

# Reference and Book List

The *Reference* section of the Notices is intended to provide the reader with frequently sought information in an easily accessible manner. New information is printed as it becomes available and is referenced after the first printing. As soon as information is updated or otherwise changed, it will be noted in this section.

## Contacting the Notices

The preferred method for contacting the Notices is electronic mail. The editor is the person to whom to send articles and letters for consideration. Articles include feature articles, memorial articles, communications, opinion pieces, and book reviews. The editor is also the person to whom to send news of unusual interest about other people's mathematics research.

The managing editor is the person to whom to send items for "Mathematics People", "Mathematics Opportunities", "For Your Information", "Reference and Book List", and "Mathematics Calendar". Requests for permissions, as well as all other inquiries, go to the managing editor.

The electronic-mail addresses are [notices@math.ou.edu](mailto:notices@math.ou.edu) in the case of the editor and [notices@ams.org](mailto:notices@ams.org) in the case of the managing editor. The fax numbers are 405-325-7484 for the editor and 401-331-3842 for the managing editor. Postal addresses may be found in the masthead.

## Upcoming Deadlines

**July 22, 2004:** Proposals for NSF CAREER Program. See <http://www.nsf.gov/pubs/2002/nsf02111/nsf02111.htm>.

**August 1, 2004:** Nominations for Clay Senior Scholars Program. See [http://www.claymath.org/senior\\_scholars](http://www.claymath.org/senior_scholars), or call 617-995-2600.

**August 1, 2004:** Applications for National Research Council Research Associateships. See <http://www4.nationalacademies.org/pga/rap.nsf>, or contact Research Associate-ship Programs, Keck Center of the National Academies, 500 Fifth Street, NW, GR322A, Washington, DC 20001; telephone 202-334-2760; fax 202-334-2759; email: [rap@nas.edu](mailto:rap@nas.edu).

**August 20, 2004:** Letters of intent for NSF Focused Research Groups. See "Mathematics Opportunities" in this issue.

**September 15, 2004:** Nominations for Alfred P. Sloan Foundation fellowships. See [http://www.sloan.org/programs/fellowship\\_](http://www.sloan.org/programs/fellowship_)

[brochure.shtml](#), or write to Sloan Research Fellowships, Alfred P. Sloan Foundation, 630 Fifth Avenue, Suite 2550, New York, NY 10111.

**September 16, 2004:** Proposals for NSF Enhancing the Mathematical Sciences Workforce in the Twenty-First Century program (including VIGRE). See "Mathematics Opportunities" in this issue.

**September 17, 2004:** Full proposals for NSF Focused Research Groups. See "Mathematics Opportunities" in this issue.

**September 30, 2004:** AMS scholarships for Math in Moscow. See "Mathematics Opportunities" in this issue.

## Where to Find It

A brief index to information that appears in this and previous issues of the Notices.

**AMS Bylaws**—November 2003, p. 1283

**AMS E-mail Addresses**—November 2003, p. 1266

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**AMS Officers 2000 and 2001 (Council, Executive Committee, Publications Committees, Board of Trustees)**—May 2004, p. 566

**AMS Officers and Committee Members**—October 2003, p. 1115

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**Conference Board of the Mathematical Sciences**—September 2003, p. 945

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**NRC Mathematical Sciences Education Board**—April 2004, p. 446

**NSF Mathematical and Physical Sciences Advisory Committee**—February 2004, p. 242

**Program Officers for Federal Funding Agencies**—October 2003, p. 1107 (DoD, DoE); December 2003, p. 1429 (DMS Program Officers); December 2003, p. 1430 (NSF Education Program Officers)

**September 30, 2004:** Nominations for Information-Based Complexity Young Researcher Award. Contact Joseph F. Traub at [traub@cs.columbia.edu](mailto:traub@cs.columbia.edu).

**October 1, 2004:** Nominations for the Louise Hay Award and the Alice T. Schafer Mathematics Prize. Call the AWM at 301-405-7892 or send email to [awm@math.umd.edu](mailto:awm@math.umd.edu).

**October 1, 2004:** Nominations for CRM-Fields Prize. See [http://www.fields.utoronto.ca/proposals/crm-fields\\_prize.html](http://www.fields.utoronto.ca/proposals/crm-fields_prize.html), or contact the Director, The Fields Institute, 222 College Street, Toronto, Ontario M5T 3J1, Canada.

