivalent to $[E(\mathbb{Q}) : \mathbb{Z}P]^2 = c_E \cdot n_E \cdot m_E \cdot |(E)|$, where (E) is the Tate-Šafarevič group of E, c_E is Manin's constant, P is the trace of a Heegner point with minimal height, n_E is the index of the canonical subgroup of $H_1(E(\mathbb{C}), \mathbb{Z})^-$, and m_E is the product of the Tamagawa numbers $c_p = |\Phi_{E,p}(_p)|$, where $\Phi_{E,p}$ denotes the component group of E at p, and p runs through the set of *finite* primes p. So it seems natural to ask whether the "missing" component group $\Phi_{E,\infty} = E(\mathbb{R})/E(\mathbb{R})^0$ of E at $p = \infty$ encodes information related in some way to the index $[E(\mathbb{Q}) : \mathbb{Z}P]$. So let us consider the canonical map $\phi_{E,\infty} : E(\mathbb{Q}) \longrightarrow \Phi_{E,\infty}$, and let $n_{E,p} = p^\alpha$, where $p^\alpha || n_E$ with p prime. We conjecture that if E is an elliptic curve of rank one and prime conductor N, then $n_{E,2} = 2^\alpha$, where $\alpha \in \{0, 2\}$ and, moreover,

$$n_{E,2} = \begin{cases} |\operatorname{coker} \phi_{E,\infty}|^2, & \text{if } (E)[2] \text{ is trivial,} \\ \\ |(E)[2]|, & \text{otherwise.} \end{cases}$$

We discuss an approach to study this conjecture which involves the intersection numbers of $X_0^+(N)(\mathbb{R})$ (which may be regarded as a generalised Heegner geodesic cycle, certainly in $H_1(X_0^+(N)(\mathbb{C}), \mathbb{Z})^+$) with the Heegner geodesic cycles in $H_1(X_0^+(N)(\mathbb{C}), \mathbb{Z})^-$. (The latter cycles yield the canonical subgroup of $H_1(E(\mathbb{C}), \mathbb{Z})^-$ via the modular parametrisation.) Here $X_0^+(N)$ is the Atkin-Lehner quotient $X_0^+(N) = X_0(N)/w_N$ of the modular curve $X_0(N)$, and the superindex in homology denotes the ± 1-eigenspace with respect to the action induced by complex conjugation.

Julio Fernàndez
Title: TBA.
Abstract: TBA.

Kiichiro Hashimoto
Title: Genus two lifts of $\mathbb{Q}$-curves whose jacobians have $\sqrt{-2}$ multiplication over $\mathbb{Q}$.
Abstract: An elliptic curve E defined over a number field K is called a $\mathbb{Q}$-curve if for each $\sigma \in \mathrm{Gal}(\bar{\mathbb{Q}}/\mathbb{Q})$, there exists an isogeny $\phi_\sigma : E \longrightarrow {}^\sigma E$. A $\mathbb{Q}$-curve E is of degree d if

$$d = \min\{\deg(\phi_\sigma) : \phi_\sigma : E \longrightarrow {}^\sigma E, id \neq \sigma \in \mathrm{Aut}(K/\mathbb{Q})\}.$$

In 1995, F.Momose gave us the following problems on $\mathbb{Q}$-curves over a quadratic field K:

- (i) When is $\mathrm{Res}_{K/\mathbb{Q}}(E)$ of GL_2-type ?
- (ii) Find as many E/K as possible satisfying (i).
- (iii) For each E/K of (ii), find a genus two curve C over $\mathbb{Q}$ such that $\mathrm{Jac}(C)$ is $\mathbb{Q}$-isogenous to $\mathrm{Res}_{K/\mathbb{Q}}(E)$.

We shall discuss these problems for $\mathbb{Q}$-curves of degree $d = 2$. If K is a quadratic field and the non-trivial $\phi := \phi_\sigma$ is defined over K, then E is called minimal; called ε-minimal if ${}^\sigma\phi\circ\phi = \varepsilon d \cdot 1$ ($\varepsilon = \pm 1$). Then the answer to (i) is now well known : $\mathrm{Res}_{K/\mathbb{Q}}(E)$ is of GL_2-type iff it is minimal. On the other hand, it seems that problems (ii) and (iii) are not fully studied, especially for those of (-1)-minimal $\mathbb{Q}$-curves.

Another way of looking at the problem (iii) for (-1)-minimal $\mathbb{Q}$-curves, through the modularity conjecture proved by Khare et.al., is stated as follows.

