



# MAT 311

## Number Theory

HOME	COURSE DESCRIPTION	HOMEWORK	PROJECTS	GRADE	
LINKS					

### Instructor:

[Sorin Popescu](#) (office: Math 3-109, tel. 632-8255, e-mail [sorin at math.sunysb.edu](mailto:sorin@math.sunysb.edu))

### Grader:

Luis E Lopez (office: Math 2-122, e-mail [llopez at math.sunysb.edu](mailto:llopez@math.sunysb.edu))

### Schedule:

TuTh 02:20pm-03:40pm, Chemistry 126

**Review session:** Friday, May 14, 3-4:30pm in Math P-131

**Final exam:** Tuesday, May 18, 2-4:30pm in Physics P-117

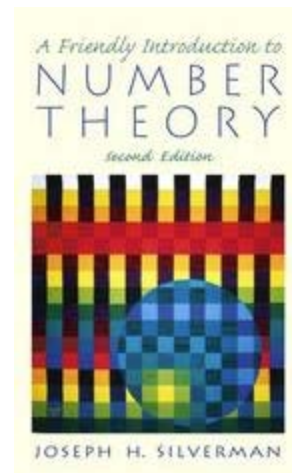
### Prerequisites:

Either **MAT 312** (Applied algebra), or **MAT 313** (Abstract Algebra) or **MAT 318** (Classical Algebra) are mandatory prerequisites for this class. In general basic algebra exposure is required and assumed, but I will try to keep prerequisites to a minimum.

### Textbook(s):

*A Friendly Introduction to Number Theory*, J.H. Silverman, (second edition), Prentice Hall.

This is indeed a nice textbook covering a number of elementary topics in number theory. The book includes a good deal of numerical examples, which are analyzed for patterns and used to make "conjectures". Various other chapters provide brief but insightful and motivating excursions into topics like Mersenne Primes, number sieves, RSA cryptography, elliptic curves, etc. There are many other excellent undergraduate books on the subject. Here is a sample (all of them available in our library):



- *Elementary Number Theory and Its Applications*, by Kenneth Rosen, (fourth edition)
- *An Introduction to the Number Theory*, H.M. Stark

- *Number Theory*, G.E. Andrews
- [Introduction to Analytic Number Theory](#), T.M. Apostol
- *Lectures on Number Theory*, P.G.L. Dirichlet with supplements by R. Dedekind
- *The higher arithmetic*, H. Davenport
- [An Introduction to the Theory of Numbers](#), I. Niven and H.S. Zuckerman
- *A Classical Introduction to Modern Number Theory*, K. Ireland and M. Rosen
- *Fundamentals of Number Theory*, W.J. LeVeque
- [Number theory with computer applications](#), R. Kumanduri and C. Romero

These are a mixture of classical texts (for example Dirichlet), modern efforts, more elementary (for example, Kumanduri and Romero) and more advanced (for example, Rosen or Ireland and Rosen), algebraic (for example, Andrews) or analytic approaches (for example, Apostol). This course will concentrate only on elementary algebraic number theory, and applications.

### Course description:

We will cover only part of the textbook and the following schedule may/will be adjusted based on students' preparation and progress.

Topic	Sections in textbook	Week	Notes
Overview / Introduction / Review	Chapter 1	1/26-1/30	
Pythagorean Triples / Sums of Higher Powers	Chapters 2,3,4	2/2-2/6	
Divisibility, Euclidean algorithm, Fundamental theorem of arithmetic	Chapters 5, 7	2/9-2/13	
Linear Diophantine equations / Congruences	Chapters 6, 8	2/16-2/20	
Fermat's little theorem / Euler's Formula	Chapter 9,10	2/23-2/27	
Multiplicative functions	Chapter 11, 19	3/1-3/5	First project due 3/4
Prime numbers	Chapter 12,13,14	3/8-3/12	Midterm 3/11
Powers modulo m	Chapter	3/15-	

	16,17	3/19	
Public key cryptography	Chapter 18	3/22-3/26	
Primitive roots	Chapter 20, 21	3/29-4/2	
Quadratic residues	Chapter 22, 21, 23, 24	4/12-4/16	
Sums of squares	Chapter 25, 26	4/19-4/23	Second project due 4/22
Primality testing	Chapter 32	4/26-4/30	
Cubic curves and elliptic curves	Chapter 40	5/3-5/7	Final exam 5/18, 2-4:30

### Projects, Homework & Grading:

Homework and projects (TBA) are an integral part of the course. Problems marked with an asterisk (\*) are for extra credit. In addition to homework you will be required to hand in 2 research/scholarship/computing projects. Projects with a nontrivial writing component may be used to satisfy the Mathematics Upper Division Writing Requirement.