**October 15, 2004:** Applications for NSF Postdoctoral Research Fellowships. See "Mathematics Opportunities" in this issue.

**December 1, 2004:** Submissions for Ferran Sunyer i Balaguer Prize. See "Mathematics Opportunities" in this issue.

**January 1, 2005:** Entries for *Cryptologia* undergraduate paper competitions. See <http://www.dean.usma.edu/math/pubs/cryptologia/>, or contact *Cryptologia*, Department of Mathematical Sciences, United States Military Academy, West Point, NY 10996; email: [Cryptologia@usma.edu](mailto:Cryptologia@usma.edu).

### Contact Information for Mathematics Institutes

#### American Institute of Mathematics (AIM) AIM Research Conference Center (ARCC)

360 Portage Avenue  
Palo Alto, CA 94306-2244  
Telephone: 650-845-2071  
Fax: 650-845-2074  
email: [conrey@aimath.org](mailto:conrey@aimath.org)  
World Wide Web:  
<http://www.aimath.org>

#### Stefan Banach International Mathematical Center

8 Sniadeckich str., P.O. Box 21  
00-950 Warszawa, Poland  
Telephone: (+48-22) 522-82-32; 628-01-92  
Fax: (+48-22) 622-57-50; 629-39-97  
email: [banach@impan.gov.pl](mailto:banach@impan.gov.pl)  
World Wide Web:  
<http://www.impan.gov.pl/BC>

#### Banff International Research Station

c/o PIMS Central Office  
University of British Columbia  
1933 West Mall  
Vancouver, BC V6T 1Z2, Canada  
Telephone: 403-762-6100  
Fax: 403-763-6990  
email: [nassif@pims.math.ca](mailto:nassif@pims.math.ca)  
World Wide Web:  
<http://www.pims.math.ca/birs/>

#### Center for Discrete Mathematics and Theoretical Computer Science (DIMACS)

CoRE Building, 4th Floor  
Rutgers University  
96 Frelinghuysen Road  
Piscataway, NJ 08854-8018  
Telephone: 732-445-5930  
Fax: 732-445-5932  
email: [center-admin@dimacs.rutgers.edu](mailto:center-admin@dimacs.rutgers.edu)  
World Wide Web:  
<http://dimacs.rutgers.edu>

#### Center for Scientific Computation and Mathematical Modeling (CSCAMM)

University of Maryland  
4146 CSIC Building #406  
Paint Branch Drive  
College Park, MD 20742-3289  
Telephone: 301-405-0662  
Fax: 301-314-6674  
email: [info@cscamm.umd.edu](mailto:info@cscamm.umd.edu)  
World Wide Web:  
<http://www.cscamm.umd.edu>

#### Centre International de Rencontres Mathématiques (CIRM)

163, avenue de Luminy Case 916  
F-13288 Marseille Cedex 09, France  
Telephone: (+33) 04 91 83 30 00  
Fax: (+33) 04 91 83 30 05  
email: [cirm@cirm.univ-mrs.fr](mailto:cirm@cirm.univ-mrs.fr)  
World Wide Web:  
<http://www.cirm.univ-mrs.fr/indexE.html>

#### Centre de Recerca Matemàtica (CRM)

Apartat 50  
E-08193 Bellaterra, Spain  
Telephone: (+34) 935 811 081  
Fax: (+34) 935 812 202  
email: [crm@crm.es](mailto:crm@crm.es)  
World Wide Web: <http://crm.es>

#### Centre for Mathematical Physics and Stochastics (MaPhySto)

Department of Mathematical Sciences  
University of Aarhus  
Ny Munkegade  
DK-8000 Aarhus C, Denmark  
Telephone: (+45) 8942 3515  
Fax: (+45) 8613 1769  
email: [maphysto@maphysto.dk](mailto:maphysto@maphysto.dk)  
World Wide Web:  
<http://maphysto.dk>