- (iii)' For each normalized Hecke eigenform $f \in S_2\left(N, \left(\frac{N}{\cdot}\right)\right)$ with $K_f = \mathbb{Q}(a_n,\, n \in \mathbb{N}) = \mathbb{Q}(\sqrt{-2})$, find a genus two curve C over $\mathbb{Q}$ such that $\mathrm{Jac}(C)$ is $\mathbb{Q}$-isogenous to A_f, Shimura's abelian surface.

We shall also discuss the problem of constructing an algebraic correspondence on C defined over $\mathbb{Q}$ which induces the endomorphism $\sqrt{-2}$ on $\mathrm{Jac}(C)$.

Example($N = 24$) The hyperelliptic curve

$$C : y^2 = (x^2 - 6x + 6)(x^4 - 6x^3 + 18x^2 - 36x + 36)$$

is corresponding to the normalized Hecke eigenform f in $S_2\left(24, \left(\frac{24}{\cdot}\right)\right)$ whose first few Fourier coefficients are

a_2	a_3	a_5	a_7	a_{11}	a_{13}	a_{17}	a_{19}
$-a$	$a-1$	0	0	$-2a$	0	$4a$	2

with $a = \sqrt{-2}$. The curve C covers the elliptic curve E_f,

$$y^2 + \sqrt{6}xy + 1 + \sqrt{6}y = x^3 + 1 - \sqrt{6}x^2 - 3\sqrt{6} + 1x - 1 - 2\sqrt{6}$$

attached to f, which is obtained by Cremona, and $\mathrm{Jac}(C)$ is isogenous to $E_f \times {}^\sigma E_f$. The algebraic correspondence T of the curve C given by

$$\mathrm{T} = \{(x, y), (u, w) \in C \times C :\ A(x, u) = 0,\ B(w, y, x, u) = 0\},$$

$$\begin{aligned} A(x,u) =& 3(12 - 6x + x^2) - 3u(6 - 4x + x^2) + u^2(3 - 3x + x^2), \\ B(w,y,x,u) =& wx^2(-144 + 108u - 18u^2 + 36x - 24ux + u^3x) \\ & - (6 - 6u + u^2)(12 - 6u + u^2)^2 y \end{aligned}$$

gives a map T on $\mathrm{Div}(C)$,

$$(u, v) \mapsto (x_1, y_1) + (x_2, y_2), \quad ((u, v), (x_i, y_i)) \in T$$

which induces an endomorphism $\mathrm{T}^2 = (-2)id$ on $\mathrm{Pic}^0(C)$.

Tsutomu Iijima
Title: Classification of covering curves of hyperelliptic curves over extension fields: odd characteristics.
Abstract: The GHS attack or cover attack is known as a method to map the discrete logarithm problem (DLP) in the Jacobian of a curve C_0 defined over the d degree extension k_d of a finite field k, to the DLP in the Jacobian of a covering curve C of C_0 over k. In this talk, we present a classification of cryptographically used elliptic and hyperelliptic curves C_0/k_d in odd characteristic case which can be attacked by the GHS attack. Our main approach is to use representation of the extension of $\mathrm{Gal}(k_d/k)$ acting on covering group $\mathrm{cov}(C/\mathbb{P}^1)$. We classify genus 1,2,3 hyperelliptic curves C_0/k_d which possess $(2, 2, .., 2)$-coverings. Explicit defining equations of such curves C_0/k_d and existential conditions of a model of C over k are also discussed.

Kiran S. Kedlaya
Title: Sato-Tate groups of abelian varieties.
Abstract: We propose a definition of the algebraic Sato-Tate group and the Sato-Tate group associated to an abelian variety, in terms of which one may properly formulate the equidistribution conjecture that generalizes the classic Sato-Tate conjecture for elliptic curves. The connected parts of these groups are determined by the Mumford-Tate group, but the component groups encode additional arithmetic information. We also enumerate some group-theoretic properties implied by the definition of these groups (the "Sato-Tate axioms"), which can be used to classify Sato-Tate groups of abelian varieties of dimension at most 3. This includes joint work with Banaszak and also joint work with Fité, Rotger, and Sutherland.

Marc Masdeu
Title: Explicit computations with ATR points.
Abstract: In his book on rational points on modular elliptic curves, Henri Darmon gives a construction of a supply of algebraic points predicted by the Birch and Swinnerton-Dyer conjecture, in cases where the Heegner point construction does not work. One of these cases arises with "Almost Totally Real" (ATR) extensions, and Darmon and Logan gathered some numerical evidence supporting the conjecture. However, all the curves for which they construct algebraic points are isogenous to to their Galois conjugates, and in that situation one might hope for a variation of the Heegner point construction to still work.

