# BRÅKET

*Information om seminarier och högre undervisning i matematiska ämnen i Stockholmsområdet*

**NR 34** **FREDAGEN DEN 27 OKTOBER 2000**



**BRÅKET**

**Veckobladet från Institutionen för matematik vid Kungl Tekniska Högskolan och Matematiska institutionen vid Stockholms universitet**

*Redaktör:* Gunnar Karlsson

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Institutionen för matematik
KTH
100 44 Stockholm

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*Sista manustid för nästa nummer:*
Torsdagen den 2 november kl. 13.00.


## SEMINARIER

**Fr 10–27 kl. 9.00–10.00. Kollokvium i fysik. Dr Richard L. Kautz,** NIST Boulder: *Chaotic dynamics of the Tilt-A-Whirl.* Sal F 01, Fysiska institutionen, KTH, Lindstedtsvägen 24, b.v. Se Bråket nr 33 sidan 6.

**Fr 10–27 kl. 10.00–11.00. Presentation av examensarbete i matematik. Jonas Gustavsson:** *Coherent measures of risk.* Sal 16, hus 5, Matematiska institutionen, SU, Kräftriket, Roslagsvägen 101.

**Fr 10–27 kl. 10.15. Seminar in Theoretical Physics.** *(Observera dagen och tiden!)* **Professor George F. R. Ellis,** University of Cape Town: *The covariant and gauge invariant approach to cosmological perturbations, including CBR anisotropies.* Rum 4731, Fysikum, SU, Vanadisvägen 9. Se Bråket nr 33 sidan 8.

*Professor Ellis är fakultetsopponent vid Hans Ringströms disputation. Se sidan 7.*

**Fortsättning på nästa sida.**

### Seminarier i statistisk genetik och bioinformatik

Det första seminariet i denna serie äger rum den 2 november. Se sidan 6.

### Disputationer i matematik

*Helge Maakestad* och *Hans Ringström* disputerar båda vid KTH den 27 oktober. Se sidan 7.

### Kurs

*Dževad Belkić:* Resolution Enhancement in Signal and Image Reconstructions. Se sidorna 10–14.

### Conference in Mathematical Analysis

Konferensen äger rum i Linköping den 14 december 2000. Se sidan 7.

### Ledig tjänst

Försvarets radioanstalt söker en kryptolog. Se sidan 8.

**Seminarier (fortsättning)**

**Fr 10−27 kl. 15.15. Matematiska institutionens kollokvium (Uppsala). Professor Lars-Erik Persson,** Luleå tekniska universitet: *Carlson's inequality — some historical remarks and recent developments.* Rum 2247, Matematiska institutionen, Polacksbacken, Uppsala universitet. Institutionen bjuder på kaffe, te och kakor kl. 14.45 i personalrummet. Efter föredraget ges möjlighet till diskussion och förfriskningar. Se Bråket nr 33 sidan 6.

**Må 10−30 kl. 13.15−15.00. Algebra and Geometry Seminar. David Singerman,** Department of Mathematics, Southampton University: *Congruence dessins and congruence subgroups.* Rum 306, hus 6, Matematiska institutionen, SU, Kräftriket, Roslagsvägen 101. Se sidan 4.

**Må 10−30 kl. 15.15−17.00. Seminarium i matematisk statistik. Gunnar Englund:** *Markov Chain Monte Carlo, contingency tables and Gröbner bases.* Seminarierum 3733, Institutionen för matematik, KTH, Lindstedtsvägen 25, plan 7. Se Bråket nr 33 sidan 3.

**Ti 10−31 kl. 13.15. Seminar in Theoretical Physics. Docent Mats Wallin,** Kondenserade materiens teori, Fysiska institutionen, KTH: *Quantum phase transitions in disordered spin systems.* Rum 4731, Fysikum, SU, Vanadisvägen 9. Se sidan 4.

**Ti 10−31 kl. 14.00−15.00. Informal Mittag-Leffler Seminar. Paul Eklof,** Irvine: *Tutorial: The combinatorics of λ-separable Abelian groups and Whitehead groups, 1st part.* Institut Mittag-Leffler, Auravägen 17, Djursholm. Se sidan 3.

**Ti 10−31 kl. 15.00−17.00. Artinian Gorenstein rings and Frobenius algebras. Joachim Kock:** *On the equivalence between 2D topological quantum field theories and (commutative) Frobenius algebras, Part II.* Sammanträdesrum 3548, Institutionen för matematik, KTH, Lindstedtsvägen 25, plan 5.

**On 11−01 kl. 11.00−12.00. Extra analysseminarium. Kathryn Hare,** University of Waterloo: *Littlewood-Paley theorem.* Seminarierum 3721, Institutionen för matematik, KTH, Lindstedtsvägen 25, plan 7. Se sidan 5.

**On 11−01 kl. 13.15. Docentföreläsning i matematik** och **Seminarium i analys och dynamiska system. Stanislav Smirnov:** *Non-uniform hyperbolicity in one-dimensional dynamics.* Seminarierum 3721, Institutionen för matematik, KTH, Lindstedtsvägen 25, plan 7. Se sidan 4.

**On 11−01 kl. 14.00−15.00. Mittag-Leffler Seminar. Boban Velickovic,** Paris: *Games played on partial isomorphisms.* Institut Mittag-Leffler, Auravägen 17, Djursholm.