Your grade will be based on the weekly homeworks (20%), two projects (15% each), midterm (20%), and the final exam (30%). The two lowest homework grades will be dropped before calculating the average.

- [Homework assignments](#)
- [Projects](#)

### Links:

The following is a short list of web sites devoted to number theory or number theoretic related topics relevant for our class:

- [An On-Line Encyclopedia of Integer Sequences.](#)
- [Fibonacci Numbers and Nature.](#) Or [Tony Phillips' "The most irrational number"](#). Also ["Who was Fibonacci?"](#): a brief biography of Fibonacci.
- [Primes](#): Lots of interesting facts about prime numbers.
- [Mersenne Primes](#): interesting facts about Mersenne primes, perfect numbers, and related topics.

- [Primes is P](#): about a recent polynomial time deterministic algorithm to test if an input number is prime or not.
- [RSA](#): The RSA company's web page containing lots of interesting information about the RSA public key cryptosystem and cryptography in general, from both a technological and a socio-political viewpoint.

A number of interesting local links that you are warmly encouraged to explore:

- [Problem of the Month](#) sponsored by the Stony Brook mathematics department. The first two winners each month get \$25!
- [Math Club](#)

## Math Learning Center

The **Math Learning Center** (MLC), located in Room S-240A of the Math Tower, is an important resource. It is staffed most days and some evenings by mathematics tutors (professors and advanced students). For more information and a schedule, consult the [MLC web site](#).

## Special needs

If you have a physical, psychiatric, medical or learning disability that may impact on your ability to carry out assigned course work, you may contact the Disabled Student Services (DSS) office (Humanities 133, 632-6748/TDD). DSS will review your concerns and determine, with you, what accommodations may be necessary and appropriate. I will take their findings into account in deciding what alterations in course work you require. All information on and documentation of a disability condition should be supplied to me in writing at the earliest possible time AND is strictly confidential. Please act early, since I will not be able to make any retroactive course changes.

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*Sorin Popescu*  
2004-1-15



# MAT 311

## Number Theory

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### Homework:

Problems marked with an asterisk (\*) are for extra credit.

- **HW 1** (due 02/05 in class) [\[solutions\]](#)
  - Chapter 1: Ex 1.1, 1.3, 1.4
  - Chapter 2: Ex 2.1, 2.3 a) and b), 2.4
- **HW 2** (due 02/12 in class) [\[solutions\]](#)
  - Chapter 3: Ex 3.1, 3.2, 3.3
  - Chapter 4: Ex 4.2 a), b), d) only
  - Chapter 5: Ex 5.1, 5.3, 5.5 a) and b) only
- **HW 3** (due 02/19 in class) [\[solutions\]](#)
  - Chapter 6: Ex 6.1, 6.2, 6.3, 6.4 a) only
  - Chapter 7: Ex 7.2, 7.3, 7.4
- **HW 4** (due 02/26 in class) [\[solutions\]](#)
  - Find the prime-power factorization of  $20!$
  - How many zeroes are at the end of  $50!$  in decimal notation? Explain!
  - Which positive integer numbers have exactly three positive divisors? Which have exactly four positive divisors?
  - Show that if  $a$  and  $b$  are positive numbers such that  $a^3|b^2$ , then  $a|b$ .
  - Chapter 7: Ex 7.5
  - Chapter 8: Ex 8.2, 8.3, 8.4
- **HW 5** (due 03/04 in class) [\[solutions\]](#)
  - Chapter 9: Ex. 9.1, 9.4
  - Chapter 10: Ex 10.1, 10.2, 10.3 (a)
  - Chapter 11: Ex 11.1, 11.2
- **HW 6** (due 03/11 in class) [\[solutions\]](#)
  - Chapter 11: Ex 11.5, 11.8, 11.9, 11.10, 11.11 a)
  - What should the check digit be to complete the following

ISBN: 0-19-081082 ?