#### Centre for Mathematics and Its Applications

Building 27  
Australian National University  
Canberra ACT 0200, Australia  
Telephone: (+61) 2 6125 2897  
Fax: (+61) 2 6125 5549  
email: [CMAadmin@maths.anu.edu.au](mailto:CMAadmin@maths.anu.edu.au)  
World Wide Web:  
<http://www.maths.anu.edu.au/CMA/>

#### Centre de Recherches Mathématiques (CRM)

Université de Montréal  
C.P. 6128, Succ. Centre-ville  
Montréal, Québec, Canada H3C 3J7  
Telephone: 514-343-7501  
Fax: 514-343-2254  
email:  
[activites@crm.umontreal.ca](mailto:activites@crm.umontreal.ca)  
World Wide Web:  
<http://www.crm.umontreal.ca>

#### Centro de Investigacion en Matemáticas (CIMAT)

A. P. 402, Guanajuato, Gto.  
C.P. 36000, Mexico  
Telephone: 473 73 271-55  
Fax: 473 73 257-49  
email: [cimat@cimat.mx](mailto:cimat@cimat.mx)  
World Wide Web:  
<http://www.cimat.mx>

#### Chennai Mathematical Institute

92 G. N. Chetty Road  
Chennai 600 017, India  
Telephone: (+91) 44-28157854,  
28157855  
Fax: (+91) 44-28157671  
email: [office@cmi.ac.in](mailto:office@cmi.ac.in)  
World Wide Web:  
<http://www.cmi.ac.in>

**Erwin Schrödinger International Institute for Mathematical Physics**  
 Boltzmanngasse 9  
 A-1090 Vienna, Austria  
 Telephone (+43) 1 317 20 47/11  
 Fax: (+43) 1 317 20 47/30  
 email: [secr@esi.ac.at](mailto:secr@esi.ac.at)  
 World Wide Web:  
<http://www.esi.ac.at/>

**Euler International Mathematical Institute**  
 nab. Fontanka, 27  
 St. Petersburg 197023, Russia  
 Telephone: 7 812 312-40-58  
 Fax: 7 812 310-53-77  
 email: [admin@euler.pdmi.ras.ru](mailto:admin@euler.pdmi.ras.ru)  
 World Wide Web:  
<http://www.pdmi.ras.ru/EIMI/index.html>

**Fields Institute for Research in Mathematical Sciences**  
 222 College Street, 2nd Floor  
 Toronto, Ontario, Canada M5T 3J1  
 Telephone: 416-348-9710  
 Fax: 416-348-9714  
 email:  
[geninfo@fields.utoronto.ca](mailto:geninfo@fields.utoronto.ca)  
 World Wide Web:  
<http://www.fields.utoronto.ca>

**Forschungsinstitut für Mathematik (FIM)**  
 Eidgenössische Technische Hochschule Zentrum  
 Rämistrasse 101  
 8092 Zurich, Switzerland  
 Telephone: (+41) 1-632-3475  
 email:  
[marcela.kraemer@fim.math.ethz.ch](mailto:marcela.kraemer@fim.math.ethz.ch)  
 World Wide Web:  
<http://www.fim.math.ethz.ch/>

**Institut des Hautes Études Scientifiques (IHÉS)**  
 Le Bois-Marie  
 35, route de Chartres  
 F-91440 Bures-sur-Yvette, France  
 Telephone: (+33) 1 60 92 66 00  
 Fax: (+33) 1 60 92 66 69  
 World Wide Web:  
<http://www.ihes.fr>

**Institute for Advanced Study (IAS)**  
 School of Mathematics  
 Einstein Drive  
 Princeton, NJ 08540  
 Telephone: 609-734-8000

Fax: 609-924-8399  
 email: [math@math.ias.edu](mailto:math@math.ias.edu)  
 World Wide Web:  
<http://www.math.ias.edu/>

**Institute for Mathematical Sciences**  
 National University of Singapore  
 3 Prince George's Park  
 Singapore 118402, Republic of Singapore  
 Telephone: 65 6874 1897  
 Fax: 65 6873 8292  
 email: [ims@nus.edu.sg](mailto:ims@nus.edu.sg)  
 World Wide Web:  
<http://www.ims.nus.edu.sg>