In a joint project with Xavier Guitart (UPC) we improve the algorithm used by Darmon and Logan in order to provide more numerical evidence in support of Darmon's conjecture. In particular, we find approximations to algebraic points on curves for which no other construction is available, not even conjecturally. In the talk I will describe the problems that one faces when computing these points, and how we have overcome them.

Kumar Murty
Title: TBA.
Abstract: TBA.

Pierre Parent
Title: Rational points of $X_0^+(p^r)$ for all primes.
Abstract: In a series of papers (Compositio Math. 1984, . J. Fac. Sci. Univ. Tokyo 1986, Nagoya Math. J. 2002), and motivated by some expected consequences on the arithmetic of elliptic curves, F. Momose tackled the question of rational points on the quotient modular curves $X_0^+(p^r)$, for $r > 1$ and p a prime number. In joint works with Yu. Bilu we proved recently, by adding analytic tools to Momose's ideas, that, as desired, those sets of rational points are only made of CM points, at least for p larger than some very large bound. Finally, the case of (not so) small primes was settled by the same authors and M. Rebolledo, by using still another algorithmic approach, thereby completing a positive answer to Momose's question (to the single exception of $p^r = 132$). We will try to sketch those proofs in our talk.

Xavi Ros
Title: On a factorization of Riemann's ζ function with respect to a quadratic field and its computation.
Abstract: Let K be a quadratic field, and let ζ_K its Dedekind zeta function. In this talk we introduce a factorization of ζ_K into two functions, L_1 and L_2, defined as partial Euler products of ζ_K, which lead to a factorization of Riemann's ζ function into two functions, p_1 and p_2. We prove that these functions satisfy a functional equation which has a unique solution, and we give series of very fast convergence to them. Moreover, when $\Delta_K > 0$ the general term of these series at even positive integers is calculated explicitly in terms of generalized Bernoulli numbers.

Victor Rotger
Title: A p-adic Gross-Zagier formula for diagonal cycles.
Abstract: The conjectures of Birch and Swinnerton-Dyer, as generalized by Bloch, Kato and Beilinson, predict that the vanishing of the L-series of a motive at a critical point should be explained by the presence of rational algebraic null-homologous cycles. When the L-series has a simple zero, this expectation is made explicit through a (often conjectural) Gross-Zagier formula which relates the height of a canonical cycle to the first derivative at the critical point. These formulae tend to admit a p-adic avatar which is particularly useful for arithmetic applications: one expects that the image of the cycle under the p-adic Abel-Jacobi map can be recovered as the value of the p-adic L-function of the motive at a point outside the region of interpolation. We shall describe one instance of this philosophy, that we have worked out in detail in collaboration with Henri Darmon.

Tsutomu Sekiguchi
Title: On the cyclotomic twisted torus and some torsors.
Abstract: This is joint work with my graduate students Y. Koide and Y. Toda. For a cyclic extension K/k of degree n with Galois group G, the subgroup scheme $\mathcal{T}(n)_k$ of the Weil restriction $\prod_{K/k} \mathbb{G}_{m,K}$ given by the intersection of whole kernels of norm maps is interesting for cryptography. On the other hand, let ζ be a primitive n-th root of unity, and $I \in \mathrm{GL}_m(\mathbb{Z})$ be the representation matrix of the multiplication ζ on $\mathbb{Z}[\zeta]$, where $m = \phi(n)$. Then by using the

matrix I, we can define an action of G on $\mathbb{G}_{m,K}^m$, and we can descent this group scheme to the one $\mathbb{G}(n)_k$ over k, which we call a cyclotomic twisted torus. Then we can prove that $\mathbb{G}(n)_k$ and $\mathcal{T}(n)_k$ are isomorphic canonically, and these have a resolution consisting of Weil restrictions of tori and norm maps. Moreover, we would like to discuss about torsors for some kind of finite group schemes by using the above cyclotomic twisted tori.