- Determine if the ISBN 1-09-231221-3 is valid?
- **HW 7** (due 03/25 in class) [\[solutions\]](#)
  - Chapter 19: Ex 19.1, 19.3
  - Find the sum of the positive divisors of each of the following integers:  $2^{100}$ , 196, and 20!
  - Which positive integers have an odd number of positive divisors?
  - Find the smallest positive integer  $n$  with  $\tau(n)=3$ .
  - Which positive integers have exactly four positive divisors?
  - Show that no two positive integers have the same product of divisors.\*
  - Find the following values of the Moebius  $\mu$  function:  $\mu(12)$ ,  $\mu(30)$
  - Show that for any positive integer  $n$  we have  $\mu(n) \mu(n+1) \mu(n+2) \mu(n+3)=0$ .
  - Is it possible for the Moebius  $\mu$  function to vanish for 5 consecutive values of  $n$ ?
  - Use the Moebius inversion formula to express the Euler  $\phi$  function in terms of the Moebius  $\mu$  function.
  - Chapter 13: Ex 13.3
- **HW 8** (due 04/15 in class) [\[solutions\]](#)
  - Chapter 17: Ex 17.1, 17.2, 17.4
  - Chapter 18: 18.1, 18.2
  - Find the primes  $p$  and  $q$  if  $pq=4,386,607$  and  $\phi(pq)=4,382,136$ . Explain the method you have used.
- **HW 9** (due 04/22 in class) [\[solutions\]](#)
  - Chapter 20: Ex 20.1, 20.2, 20.3, 20.4, 20.6, 20.7 a) only, 20.8
  - Chapter 21: Ex 21.1, 21.3
- **HW 10** (due 04/29 in class)
  - Chapter 22: Ex 22.3
  - Chapter 23: Ex 23.1, 23.3, 23.5
  - Chapter 24: Ex 24.1, 24.2, 24.4, 24.6, 24.7, 24.9
  - Chapter 25: Ex 25.2 (bonus problem)

- **HW 11** (due 05/6 in class; bonus problems)
  - Chapter 25: Ex 25.3, 25.5
  - Chapter 26: Ex 26.1, 26.6

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*Sorin Popescu*  
2004-2-11



# MAT 311

## Number Theory

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### Information about Project 1

Project 1 should be handed in by 03/04. Please select one of the topics or one of the programming projects listed below. You need to make your selection and also inform me of it by 2/19.

- A proof that the rational and algebraic numbers are countable and that the irrationals and transcendental numbers are not.
- A short (2 to 4 typed pages) biography of a prominent number theorist.
- Write a program to implement the  $3n+1$  algorithm' in exercise 5.6 (see also exercise 5.5). The user will input  $n$  and your program should return the length and the terminating value of the  $3n+1$  algorithm. Use your program to find the length and terminating value for all starting values  $1$ .
- Write a program to find a solution  $(x,y)$  in integers to the equation  $ax+by=\gcd(a,b)$ . Write also a version of the program so that if  $a$  and  $b$  are positive, then the returned solution always has  $x>0$ .
- Write a program that finds all twin primes less than 20,000. Hardy and Littlewood conjectured that the number of twin primes not exceeding  $n$  is asymptotic to  $C n/(\ln n)^2$  for a constant  $C$ , approximately equal to 0.66016. Determine how accurate this asymptotic formula is for values of  $n$  as large as you can compute.
- Exercise 11.6
- Compare the number of primes of the form  $4n+1$  and the number of primes of the form  $4n+3$  for a range of values of  $n$ . Can you make any conjectures about the relationship between these numbers?
- Write a program to find the number of zeroes at the end of the decimal expansion of  $n!$ .
- Write a program to find the prime factorization of  $n!$ .



- Show that if  $n$  is a Carmichael number then it is squarefree.
- Show that if  $n=p_1p_2\dots p_n$  is a product of distinct primes such that  $p_i-1|n-1$  for all  $i$ , then  $n$  is a Carmichael number. Use this to show that 564651361 is a Carmichael number. Can you write a program to find other Carmichael numbers?

## Information about Project 2

Project 2 should be handed in by 04/30. Please select one of the topics or one of the programming projects listed below. You need to make your selection and also inform me of it by 04/23.