**Institute for Mathematics and its Applications (IMA)**  
 University of Minnesota  
 400 Lind Hall  
 207 Church Street, SE  
 Minneapolis, MN 55455-0436  
 Telephone: 612-624-6066  
 Fax: 612-626-7370  
 email: [ima-staff@ima.umn.edu](mailto:ima-staff@ima.umn.edu)  
 World Wide Web:  
<http://www.ima.umn.edu/>

**Institut Henri Poincaré**  
 11, rue Pierre et Marie Curie  
 75231 Paris Cedex 05, France  
 Telephone : 01 44 27 67 89  
 Fax : 01 43 25 40 67  
<http://www.ihp.jussieu.fr/>

**Institut Mittag-Leffler**  
 Auravägen 17  
 S-182 60 Djursholm, Sweden  
 Telephone: (+46) 8 622 05 60  
 Fax: (+46) 8 622 05 89  
 email: [widman@m1.kva.se](mailto:widman@m1.kva.se)  
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**Institute for Pure and Applied Mathematics (IPAM)**  
 IPAM Building  
 460 Portola Plaza  
 Box 957121  
 Los Angeles, CA 90095-7121  
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 Fax: 310-825-4756  
 email: [ipam@ucla.edu](mailto:ipam@ucla.edu)  
 World Wide Web:  
<http://www.ipam.ucla.edu>

**Institute of Mathematical Sciences**  
 Chinese University of Hong Kong  
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 Shatin, Hong Kong  
 Telephone: 852 2609-8038  
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 email: [ims@ims.cuhk.edu.hk](mailto:ims@ims.cuhk.edu.hk)  
 World Wide Web:  
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**International Center for Theoretical Physics (ICTP)**  
 Strada Costiera 11, P.O. Box 586  
 34100 Trieste, Italy  
 Telephone: (+39) 040 2240111  
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 email: [sci\\_info@ictp.trieste.it](mailto:sci_info@ictp.trieste.it)  
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 World Wide Web:  
<http://www.ma.hw.ac.uk/icms>

**Isaac Newton Institute for Mathematical Sciences**  
 20 Clarkson Road  
 Cambridge CB3 0EH, UK  
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 World Wide Web: <http://www.newton.cam.ac.uk/>

**Instituto Nacional de Matemática Pura e Aplicada (IMPA)**  
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 Jardim Botânico  
 22460-320 Rio de Janeiro, RJ, Brazil  
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 Fax: (+55) 21-2512-4115  
 World Wide Web:  
<http://wwwimpa.br>

**Istituto Nazionale di Alta Matematica "F. Severi" (INDAM)**  
 Citta Universitaria  
 P. le Aldo Moro 5  
 00185 Rome, Italy  
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 Fax: 39 064462293  
 email: [indam@altamatematica.it](mailto:indam@altamatematica.it)  
 World Wide Web:  
<http://www.altamatematica.it>

**Korea Institute for Advanced Study (KIAS)**

207-43 Cheongnyangni 2-dong  
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Seoul 130-722, Korea  
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World Wide Web:  
<http://www.kias.re.kr>

**Mathematical Biosciences Institute**

The Ohio State University  
231 West 18th Avenue  
Columbus, OH 43210  
Telephone: 614-292-3648  
Fax: 614-247-6643  
email: [rebecca@mbi.osu.edu](mailto:rebecca@mbi.osu.edu)  
World Wide Web:  
<http://www.mbi.osu.edu>

**Mathematical Research Centre (MCAA)**

University of Aarhus  
Department of Mathematical Sciences  
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email: [imadsen@imf.au.dk](mailto:imadsen@imf.au.dk)  
World Wide Web:  
<http://www.imf.au.dk/ResearchC/MCAA/index.html>

**Mathematical Sciences Research Institute (MSRI)**

17 Gauss Way  
Berkeley, CA 94720-5070  
Telephone: 510-642-0143  
Fax: 510-642-8609  
email: [inquiries@msri.org](mailto:inquiries@msri.org)  
World Wide Web:  
<http://www.msri.org/>

**Mathematics Institute**

University of Warwick  
Coventry CV4 7AL, UK  
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World Wide Web:  
<http://www.maths.warwick.ac.uk/>

**Mathematisches Forschungsinstitut (Oberwolfach)**

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Fax: (+49) 7834 979 55  
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World Wide Web:  
<http://www.mfo.de>