Mahoro Shimura
Title: Hyperelliptic curve cryptosystems are based on the discrete logarithm problem (DLP) of hyperelliptic curves defined over finite fields.
Abstract: Let k be a finite field, and let k_d be its extension field of degree d. If an hyperelliptic curve C_0 defined over k_d has a covering curve C defined over k, we can transfer the DLP of $J(C_0)$ into the DLP of $J(C)$ ($J(C)$ is the Jacobian variety of C). When the latter is easier than former, this attack (so-called GHS attack) works and we call C_0 is a weak curve. In this talk, we present a classification of hyperelliptic curves defined over k_d with even characteristic, which have $(2, 2, ...2)$-coverings over k therefore can be attacked by GHS attack. In particular, we show the density of the weak curves in the case that C_0 are elliptic curves. When the degree of k over $\mathbf{F}_2$ is even, the density of weak curves is about $3/4$, and when the degree is odd, the density is about a half. Therefore the even characteristic case has more weak curves than the odd characteristic case.

Andrew V. Sutherland
Title: Computing Sato-Tate distributions of low genus curves.
Abstract: The generalized Sato-Tate conjecture predicts that the distribution of normalized Euler factors of an abelian variety A of dimension g converges to the distribution of characteristic polynomials in a certain compact Lie group ST_A (the Sato-Tate group of A) that is subgroup of $\mathrm{USp}(2g)$ (the group of $2g \times 2g$ complex matrices that are both unitary and symplectic). We have developed a suite of computational tools to very efficiently compute, in the case that A is the Jacobian of a curve of genus $g \leq 2$, statistics that allow one to to provisionally determine ST_A, as well as techniques for then proving that this provisional identification is correct. In this talk I will describe some of these tools, which played a key role in the recently completed classification of the 52 Sato-Tate groups that arise in genus 2. Time permitting, I will also discuss the prospects in genus 3, where some preliminary work has begun. This is joint work with Francesc Fité, Victor Rotger, and Kiran Kedlaya.

Akio Tamagawa
Title: Uniform boundedness and arithmetic fundamental groups.
Abstract: TBA.

Carlos de Vera
Title: Galois representations attached to points on Shimura curves.
Abstract: In this talk I will explain a method to study rational points over a number field K on a coarse moduli space X of abelian varieties with endomorphism structure, especially in the case where the moduli problem is not fine and points in $X(K)$ may not be represented by an abelian variety admitting a

model rational over K. The main idea, inspired on the work of Ellenberg and Skinner on the modularity of $\mathbb{Q}$-curves, is that we can attach certain Galois representations to points in $X(K)$ rather than to the abelian varieties representing them.

This method can be applied to extend some results of Jordan (1986) and Skorobogatov (2005) on the non-existence of rational points on Shimura curves over imaginary quadratic fields, obtaining new counterexamples to the Hasse principle that are accounted for by the Brauer-Manin obstruction. It can also be applied to produce examples of Atkin-Lehner quotients of Shimura curves violating the Hasse principle over $\mathbb{Q}$. This is joint work with V. Rotger.

5 Internet

There are two options for the access to the internet. If you bring your own labtop, you can use the network "XSF-UPC" as a guest. Use the option "convidat/guest" when asked for a password.

We have also booked the computer rooms:

PC1	Monday 21st from 8:00 to 14:00
PC3	Tuesday 22nd from 11:00 to 18:00
PC3	Wednesday from 8:00 to 18:00

To use the computers enter the username "BBTNTS" and the password "bcn2012".

6 Lunch on campus

We recommend two options for lunch on Campus:

- *Buffet of the Physics and Chemistry School* (Av. Diagonal, 647).
- *Restaurant vegetarià La Riera*, (C/Regent Mendieta, 15).

The first option is a buffet with several choices. A room has been booked for the participants in the conference. The price is 8.45 euros and it is 3 minutes away from the Conference Building.

The second option is a vegetarian restaurant (with a veagan option). The menu costs 9 euros and there is a nice walk of 15 minutes from the Conference Building.

We will leave in two groups after the last talk in the morning.

7 Social events

We have organized two social events for the meeting on Wednesday 23rd:

- A guided visit to *Sagrada Família* from 19:00 until 20:00.
- A dinner at *Restaurant Bistronou* (C/Aribau, 106) at 20:30.

The price for the guided visit is 20 euros and the price for the dinner is 40 euros. The dinner will include a vegetarian option. You can decide to register to any of them. The payment will be done during the Registration on Monday 21st at 9:00 only in **cash**.

There will be a bus leaving at 18:00 from the Conference Building. The same bus will take us from *Sagrada Família* to *Restaurant Bistronou*.

8 List of participants

Montserrat Alsina (Universitat Politècnica de Catalunya)
Samuele Anni (Universiteit Leiden and Université Bordeaux 1)
Keisuke Arai (Tokyo Denki University)
Francesc Bars (Universitat Autònoma de Barcelona)
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