- Write a program finding the primes  $p$  smaller than a given number  $n$  for which  $2^{p-1}$  is congruent to 1 modulo  $p^2$ .
- Find as many Carmichael numbers of the form  $(6m+1)(12m+1)(18m+1)$  as you can.
- Show that there are infinitely many pseudoprimes to any base  $m$ .
- Lehmer has conjectured that  $n$  is prime if  $\phi(n)$  divides  $n-1$ . Gather evidence for this conjecture, or find a counterexample if you can.
- Carmichael has conjectured that for every positive integer  $n$  there is a positive integer  $m$  distinct from  $n$  such that  $\phi(n) = \phi(m)$ . Gather evidence for this conjecture.
- An integer  $n$  is called highly composite if  $\tau(n) = \tau(m)$  for all integers  $m < n$ . Find all highly composite numbers not exceeding 10,000.
- Exercises 20.10 and 20.11.
- Write a program encrypting and decrypting messages using the Caesar cipher.
- Write a program to decrypt messages which have been encrypted using Vigenere ciphers.
- The El Gamal Cryptosystem (Exercises 21.6, 21.7). Write a program to encrypt/decrypt messages using the El Gamal Cryptosystem. Show that if the same random number  $r$  is used to encrypt two plaintext messages  $P$  and  $Q$  using the El Gamal Cryptosystem, then  $Q$  can be found once the plaintext message  $P$  is known.
- Exercise 22.2
- Show that if  $p$  is a prime of the form  $4k+3$  and  $q=2p+1$  is prime, then  $q$  divides the Mersenne number  $M_p=2^p-1$ . (Hint: use Legendre symbols).

- A short (3 to 4 typed pages) paper on the mathematical contributions of a number theorist. Note: This is **not** a biography - you will need to describe mathematical results, their proofs, etc.

For any of the programming projects, please email me at [sorin@math.sunysb.edu](mailto:sorin@math.sunysb.edu) the program source code (in readable form -- indented and commented), and hand in the program outline and a reasonable amount of program output. You can use any programming language you like (within reasonable limits - i.e., a language for which there exist easily available compilers). Preferred ones are *Maple*, *Mathematica* (yes, they are programming languages), *C*, *OCAML* and *Java*, but you can also use *C++*, *Pascal*, *Python*, *Fortran*, *Lisp*, *Turing machine*...

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*Sorin Popescu*  
2004-1-15



## Sorin Popescu

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**Research Interests:** Algebraic Geometry, Commutative Algebra, Combinatorics and Computational methods

**Teaching:**

Spring 2006









[MAT 311 Number Theory](#)

[MAT 614 Topics in Algebraic Geometry](#)












Previous years

[Teaching Archive](#)

**Algebra, Geometry and Physics seminar:** [Spring 2006](#)



**Publications & E-Prints:** Unless otherwise indicated, the files below are DVI files () , PostScript files () , PDF files () , or tar gzipped DVI and PostScript files () . Files marked as () or () are hyperlinked PDF or Macromedia Flash files formatted for screen viewing. Other formats (source, PS using Type I fonts) can be obtained via the UC Davis Front to the [Mathematics ArXiv](#). Click on () or () for related [Macaulay2](#), or [Macaulay](#) code.

**Syzygies:**










- [Gale Duality and Free Resolutions of Ideals of Points](#) [] , [] [] [] [] , *Invent math* **136** (1999) 2, 419-449  
David Eisenbud and Sorin Popescu
- [The Projective Geometry of the Gale Transform](#) [] , [] [] [] , *J. Algebra* **230** (2000), no. 1, 127-173  
David Eisenbud and Sorin Popescu  
(in the D. Buchsbaum anniversary volume of *J. Algebra*)
- [Syzygy Ideals for Determinantal Ideals and the Syzygetic Castelnuovo Lemma](#) [] [] , [[MathSci](#)] ,