**Max-Planck-Institut für Mathematik**

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Fax: (+49) 228 402277  
email: [admin@mpim-bonn.mpg.de](mailto:admin@mpim-bonn.mpg.de)  
World Wide Web:  
<http://www.mpim-bonn.mpg.de>

**Max-Planck-Institut für Mathematik in den Naturwissenschaften**

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World Wide Web:  
<http://www.mis.mpg.de>

**Nankai Institute of Mathematics**

Nankai University  
Weijin Road 94  
Tianjin 300071, China  
Fax: (+86) 22-23501532  
World Wide Web:  
<http://202.113.29.3/english/2.htm>

**New Zealand Institute of Mathematics and its Applications (NZIMA)**

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Auckland, New Zealand  
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Fax: (+64) 9-373-7457  
email: [nzima-admin@nzima.auckland.ac.nz](mailto:nzima-admin@nzima.auckland.ac.nz)  
World Wide Web:  
<http://nzima.auckland.ac.nz>

**Pacific Institute for the Mathematical Sciences (PIMS)**

University of British Columbia  
1933 West Mall  
Vancouver, BC V6T 1Z2, Canada  
Telephone: 604-822-3922  
Fax: 604-822-0883  
email: [pims@pims.math.ca](mailto:pims@pims.math.ca)  
World Wide Web:  
<http://www.pims.math.ca>

**Alfréd Rényi Institute of Mathematics**

Hungarian Academy of Sciences  
Reáltanoda utca 13-15  
H-1053 Budapest, Hungary  
Telephone: +361-483-8302  
Fax: +361-483-8333  
email: [math@renyi.hu](mailto:math@renyi.hu)  
World Wide Web:  
<http://www.renyi.hu>

**Research Institute for Mathematical Sciences (RIMS)**

Kyoto University  
Kyoto 606-8502, Japan  
Fax: (+81) 75 753 7276  
World Wide Web: <http://www.kurims.kyoto-u.ac.jp/>

**Statistical and Applied Mathematical Sciences Institute (SAMSI)**

19 T. W. Alexander Drive  
P.O. Box 14006  
Research Triangle Park, NC 27709-4006  
Telephone: 919-685-9350  
Fax: 919-685-9360  
email: [info@samsi.info](mailto:info@samsi.info)  
World Wide Web:  
<http://www.samsi.info/>

**Steklov Institute of Mathematics**

Russian Academy of Sciences  
8 Gubkina str., 119991  
Moscow, Russia  
Telephone: (+7) 095 135-22-91  
Fax: (+7) 095 135-05-55  
World Wide Web: [http://www.mis.ras.ru/index\\_e.html](http://www.mis.ras.ru/index_e.html)

**Steklov Institute of Mathematics**

27, Fontanka  
St. Petersburg 191023, Russia  
Telephone: (+7) 812-312-40-58  
Fax: (+7) 812-310-53-77  
email: [admin@pdmi.ras.ru](mailto:admin@pdmi.ras.ru)  
World Wide Web:  
<http://www.pdmi.ras.ru>

**Tata Institute of Fundamental Research**

School of Mathematics  
Dr. Homi Bhabha Road  
Bombay 400 005, India  
Telephone: (+91) 22 22804545  
Fax: (+91) 22 22804610, 22804611  
email: [registra@tifr.res.in](mailto:registra@tifr.res.in)  
World Wide Web:

<http://www.math.tifr.res.in>

**Weierstrass Institute for Applied Analysis and Stochastics**

Mohrenstrasse 39  
10117 Berlin, Germany  
Telephone: (+49) 30-203720  
Fax: (+49) 30-2044975  
email: [lohse@wias-berlin.de](mailto:lohse@wias-berlin.de)  
World Wide Web:  
<http://www.wias-berlin.de/>

**Book List**

*The Book List highlights books that have mathematical themes and are aimed at a broad audience potentially including mathematicians, students, and the general public. When a book has been reviewed in the Notices, a reference is given to the review. Generally the list will contain only books published within the last two years, though exceptions may be made in cases where current events (e.g., the death of a prominent mathematician, coverage of a certain piece of mathematics in the news) warrant drawing readers' attention to older books. Suggestions for books to include on the list may be sent to [notices-booklist@ams.org](mailto:notices-booklist@ams.org).*

\*Added to "Book List" since the list's last appearance.