**On 11−01 kl. 15.15. Seminarium i matematisk statistik. Marianne Mæhle-Schmidt,** Matematisk statistik, SU, och Medicinsk strålningsfysik, KI: *Bayesian sequential updating of radiobiological parameters and optimal treatment dose.* Rum 306, Cramérrummet, hus 6, Matematiska institutionen, SU, Kräftriket, Roslagsvägen 101. Se sidan 7.

**On 11−01 kl. 15.15−16.00. Seminarium i matematik och fysik vid Mälardalens högskola (Västerås). David Singerman,** Department of Mathematics, Southampton University: *From Galois' last letter to Hecke groups and the Buckyball.* Rum N16, Mälardalens högskola, Högskoleplan, Västerås. Internet-adressen till information om seminariet är http://www.ima.mdh.se/_seminars.htm.

**Fortsättning på nästa sida.**

**Seminarier (fortsättning)**

**On 11–01 kl. 15.30 – 16.30. Mittag-Leffler Seminar. Andrey Bovykin,** Birmingham: *Three topics in model theory of arithmetic.* Institut Mittag-Leffler, Auravägen 17, Djursholm.

**To 11–02 kl. 10.30 – 11.15. Waveletseminarium.** *(Observera lokalen!)* **Professor Dževad Belkić,** Medicinsk strålningsfysik, Karolinska institutet och Stockholms universitet: *New high-resolution methods for signal and image processing.* Rum 1537, NADA, KTH, Lindstedtsvägen 3, plan 5. Se Bråket nr 33 sidan 7.

**To 11–02 kl. 13.30 – 15.00. Seminarium i statistisk genetik och bioinformatik. Timo Koski,** Matematisk statistik, Linköping: *Approximate common substring-problemet i bioinformatik.* Sal 21, hus 5, Matematiska institutionen, SU, Kräftriket, Roslagsvägen 101. Se sidan 6.

**To 11–02 kl. 16.15 – 18.00. Seminarium i matematik och fysik vid Mälardalens högskola (Eskilstuna). Johan Lithner,** Umeå universitet: *Matematiska resonemang i lärobokens uppgifter.* Rum B315, Mälardalens högskola, Eskilstuna. Se Bråket nr 33 sidan 10. Internet-adressen till information om seminariet är http://www.ima.mdh.se/_seminars.htm.

**Må 11–06 kl. 15.15 – 17.00. Seminarium i matematisk statistik. Torkel Erhardsson:** *Compound Poisson approximation for visits to rare sets by certain stationary Markov chains and renewal reward processes.* Seminarierum 3733, Institutionen för matematik, KTH, Lindstedtsvägen 25, plan 7. Se sidan 5.

**On 11–08 kl. 15.15 – 16.00. Seminarium i matematik och fysik vid Mälardalens högskola (Västerås). Hillevi Gavel,** Institutionen för matematik och fysik, Mälardalens högskola: *Permutationsordningar och relationsmatriser.* Rum N24, Mälardalens högskola, Högskoleplan, Västerås. Se sidan 5. Internet-adressen till information om seminariet är http://www.ima.mdh.se/_seminars.htm.

**To 11–09 kl. 13.15 – 14.15. Dynamiskt systemseminarium. Professor David Broomhead,** Manchester: *Delay methods applied to iterated function systems.* Seminarierum 3721, Institutionen för matematik, KTH, Lindstedtsvägen 25, plan 7. Se sidan 6.

**To 11–09 kl. 13.30 – 15.00. Seminarium i statistisk genetik och bioinformatik. Stefan Arnborg,** NADA, KTH: *Human Brain Informatics: understanding causes of mental illness.* Sal 21, hus 5, Matematiska institutionen, SU, Kräftriket, Roslagsvägen 101. Se sidan 6.

**Må 11–13 kl. 11.00 – 12.00. Special Lecture. Matematikens år 2000. Professor John Conway,** Princeton: *Title to be announced.* Sal E1, KTH, Lindstedtsvägen 3, b.v.

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**INFORMAL MITTAG-LEFFLER SEMINAR**

**Paul Eklof: Tutorial: The combinatorics of $\lambda$-separable Abelian groups and Whitehead groups, 1st part**

*Abstract:* We present the use of ladder systems, uniformization, and $\lambda$-systems in the construction of groups.

*Tid och plats:* Tisdagen den 31 oktober kl. 14.00 – 15.00 i Institut Mittag-Leffler, Auravägen 17, Djursholm.

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## ALGEBRA AND GEOMETRY SEMINAR

**David Singerman:**
**Congruence dessins and congruence subgroups**

*Abstract:* The most well-known congruence subgroups of the modular group are $\Gamma(N)$, $\Gamma_0(N)$, and $\Gamma_1(N)$. Since the work of Klein, we know that some of the well-known regular maps (or dessins) on the sphere come from quotients of $\Gamma(N)$; for example $N = 5$ gives the regular icosahedron. In this talk we give dessin interpretations of some of the other congruence subgroups. It is also necessary to generalize the modular group to other Hecke groups, but here the solutions are now much less clear.

*Tid och plats:* Måndagen den 30 oktober kl. 13.15 – 15.00 i rum 306, hus 6, Matematiska institutionen, SU, Kräftriket, Roslagsvägen 101.