Springer 1999

David Eisenbud and Sorin Popescu

- *Extremal Betti Numbers and Applications to Monomial Ideals* [] [] [] [], *J. Algebra* **221** (1999), no. 2, 497-512  
Dave Bayer, Hara Charalambous and Sorin Popescu
- *Lagrangian Subbundles and Codimension 3 Subcanonical Subschemes* [], [] [] [], *Duke Math. J.* **107** (2001), no. 3, 427-467  
David Eisenbud, Sorin Popescu and Charles Walter
- *Enriques Surfaces and other Nonpfaffian Codimension 3 Subcanonical Subschemes* [] [] [] [], *Comm. Algebra* **28** (2000), 5629-5653  
David Eisenbud, Sorin Popescu and Charles Walter  
(in the Hartshorne anniversary volume of *Comm. Algebra*)
- *Syzygies of Unimodular Lawrence Ideals* [] [] [] [], *J. Reine Angew. Math* **534** (2001), 169-186  
Dave Bayer, Sorin Popescu and Bernd Sturmfels
- *Hyperplane Arrangement Cohomology and Monomials in the Exterior Algebra* [] [] [] [] [], *Trans. AMS.* **355** (2003), 4365-4383  
David Eisenbud, Sorin Popescu and Sergey Yuzvinsky
- *Exterior algebra methods for the Minimal Resolution Conjecture* [] [] [] [], *Duke Math. J.* **112** (2002), no. 2, 379-395  
David Eisenbud, Frank-Olaf Schreyer, Sorin Popescu and Charles Walter
- *Symmetric resolutions of coherent sheaves* [] [] []  
David Eisenbud, Sorin Popescu and Charles Walter
- *A note on the Intersection of Veronese Surfaces* [] [] [] [] [],  
David Eisenbud, Klaus Hulek and Sorin Popescu
- *Restricting linear syzygies: algebra and geometry* [] [] [] [] [], *Compositio Math.* **141** (2005), no.6, 1460-1478  
David Eisenbud, Mark Green, Klaus Hulek and Sorin Popescu
- *Small schemes and varieties of minimal degree* [] [] [] [] [], *Amer. J of Math* (2005), to appear  
David Eisenbud, Mark Green, Klaus Hulek and Sorin Popescu





#### Abelian varieties, modular varieties and equations:

- *Equations of (1,d)-polarized abelian surfaces* [] [] [], *Math. Ann.* **310** (1998), no. 2, 333-377  
Mark Gross and Sorin Popescu
- *The moduli space of (1,11)-polarized abelian surfaces is unirational* [] [] [], *Compositio Math.* **126** (2001), no. 1, 1-24  
Mark Gross and Sorin Popescu
- *Calabi-Yau threefolds and moduli of abelian surfaces I* [] [] [], *Compositio Math.* **127**, no. 2, (2001), 169-228  
Mark Gross and Sorin Popescu




























[Calabi-Yau threefolds and moduli of abelian surfaces II](#) [  ] [  ] [  ]




Mark Gross and Sorin Popescu

- [Elliptic functions and equations of modular curves](#) [  ] [  ] [  ] [  ], *Math. Ann.* **321** (2001), no. 3, 553-568  
Lev A. Borisov, Paul Gunnells, and Sorin Popescu

#### Surfaces in $P^4$ and threefolds in $P^5$ :

- [The Geometry of Bielliptic Surfaces in  \$P^4\$](#)  [  ], [  ] [  ], *Internat. J. Math.* **4** (1993), no. 6, 873-902  
A. Aure, W. Decker, K. Hulek, S. Popescu and K. Ranestad
- [On Surfaces in  \$P^4\$  and Threefolds in  \$P^5\$](#)  [  ] [  ] [  ], [ **MathSci** ], LMSLN **208**, 69--100  
W. Decker and S. Popescu
- [Surfaces of degree 10 in  \$P^4\$  via linear systems and linkage](#) [  ] [  ] [  ] [  ] [  ], *J. Algebraic Geom.* **5** (1996), no. 1, 13-76  
S. Popescu and K. Ranestad
- [Syzygies of Abelian and Bielliptic Surfaces in  \$P^4\$](#)  [  ] [  ] [  ], *Internat. J. Math.* **8** (1997), no. 7, 849-919  
A. Aure, W. Decker, K. Hulek, S. Popescu and K. Ranestad
- [Examples of smooth non general type surfaces in  \$P^4\$](#)  [  ] [  ] [  ] [  ] [  ], *Proc. London Math. Soc.* (3) **76** (1998), no. 2, 257-275  
S. Popescu
- [Surfaces of degree  \$\geq 11\$  in the Projective Fourspace](#) [  ] [  ] [  ] + [Appendix](#) [  ] [  ] [  ]  
S. Popescu

#### PRAGMATIC 1997: A summer school in Catania, Sicily

- [Research Problems for the summer school](#) [  ], [  ] [  ], [ **MathSci** ], *Matematiche* (Catania) **53** (1998), 1-14  
David Eisenbud and Sorin Popescu

#### Algorithmic Algebra and Geometry: Summer Graduate Program (1998) at MSRI:

- Poster [  ] [  ], [lecture slides and streaming video](#) , CD ROM,  
Dave Bayer and Sorin Popescu

#### Linear algebra notes

- [On circulant matrices](#) [  ], [  ] [  ] [  ] [  ],  
Daryl Geller, Irwin Kra, Sorin Popescu and Santiago Simanca






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#### Upcoming conferences:

- DARPA FunBio Mathematics-Biology Kick-off meeting, Princeton, September 21-23, 2005
- [MAGIC 05: Midwest Algebra, Geometry and their Interactions Conference](#), University of Notre Dame, Notre Dame, October 7-11, 2005
- [AMS Special Session on Resolutions](#), Eugene, OR, November 12-13, 2005
- [Clay Workshop on Algebraic Statistics and Computational Biology](#), Clay Mathematics Institute, November 12-14, 2005
- [CIMPA School on Commutative Algebra](#), December 26, 2005 - January 6, 2006, Hanoi, Vietnam
- [AMS Special Session on Syzygies in Commutative Algebra and Geometry](#), San Antonio, TX, January 12-15, 2006
- [KAIST Workshop on Projective Algebraic Geometry](#), January 23-25, 2006, Korean Advanced Institute of Science and Technology, Daejeon
- [AMS Special Session on the Geometry of Groebner bases](#), San Francisco, CA, April 29-30, 2006
- [Castnuovo-Mumford regularity and related topics](#), Workshop at CIRM, Luminy, France, May 9-13, 2006
- [Commutative Algebra and its Interaction with Algebraic Geometry](#), Workshop at CIRM, Luminy, France, May 22-26, 2006
- [Syzygies and Hilbert Functions](#), Banff International Research Meeting, Canada, October 14-19, 2006

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#### Past conferences:

- A [conference](#) on algebraic geometry to celebrate Robin Hartshorne's 60th birthday, Berkeley, August 28-30, 1998
- [Western Algebraic Geometry Seminar](#), MSRI, Berkeley, December 5-6, 1998
- [Conference on Groebner Bases, Guanajato](#), Mexico, February 8-12, 1999
- [The Pacific Northwest Geometry Seminar](#) 
- [Computational Commutative Algebra and Combinatorics](#), Osaka, July 21-30, 1999. 
- [Kommutative Algebra und Algebraische Geometrie](#), Oberwolfach, August 8-14, 1999. 
- [AMS Western Section Meeting](#) Salt Lake City, UT, September 25-26, 1999.
- [Algebra and Geometry of Points in Projective Space](#), Napoli, February 9-12, 2000.
- [AMS Spring Eastern Sectional Meeting](#) Lowell, MA, April 1-2, 2000.
- [Algèbre commutative et ses interactions avec la géométrie algébrique](#), Centre International de Rencontres Mathématiques, June 5-9, 2000.
- [Topics in Classical Algebraic Geometry](#), Oberwolfach, June 18-24, 2000 
- [AMS Fall Central Section Meeting](#) Toronto, Ontario Canada, September 22-24, 2000
- [AMS Fall Eastern Section Meeting](#), New York, Columbia U. in New York, November 4-5, 2000
- [Exterior algebra methods and other new directions in Algebraic Geometry, Commutative Algebra and Combinatorics](#), 8-15 September 2001, Ettore Majorana Centre, Erice, Sicily, Italy. [Photos](#) from the conference.
- [Classical Algebraic Geometry](#), Oberwolfach, May 26 - June 1, 2002 
- [Current trends in Commutative Algebra](#), Levico, Trento, June 17-21, 2002
- [Birational and Projective Geometry of Algebraic Varieties](#), Ferrara, September 2-8, 2002
- [Commutative Algebra, Singularities and Computer Algebra](#), Sinaia, September 17-22, 2002. [Photos](#) from the conference.
- [James H. Simons Conference on Quantum and Reversible Computation](#), Stony Brook, May 25-31, 2003

- [Conference on Commutative Algebra](#), Lisbon, June 23-27 2003. [Photos](#) from the conference. Also [photos](#) from Belém.
- [Commutative Algebra and Interactions with Algebraic Geometry and Combinatorics](#), ICTP, Trieste, June 6-11
- [III Iberoamerican Congress on Geometry](#), Salamanca, June 7-12
- [Projective Varieties: A Conference in honour of the 150<sup>th</sup> anniversary of the birth of G. Veronese](#), Siena, June 8-12 , 2004. [Photos](#) from the conference.
- [Algebraic Geometry: conference in honour of Joseph Le Potier & Christian Peskine](#), Paris, June 15-18, 2004
- [Classical Algebraic Geometry](#), Oberwolfach, June 27-July 3, 2004
- [Combinatorial Commutative Algebra](#), Oberwolfach, July 4-10th, 2004

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Last updated on 10 Dec 2003