*Abel's Proof: An Essay on the Sources and Meaning of Mathematical Unsolvability*, by Peter Pesic. MIT Press, May 2003. ISBN 0-262-16216-4. (Reviewed March 2004.)

*Across the Board: The Mathematics of Chessboard Problems*, by John J. Watkins. Princeton University Press, April 2004. ISBN 0-691-11503-6.

*Adam Spencer's Book of Numbers*, by Adam Spencer. Four Walls Eight Windows, January 2004. ISBN 1-568-58289-7.

*After Math*, by Miriam Webster. Zinka Press, June 1997. ISBN 0-9647-1711-5. (Reviewed October 2003.)

*Alan Turing: Life and Legacy of a Great Thinker*, edited by Christof Teuscher. Springer, 2004. ISBN 3-540-20020-7.

*Alpha & Omega: The Search for the Beginning and End of the Universe*, by Charles Seife. Viking, July 2003. ISBN 0-670-03179-8.

*Automated Reasoning and the Discovery of Missing and Elegant Proofs*,

by Larry Wos and Gail Pieper. Rinton Press, December 2003. ISBN 1-58949-023-1.

*Beyond the Limit: The Dream of Sofya Kovalevskaya*, by Joan Spicci. Forge, August 2002. ISBN 0-765-30233-0. (Reviewed January 2004.)

*The Book of My Life*, by Girolamo Cardano. New York Review of Books Classics Series/Granta. ISBN 1-590-17016-4.

*Calculated Risks: How to Know When Numbers Deceive You*, by Gerd Gigerenzer. Simon & Schuster, March 2003. ISBN 0-743-25423-6.

*California Dreaming: Reforming Mathematics Education*, by Suzanne M. Wilson. Yale University Press, January 2003. ISBN 0-300-09432-9. (Reviewed November 2003.)

*The Changing Shape of Geometry: Celebrating a Century of Geometry and Geometry Teaching*, edited by Chris Pritchard. Cambridge University Press, January 2003. ISBN 0-521-53162-4.

*Codebreakers: Arne Beurling and the Swedish Crypto Program during World War II*, by Bengt Beckman, translated by Kjell-Ove Widman. AMS, February 2003. ISBN 0-8218-2889-4. (Reviewed September 2003.)

\* *Cogwheels of the Mind: The Story of Venn Diagrams*, by A. W. F. Edwards. Johns Hopkins University Press, April 2004. ISBN 0-801-87434-3.

*The Constants of Nature: From Alpha to Omega—The Numbers That Encode the Deepest Secrets of the Universe*, by John D. Barrow. Jonathan Cape, September 2002. Pantheon Books, January 2003. ISBN 0-375-42221-8.

*Correspondance Grothendieck-Serre*, Pierre Colmez and Jean-Pierre Serre, editors. Société Mathématique de France, 2001. ISBN 2-85629-104-X. (Reviewed October 2003.)

\* *Count Down: Six Kids Vie for Glory at the World's Toughest Math Competition*, by Steve Olson. Houghton Mifflin, April 2004. ISBN 0-618-25141-3. (Reviewed in this issue.)

*The Curious Life of Robert Hooke, the Man Who Measured London*, by Lisa Jardine. HarperCollins, February 2004. ISBN 0-060-53897-X.

*Einstein's Clocks, Poincaré's Maps: Empires of Time*, by Peter Galison.

W. W. Norton & Company, August 2003. ISBN 0-393-02001-0.

*Everything and More: A Compact History of Infinity*, by David Foster Wallace. W. W. Norton & Company, October 2003. ISBN 0-393-00338-8. (Reviewed June/July 2004.)

\* *The Fabric of the Cosmos*, by Brian Greene. Knopf, February 2004. ISBN 0-375-41288-3.

*Fields Medalists' Lectures*, edited by Sir Michael Atiyah and Daniel Iagolnitzer. World Scientific, 2nd edition, December 2003. ISBN 9-812-38259-3.

*Four Colors Suffice: How the Map Problem Was Solved*, by Robin Wilson. Princeton University Press, March 2003. ISBN 0-691-11533-8. (Reviewed February 2004.)