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## SEMINAR IN THEORETICAL PHYSICS

**Mats Wallin:**
**Quantum phase transitions in disordered spin systems**

*Abstract:* Quantum phase transitions take place at zero temperature and are driven by quantum zero point fluctuations, rather than thermal fluctuations as for finite temperature thermal phase transitions. The traditional understanding of these phenomena build on mappings that place quantum systems in $d$ dimensions and classical systems in $d + 1$ dimensions in common universality classes. Therefore it is highly interesting that disordered quantum systems instead form new universality classes which in general lack classical counterparts. One such example is the recently extensively studied random transverse field Ising spin systems. Remarkably, the renormalization group treatment due to D. Fisher gives many properties of this system exactly for the one-dimensional case, but in higher dimensions very little is understood. I will review some recent work on the two-dimensional random transverse field Ising model, and explain why previous work on this system may have led to incorrect conclusions.

*Tid och plats:* Tisdagen den 31 oktober kl. 13.15 i rum 4731, Fysikum, SU, Vanadisvägen 9.

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## DOCENTFÖRELÄSNING I MATEMATIK
**och**
## SEMINARIUM I ANALYS OCH DYNAMISKA SYSTEM

**Stanislav Smirnov:**
**Non-uniform hyperbolicity in one-dimensional dynamics**

*Abstract:* It is often said that the purpose of dynamical systems as a subject is to describe "most of the dynamics of most of the dynamical systems". We will discuss iteration of rational functions and polynomials from this point of view.

Dynamics of hyperbolic rational functions is completely understood, but unfortunately in many senses they are non-generic, and hence do not account for "most of the dynamical systems". We will examine various notions of non-uniform hyperbolicity, so that such functions become generic while preserving nice properties of the hyperbolic case.

*Tid och plats:* Onsdagen den 1 november kl. 13.15 i seminarierum 3721, Institutionen för matematik, KTH, Lindstedtsvägen 25, plan 7.

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## EXTRA ANALYSSEMINARIUM

### Kathryn Hare: Littlewood-Paley theorem

*Abstract:* The classical Littlewood-Paley theorem and its generalizations have been an important topic in harmonic analysis for many years. It is natural to ask if there are partitions other than (the known examples of) lacunary sets and their iterates for which such a theorem holds. We will discuss joint work with Klemes, which partially answers the conjecture that the Littlewood-Paley theorem holds for any rearrangement of a lacunary partition. Our methods give a new and more elementary proof of the classical theorem and easily transfers to other settings.

*Tid och plats:* Onsdagen den 1 november kl. 11.00 – 12.00 i seminarierum 3721, Institutionen för matematik, KTH, Lindstedtsvägen 25, plan 7.

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## SEMINARIUM I MATEMATISK STATISTIK

### Torkel Erhardsson: Compound Poisson approximation for visits to rare sets by certain stationary Markov chains and renewal reward processes

*Abstract:* Let $\eta$ be a stationary discret time Markov chain which is "strongly aperiodic Harris recurrent" (e.g., an irreducible and positive recurrent Markov chain on a countable state space), with stationary distribution $\mu$. What can be said about the distribution of the number of visits up to time $n$ by $\eta$ to a subset $S_1$ of the state space such that $\mu(S_1)$ is small?

We will here give a bound for the total variation distance between this distribution and a compound Poisson distribution. It will be shown how the bound can be derived using Stein's method, regenerative properties of Harris recurrent Markov chains, and couplings. The bound depends only on much studied quantities like hitting probabilities and expected hitting times, which can be easily computed of the state space is finite. Under certain conditions the bound is of order close to $\log(n\mu(S_1))\mu(S_1)$, or even $\mu(S_1)$.

If time permits, it will also be indicated how these results can be extended, using point process theory, to compound Poisson approximation for the accumulated rewards of stationary renewal reward processes in discrete or continuous time.

*Tid och plats:* Måndagen den 6 november kl. 15.15 – 17.00 i seminarierum 3733, Institutionen för matematik, KTH, Lindstedtsvägen 25, plan 7.

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## SEMINARIUM I MATEMATIK OCH FYSIK VID MÄLARDALENS HÖGSKOLA (VÄSTERÅS)

### Hillevi Gavel: Permutationsordningar och relationsmatriser

*Sammanfattning:* Presentation av några olika permutationsordningar. Ett detaljerat studium av den rekursiva strukturen hos relationsmatriserna för ordningarna i fråga. Presentation av en metod för att beräkna hur svår en permutation är att generera, om elementen står i en cirkel och får byta plats med grannen (cyclicly adjacent transpositions), och några ord om andra variationer på temat omflyttning av objekt placerade i en ring.

*Tid och plats:* Onsdagen den 8 november kl. 15.15 – 16.00 i rum N24, Mälardalens högskola, Högskoleplan, Västerås.

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## DYNAMISKT SYSTEMSEMINARIUM

**David Broomhead:**
**Delay methods applied to iterated function systems**

*Abstract:* When Ruelle and Takens first speculated about the possible relevance of strange attractors to the understanding of fluid turbulence in the late 1970's, they stimulated a great deal of scientific activity. Much of this was by physicists who wished to look for experimental evidence to support the Ruelle-Takens view. This interest caused several people — including Floris Takens and Crutchfield, Farmer, Packard and Shaw in USA — to look for a way to connect the simple time series measurements that experimentalists are able to make with the natural state space description of a system used in dynamical systems theory. The technique they developed is known as "delay embedding" or "the method of delays". In the following 20 years, this basic idea has taken on a significance which has outlived its original motivation. This talk will concern a recent application of the method of delays to iterated functions systems. One potentially important use of this work is in digital signal processing.