*The Fractal Murders*, by Mark Cohen. Mysterious Press, Warner Books, May 2004. ISBN 0-89296-799-4. (Reviewed October 2003.)

\* *From Newton to Hawking: A History of Cambridge University's Lucasian Professors of Mathematics*, edited by Kevin C. Knox and Richard Noakes. Cambridge University Press, November 2003. ISBN 0-521-66310-5.

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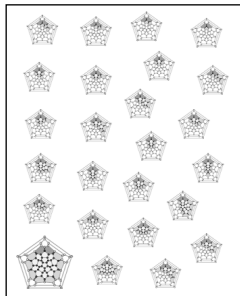
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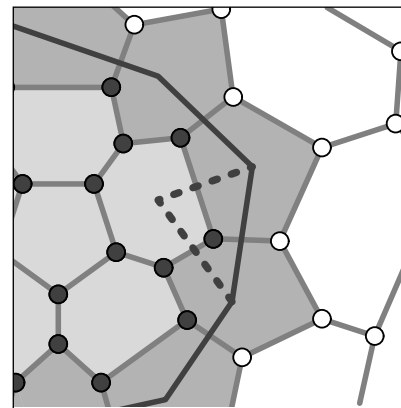
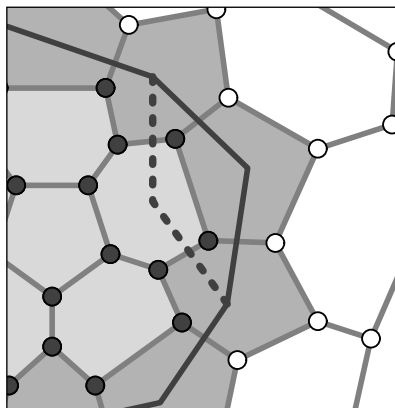
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### About the Cover

In preparing diagrams for Peter Sarnak's article in this issue on Ramanujan graphs, we decided that it would be an interesting exercise to verify that its expansion constant  $h$  is  $1/4$ . I recall that if the graph has  $N$  nodes, then this constant is the minimum value of  $|\partial X|/|X|$ , where  $X$  varies over the subsets of nodes of size at most  $N/2$ . Thus a priori one might expect to have to look at close to  $2^{80}$  subsets of nodes, and, indeed, it has been shown by M. Blum et al. (*Inform. Process. Lett.* **13** (1981)) that this is a very difficult problem. For the graph at hand, however, Sarnak was able to verify by hand that  $h = 1/4$ , and it was also possible to verify the calculation with a computer program that might



work as well for more general 3-regular graphs. The basic idea of the program is to look at the possible *cut sets* separating  $X$  from its complement. There are two key observations that the program is based on. The first is that one need only look at connected subsets  $X$ , and in fact only at cut sets that are Jordan curves. The second observation is that in certain circumstances one need only look at cut sets that satisfy a kind of convexity condition at each vertex. The exact conditions ought to be clear from the accompanying diagrams, where the dashed lines cannot be the cut sets for a candidate  $X$ , since adjusting them in a simple way increases  $|X|$  without decreasing  $|\partial X|$ . (The nodes in  $X$  are dark.)



It is straightforward and entirely practical to make up an algorithm that constructs all admissible cut sets. If  $|X|$  for all of these is not greater than half the number of nodes, the convexity argument above shows that  $h$  can be calculated by perusing the list. Because of the symmetries in the graph at hand, it is necessary to consider only two types of cut sets, and the cover illustration is, in effect, the program output for one of these types. It shows all convex cut sets passing through the top two gray faces (up to mirror symmetry). The minimum value  $1/4$  is achieved in the large diagram at lower left, where  $|X|$  is also the maximum value of 40. This graph is a Ramanujan graph. A result of Lipton and Tarjan (*SIAM J. Appl. Math.* **36** (1979)) implies that there are at most finitely many planar Ramanujan graphs. The largest ones known are 84:20, and 84:23 in the *Atlas of Fullerenes* by P. Fowler and D. Manolopoulos. I'd like to thank A. Gamburd for calling my attention to the graph used here, which he found in a paper by P. Frankin on the four-color problem, and also for telling me about Fullerenes.

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