*Tid och plats:* Torsdagen den 9 november kl. 13.15 – 14.15 i seminarierum 3721, Institutionen för matematik, KTH, Lindstedtsvägen 25, plan 7.

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## SEMINARIER I STATISTISK GENETIK OCH BIOINFORMATIK

Under höstterminen 2000 kommer en serie seminarier om statistisk genetik och bioinformatik att äga rum vid Matematiska institutionen, avd. matematisk statistik, vid Stockholms universitet enligt följande schema:

**To 11–02 kl. 13.30 – 15.00. Timo Koski,** Matematisk statistik, Linköping: *Approximate common substring-problemet i bioinformatik.* Sal 21.

**To 11–09 kl. 13.30 – 15.00. Stefan Arnborg,** NADA, KTH: *Human Brain Informatics: understanding causes of mental illness.* Sal 21.

**To 11–16 kl. 11.00. Juha Kere,** Genome Centre, Helsingfors Universitet: *Finding genes in multifactorial diseases — a rare population approach.* Sal 14 (Gradängsalen).

**To 11–16 kl. 11.50. Holger Luthman,** Clinical Genetics, KI: *Animal models for multifactorial diseases.* Sal 14 (Gradängsalen).

**To 11–16 kl. 13.30. Joe Terwilliger,** Columbia University, New York: *Title to be announced.* Sal 14 (Gradängsalen).

**To 11–16 kl. 14.20. Paul Burton,** Genetic Epidemiology, Leicester University, UK: *Generalized linear mixed models in statistical genetics.* Sal 14 (Gradängsalen).

**To 11–16 kl. 15.30. David Clayton,** Cambridge University, UK: *Title to be announced.* Sal 14 (Gradängsalen).

**To 11–30 kl. 13.30 – 15.00. Gunnar von Heijne,** Stockholm Bioinformatic Centre, SU: *Why bother about bioinformatics — and what is it anyway?* Sal 21.

**To 12–07 kl. 13.30 – 15.00. Gunnar Persson,** Stockholm Bioinformatic Centre, KI: *Bioinformatik i sökande efter proteinfunktion.* Sal 21.

Salarna finns i hus 5, Matematiska institutionen, SU, Kräftriket, Roslagsvägen 101.

Välkomna!
Juni Palmgren och Åke Svensson

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## DISPUTATION I MATEMATIK

**Helge Maakestad**

disputerar på avhandlingen

**Chow-groups of discriminants and principal parts on $P^1$**

fredagen den 27 oktober 2000 kl. 10.00 i sal D3, KTH, Lindstedtsvägen 5, b.v. Till fakultetsopponent har utsetts *professor Trygve Johnsen,* Matematisk Institutt i Bergen.

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## DISPUTATION I MATEMATIK

**Hans Ringström**

disputerar på avhandlingen

**On the asymptotics of Bianchi class A spacetimes**

fredagen den 27 oktober 2000 kl. 13.15 i sal E1, KTH, Lindstedtsvägen 3, b.v. Till fakultetsopponent har utsetts *professor George F. R. Ellis,* University of Cape Town.

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## SEMINARIUM I MATEMATISK STATISTIK

**Marianne Mæhle-Schmidt: Bayesian sequential updating of radiobiological parameters and optimal treatment dose**

*Abstract:* A sequential approach for updating parameters in a radiobiological model, and thereby the radiation doses used to treat cancer patients will be presented. The model is defined in terms of the probability of achieving tumour control and the risk of inducing injury. Formally the statistical model is specified as a generalized linear mixed model with a complementary log-log link. The patients treated are divided into sequences of patients. In each sequence historical prior information and new patient outcomes are used to calculate an updated posterior distribution for the radiobiological parameters. The posterior is then used as a new prior and the process is iterated. The underlying Bayesian model will be presented together with results of simulation studies on convergence when varying parameters in the model. Furthermore ideas for extension of the model will be discussed.

*Tid och plats:* Onsdagen den 1 november kl. 15.15 i rum 306, Cramérrummet, hus 6, Matematiska institutionen, SU, Kräftriket, Roslagsvägen 101.

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**Conference in Mathematical Analysis on the occasion of Lars Inge Hedberg's 65th birthday**

This conference will be held at Linköping University on December 14, 2000. The speakers will be Lennart Carleson, Viktor Havin, Olli Martio, and Vladimir Maz'ya. For more information see http://www.mai.liu.se/TM/LIH-conference/.

Please notice that the deadline for registration is November 10.

Welcome!

Anders Björn
E-mail: anbjo@mai.liu.se

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### Vill du bli kryptolog?

FRA, Försvarets radioanstalt, är en civil myndighet under Försvarsdepartementet, som genom signalspaning svarar för en betydande del av Sveriges underrättelsetjänst.

*Arbetsuppgifter:* Du kommer att ingå i en grupp som löser komplicerade och stimulerande kryptologiska problem. Enskilt och tillsammans med andra skall du konstruera och analysera matematiska modeller och metoder för problemlösning, programmera och göra utredningar av teoretisk karaktär. Arbetet sker under stort eget ansvar och du får goda möjligheter att vidareutveckla och fördjupa dina kunskaper.

*Kvalifikationer:* Vi söker dig med en utbildning i matematik, datalogi eller liknande, gärna forskarutbildning. För att lyckas i jobbet bör du dessutom ha fantasi, vara optimistisk samt resultatinriktad.

*Mer information:* Vi är övertygade om att en blandning av kvinnor och män i alla åldrar skapar en dynamisk och kreativ arbetsmiljö. Arbetsplatsen är belägen på Lovön, cirka 10 minuter med buss från Brommaplan. Svenskt medborgarskap är ett krav, och innan du anställs kommer registerkontroll att göras. Ytterligare upplysningar lämnas av Anders Eriksson eller Ola Sommelius, telefon 08-471 46 00. Se även FRA:s företagspresentation under www.stepstone.se. Din ansökan med betygskopior, märkt dnr 16 321:61247, vill vi ha senast måndagen den 6 november 2000 till FRA, Box 301, 161 26 Bromma.

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## MONEY, JOBS

*Columnist:* Pär Holm, Department of Mathematics, SU. E-mail: pho@matematik.su.se.

Info = information. This will be given and repeated until obsolete. Rely on other sources as well.
BBKTH = Bulletin Board at the Department of Mathematics, KTH.
BBSU = Bulletin Board at the Department of Mathematics, SU.
Unless stated otherwise, a given date is the last date (e.g. for applications), and the year is 2000. A number without an explanation is a telephone number.

### Standard information channels

1. A channel to information from TFR: http://www.tfr.se.
2. A channel to information from NFR: http://www.nfr.se.
3. A channel to information from the European Mathematical Society: http://www.emis.de.
4. A channel to information from the American Mathematical Society: http://www.ams.org.
5. KTH site for information on funds, etc., weekly: http://www.kth.se/aktuellt/stipendier/.
6. Stockholm University site for information on funds: http://apple.datakom.su.se/stipendier/.
7. Umeå site for information on funds: http://www.umu.se/umu/aktuellt/stipendier_fond_anslag.html.
8. Job announcement site: http://www.maths.lth.se/nordic/Euro-Math-Job.html. This is run by the European Mathematical Society.
9. KTH site for information on research: http://www.admin.kth.se/CA/extrel/index/forsk.html.

### New information

*Jobs, to apply for*

10. Försvarets radioanstalt (FRA) söker person med utbildning i matematik, datalogi eller liknande, gärna forskarutbildning, för arbete som kryptolog, 6 november. Svenskt medborgarskap är ett krav och innan man anställs kommer registerkontroll att göras. Info: Anders Eriksson eller Ola Sommelius, 08-471 46 00. Web-info: http://www.stepstone.se/sok/ramme2.html?fs=finn&done=yes&sok=kundeid&id=47069. Se detta nr av Bråket sidan 8.

(Continued on the next page.)

11. Sida söker till ett projekt i Asmara, Eritrea, en matematiker att arbeta med staffsecondment (undervisning, delta i uppbyggandet av institutionen) under vårterminen 2001. Det finns inget sista ansökningsdatum, men besked önskas så snart som möjligt. Info: Staffan Wiktelius, staffan.wiktelius@isp.uu.se, Sten Kaijser, sten.kaijser@math.uu.se, eller Leif Abrahamsson, leif.abrahamsson@math.uu.se. Web-info: Finns ingen rörande denna tjänst, men information om projektet finns på http://www.uu.se:80/Adresser/Directory/deps/SI12.html.

**Old information**

*Money, to apply for*

12. Kungliga Vetenskapsakademien (KVA) utlyser följande stipendier och anslag inom bl.a. matematik:

    Postdoc-stipendier för ett till två års vistelse i Japan, Israel eller Sydafrika. 1 november.

    Anslag för projektsamarbete mellan forskare i Sverige och länderna inom f.d. Sovjetunionen. 15 februari 2001.

    Anslag för projektsamarbete med forskare i Polen, Storbritannien, Tjeckien eller Ungern. 26 februari 2001.

    Forskarutbyte för vistelse två till åtta veckor i Estland, Lettland eller Litauen; två veckor till sex månader i Japan, Kina eller Ryssland, eller högst två veckor i Österrike. 1 november.

    Info: 08-673 95 00, stipendier@kva.se. Web-info: http://www.kva.se/sve/pg/int_samarbete/utbyte/index.asp.

13. Stiftelsen för internationalisering av högre utbildning och forskning (STINT) utlyser bidrag för kortare utlandsvistelser för lärare eller forskare vid svenskt universitet, högskola eller forskningsinstitut, dock ej doktorander. Ansökan kan inlämnas fortlöpande under året, dock senast 8 veckor före den dag då utlandsvistelsen avses påbörjas. Web-info: http://www.stint.se/KPutlys.html.

14. Anslag ställs, från Knut och Alice Wallenbergs Stiftelse, till rektors för KTH förfogande för att "i första hand användas till bidrag för sådana resor, som bäst befordrar ett personligt vetenskapligt utbyte till gagn för svensk forskning. Bidrag skall främst beviljas till yngre forskare." Ansökan om resebidrag skall ställas till rektors kansli. Bidrag kan sökas när som helst under året. Info: se punkt 5 ovan.

15. Nordisk Forskerutdanningsakademi (NorFA) finansierar nordiskt samarbete inom forskning och forskarutbildning genom dels personliga stipendier (mobilitetsstipendier och för deltagande i nationella forskarutbildningskurser), dels anslag till institutioner (forskarutbildningskurser, nordiska nätverk, gästprofessurer och workshops). Info: http://www.norfa.no.

16. Svenska Institutet (SI) utlyser kontinuerligt stipendier och bidrag för studier och forskning utomlands: stipendier för Europastudier, internationella forskarstipendier, Östersjöstipendier, Visbyprogrammet, m.m. Aktuell information om SI:s samtliga stipendiemöjligheter och ansökningshandlingar finns på SI:s hemsida: http://www.si.se.

17. Stiftelsen för internationalisering av högre utbildning och forskning (STINT) utlyser medel för att främja samarbete med universitet och högskolor i Republiken Korea (Sydkorea), Taiwan, Hongkong, Indonesien och Egypten. Ansökningar skall inlämnas minst 6 – 8 veckor före verksamhetsstarten, och medlen kan sökas löpande under året. Info: STINT, Skeppargatan 8, 114 52 Stockholm, 08-662 76 90. Web-info: www.stint.se.

18. Wenner-Gren Stiftelserna utlyser gästföreläsaranslag, avsedda att möjliggöra för svenska forskare eller institutioner att inbjuda utländska gästföreläsare. Anslag sökes av den inbjudande forskaren eller institutionen. Ansökan kan inlämnas när som helst under året. Web-info: http://www.swgc.org/.

19. NUTEK stipends for stay in research institutions (not universities) in Japan. Short or long periods. For persons with or almost with doctoral degree. Info: Kurt Borgne, 08-681 92 65, kurt.borgne@nutek.se. You can apply at any time.

*Jobs, to apply for*

20. Institutionen för matematik vid Luleå tekniska universitet utlyser två doktorandtjänster i matematik (waveletsteori med tillämpningar inom signalbehandling och medicinsk teknik), 1 november. Info: Thomas Gunnarsson, 0920-918 50, tomas@sm.luth.se, eller Lars-Erik Persson, 0920-911 17, larserik@sm.luth.se. Web-info: http://www.sm.luth.se/math/staff/vacancy.html.

21. Matematiska institutionen vid SU söker en 1:e forskningsingenjör, 10 november. Info: Torsten Ekedahl, 08-16 45 26, eller Torbjörn Tambour, 08-16 45 16. Web-info: http://www.matematik.su.se/matematik/jobb/Foingannons.html.

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22. Institutionen för matematik, natur- och datavetenskap vid Högskolan i Gävle söker två universitetslektorer i matematik, 20 november. Info: Birgit Sandqvist, 026-64 87 85, bst@hig.se, eller Mirco Radic, 026-64 87 83, mrc@hig.se. Web-info: http://www.hig.se/aktuellt/lediga_anstallningar/ma_lektorer.html.
23. Matematiska institutionen vid Linköpings universitet söker minst en universitetslektor i tillämpad matematik, 22 november. Info: Svante Linusson, 013-28 14 45, svlin@mai.liu.se, eller Arne Enqvist, 013-28 14 14, arenq@mai.liu.se. Web-info: http://www.info.liu.se/jobb/mera/LiU1313-00-32.html.
24. Matematiska institutionen vid Linköpings universitet söker en universitetslektor i matematisk statistik, 22 november. Info: Timo Koski, 013-28 14 54, tikos@mai.liu.se, eller Eva Enqvist, 013-28 14 33, evenq@mai.liu.se. Web-info: http://www.info.liu.se/jobb/mera/LiU1293-00-32.html.
25. Matematiska institutionen vid Linköpings universitet söker en forskarassistent i matematisk statistik, 22 november. Info: Timo Koski, 013-28 14 54, tikos@mai.liu.se. Web-info: http://www.info.liu.se/jobb/mera/DnrLiU1292-00-32.html.
26. Naturvetenskapliga forskningsrådet (NFR) utlyser en forskartjänst inom stokastiska processer, 15 december. Info: Natalie Lunin, 08-454 42 32. Web-info: se punkt 2 ovan.

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## GRADUATE COURSE

### Dževad Belkić:
### Resolution Enhancement in Signal and Image Reconstructions

*Dževad Belkić* is Guest Professor in "Mathematical Radiation Physics" at Karolinska Institutet, Stockholm.

The credit of the course is 5 p. It is given on one day per week (Wednesday) from January 24, 2001, to March 21, 2001.

The course is given in room 1537, NADA, KTH, Lindstedsvagen 3, floor 5.

*Literature:*

1. A textbook by Frank Natterer, *The Mathematics of Computerized Tomography,* John Wiley & Sons, New York (1989).
2. A textbook by Dževad Belkić, *The Principles and Methods of Quantum Scattering Theory,* Institute of Physics Publishing Ltd. (Bristol, England), to appear in March 2001 [ISNP 075030496] (http://bookmark.iop.org/bookpge.htm?ID=617983879-6410-59741210-D&book=493h).

#### *Description of the course*

Three novel nonlinear parameter estimators for spectra and images are devised and implemented for accurate and fast processing of experimentally measured or theoretically generated time signals of arbitrary length. The new techniques can also be used as powerful tools for diagonalization of large matrices that are customarily encountered in physics, chemistry, biology, medicine, and in many other interdisciplinary research fields. The key to the success and the common denominator of the proposed methods is a considerably reduced dimensionality of the original data matrix. This is achieved in a pre-processing stage called beamspace-windowing or band-limited decimation. The methods are Decimated Signal Diagonalization (DSD), Decimated Linear Predictor (DLP), and Decimated Padé Approximant (DPA). Particularly attractive is DPA, which is a generic rational approximation, and for a given series it is defined as the *unique* quotient of two polynomials. The mathematical equivalence of the three operationally different methods, DSD, DLP, and DPA, is shown for signals that are modelled by a linear combination of time-dependent damped exponentials with stationary amplitudes. The ability to obtain all the peak parameters first and construct the required spectra afterwards enables the present methods to phase correct the absorption mode. Our results for spectra and images obtained using both synthesized and experimental time signals show that DSD/DLP/DPA exhibit an enhanced resolution

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power relative to the standard Fast Fourier Transform (FFT). Of the three methods, DPA is found to be the most efficient computationally. In practice, it is particularly important that by a factor of *2* improved resolution within DPA relative to FFT in, e.g., Fourier-based mass spectroscopy via the so-called Ion Cyclotron Resonance (ICR) experimental technique, is equivalent to the usage of *1/2* of the strength $B$ of the magnetic field, which is more than *twice* cheaper. The current world record of 1 per $8 \times 10^6$ resolving power in mass spectroscopy is achievable within a handfull of laboratories possessing the magnets with $B = 11.4$ T. The same accuracy with the magnetic field strength of only $B/2$ would enable hundreds of more laboratories worldwide to significantly participate to this field, the progress of which has thus far been unnecessarily restricted and dictated exclusively by advances in hardware. The new robust and stable processors DSD/DLP/DPA have already produced *the paradigm shift* in here demonstrating that high resolution in measurements crucially depends upon data processing, i.e., software and not exclusively on hardware upgrading. Even with most advanced commercial hardware, one still relies heavily upon the FFT processor, which is built in every spectrometer. It then appears natural to complement FFT in these spectrometers with some alternative high-resolution parametric processors, e.g., DSD/DLP/DPA that are capable of simultaneously supplying both the shape of the examined spectra and the necessary quantification of every spectral feature via peak searching of the positions, widths, relaxation times and phases without recourse to any post-processing fits and adjustments. Strong and abundant evidence which supports such a far-reaching refreshed strategy in data processing will thoroughly be presented during this course. The illustrative figure shown in this abstract of one of the lectures indicates the superior performance of DPA relative to FFT.

The original development of DSD/DLP/DPA has been accomplished in processing general one-dimensional time signals. However, there is a remarkable flexibility, particularly of the Padé approximant, for versatile extensions of our codes to advanced processing of data in any finite number of dimensions. Such a fascinating opportunity has indeed been recently exploited, and we introduced the Fast Padé transform (FPT) within the two-dimensional sampling in the momentum $\vec{k}$-space. Unlike DPA, the FPT does not necessitate windowing and, therefore, can produce the entire spectra and images from the full Nyquist intervals without any band limited decimation of the original signal. The first results obtained by FPT in Magnetic Resonance Imaging (MRI) showed great promise in the anticipated outperformance over the conventional FFT, especially regarding the higher resolving power and noise reduction which is based on the stabilization method from resonance scattering theory. Images that we have reported at the Nobel Institute sponsored International Conference "Imaging 2000" (Stockholm, June 28 – July 1, 2000) aroused considerable attention and were awarded with the message delivered by Professor S. Majewski in the concluding talk of the Conference indicating, in his words, that "the Fast Padé Transform is the method of choice which promotes Karolinska Institutet to the leading role in imaging".

Recently, we extended FPT to encompass the Computerized Tomography (CT) by using the Padé ansatz as an optimal filter and also as an accelerator of two-dimensional quadratures. Here, based upon the principles and methods of scattering theory, which is the main theme of this course, we implemented a newly discovered *explicit* version of the attenuated Radon Transform (RT), $R_\mu(\omega, p)$, where the Padé polynomial quotient is advantageously employed to enhance convergence of the inherent Riemann sum, which is a simple trapezoidal-type numerical integration. In CT, given the map of the attenuation coefficients $\mu(x)$ of tissue, one measures the radiation flux or emission data, $g(\omega, p)$, defined by the attenuated RT:

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$$g(\omega,p)\equiv(R_\mu f)(\omega,p)=\int_{x\cdot\omega=p} f(x)\rho^-(\omega^\perp,x)dx,$$

where $dx$ is the two-dimensional Lebesgue measure restricted to the line $x\cdot\omega=p$, the symbol $\omega\cdot x$ denotes the inner product, $\omega$ is a directional two-component angle, $\omega=(\cos\phi,\sin\phi)$, $\omega^\perp=(-\sin\phi,\cos\phi)$ and $\rho^\pm(\omega,x)=\exp(\pm\int_0^\infty dt\,\mu(x+t\omega)$, with $t$ being a scalar. The final mathematical goal in CT is to numerically invert the above equation for $g(\omega,p)$ and obtain the integrand $f(x)$, which is the activity distribution. In computations, we employ a novel explicit inversion formula for $f(x)$ which is given by:

$$f(x)=-\frac{1}{4\pi}\mathrm{div}\,Re\int_{S^1} d\omega\omega\rho^+(\omega^\perp,x)g_\mu(\omega,x\cdot\omega),$$

where $S^1$ is a circle. Here, $g_\mu(\omega,p)=(\mathrm{e}^{-h}H\mathrm{e}^h g)(\omega,p)$, with $2h\equiv 2h(\omega,p)=(I+iH)R_\mu(\omega,p)$, where $I$ and $H$ are the identity and the Hilbert transform, $(Hg)(\omega,p)=(1/\pi)\mathcal{P}\int d\tau\, g(\omega,\tau)/(p-\tau)$, respectively, and the symbol $\mathcal{P}$ stands for the usual Cauchy principal value. Our implementation of the above explicit inversion formula for $f(x)$, when computationally refined through FPT, yields much more accurate results than the conventional back-projection technique for numerical inversion of the quoted integral in RT for $g(\omega,p)$ with the known kernel $\rho^-(\omega^\perp,x)$.

Critical to MRI and CT is the accuracy and speed of computations as well as stability and robustness. Accuracy is the weakest point of FFT, but the other three mentioned features are not a problem. It is these three later properties that FPT shares with FFT. One of the novel features brought to the field of MRI and CT by FPT is its improved accuracy, which is enhanced by *orders of magnitude* relative to the conventional algorithms, and this will be thoroughly illustrated during the course. To this end we have carried out a large number of tests to check the precision of FPT. Since the basic equations in MRI and CT are direct two-dimensional (2D) quadratures, the performance of FPT will be most clearly tested on some exactly solvable double integrals. Therefore, we computed the following typical integral:

$$\int_{a_1}^{b_1}\int_{a_2}^{b_2} dudvF(u,v)=\Delta_1\Delta_2\sum_{m_1=0}^{2^m-1}\sum_{m_2=0}^{2^m-1}F(a_1+m_1\Delta_1,a_2+m_2\Delta_2),$$

where $\Delta_j=(b_j-a_j)/N$, $N=2^m(m=0,1,2,\ldots)$. The special one-dimensional (1D) case of this equation is obtained by supressing $y$ and $\Delta_2$, so that the resulting integral over the function $F(u)$ finally leads to a single summation. The above twofold quadrature is replaced by the Riemann sum which, in the case of convergence, gives the exact result as $m$ reaches its infinitely large value. To have a more compact tabular display of the outcomes of the computations, we shall here present only the results for real functions $F(u)$ and $F(u,v)$. Our findings are reported in the displayed Table for a set of the selected 1D- and 2D-quadratures. The results labelled as 'Fourier' correspond to the direct additions of the Riemann partial sums that are also encountered in FFT and RT. The results headed with the name 'Padé' are obtained from the Wynn epsilon-algorithm of the Padé approximant. We found that the results of the Fourier method exhibit poor accuracy and bad convergence properties with the increasing number $N$ of the integration points despite the simple functions selected in the 1D and 2D quadratures. By contrast, the Padé method is seen in the shown Table to be highly satisfactory, since its convergence is indeed impressively fast and the achieved accuracy is remarkable. For example, using $N=1024$, the Fourier method barely secures

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one or at most two decimal places relative to *the unprecedented 12 exact decimal places* obtained by the Padé approximant. Even $N = 256$ suffices for the Padé method to yield at least seven decimal places of accuracy. The notation $1.234, n$ in the Table denotes $1.234 \times 10^n$.

**ONE- AND TWO-DIMENSIONAL FOURIER & PADÉ TRANSFORMS:**

**ONE DIMENSION (1D);** $\int\limits_{R^1} du F(u)$ :

| $F(u)$ | $u^2$ | $u(1-\frac{3}{4}\sin^2 u)^{-1/2}$ | $\mathrm{e}^{5/4-u}(1+\frac{1}{4}u^2)^{-1}\cos\frac{11}{4}u$ |
|---|---|---|---|
| $N \setminus R^1$ | $u \in [0, \pi/2]$ | $u \in [0, \pi]$ | $u \in [0, 1]$ |
| **Padé** | | | |
| 16 | 1.291928195012, 0 | 6.020866480275, 0 | 7.436813973732, −1 |
| 64 | 1.291928195012, 0 | 6.003555951081, 0 | 7.409522181371, −1 |
| 256 | 1.291928195012, 0 | 6.003551456295, 0 | 7.409429958049, −1 |
| 1024 | 1.291928195012, 0 | 6.003551456295, 0 | 7.409429950859, −1 |
| **exact** | 1.291928195012, 0 | 6.003551456295, 0 | 7.409429950859, −1 |
| Fourier (1024) | 1.2938, 0 | 6.008, 0 | 7.422, −1 |

**TWO DIMENSIONS (2D);** $\iint\limits_{R^2} du dv F(u, v)$ :

| $F(u, v)$ | $u^2 v^2$ | $(1+u^2+v^2)^{-2}$ | $\mathrm{e}^{\lvert 3(u+v-1)/4\rvert}\cos\frac{3}{4}(u+v)$ |
|---|---|---|---|
| $N \setminus R^2$ | $u \& v \in [0, \pi/2]$ | $u \& v \in [0, \infty]$ | $u \& v \in [0, 1]$ |
| **Padé** | | | |
| 16 | 1.552840436072, 0 | 7.867535995581, −1 | 9.021774810629, −1 |
| 64 | 1.669281593715, 0 | 7.853987581645, −1 | 9.014768838583, −1 |
| 256 | 1.669078461068, 0 | 7.853981600598, −1 | 9.014787590608, −1 |
| 1024 | 1.669078461068, 0 | 7.853981633975, −1 | 9.014787554676, −1 |
| **exact** | 1.669078461068, 0 | 7.853981633975, −1 | 9.014787554676, −1 |
| Fourier (1024) | 1.664, 0 | 7.866, −1 | 9.023, −1 |

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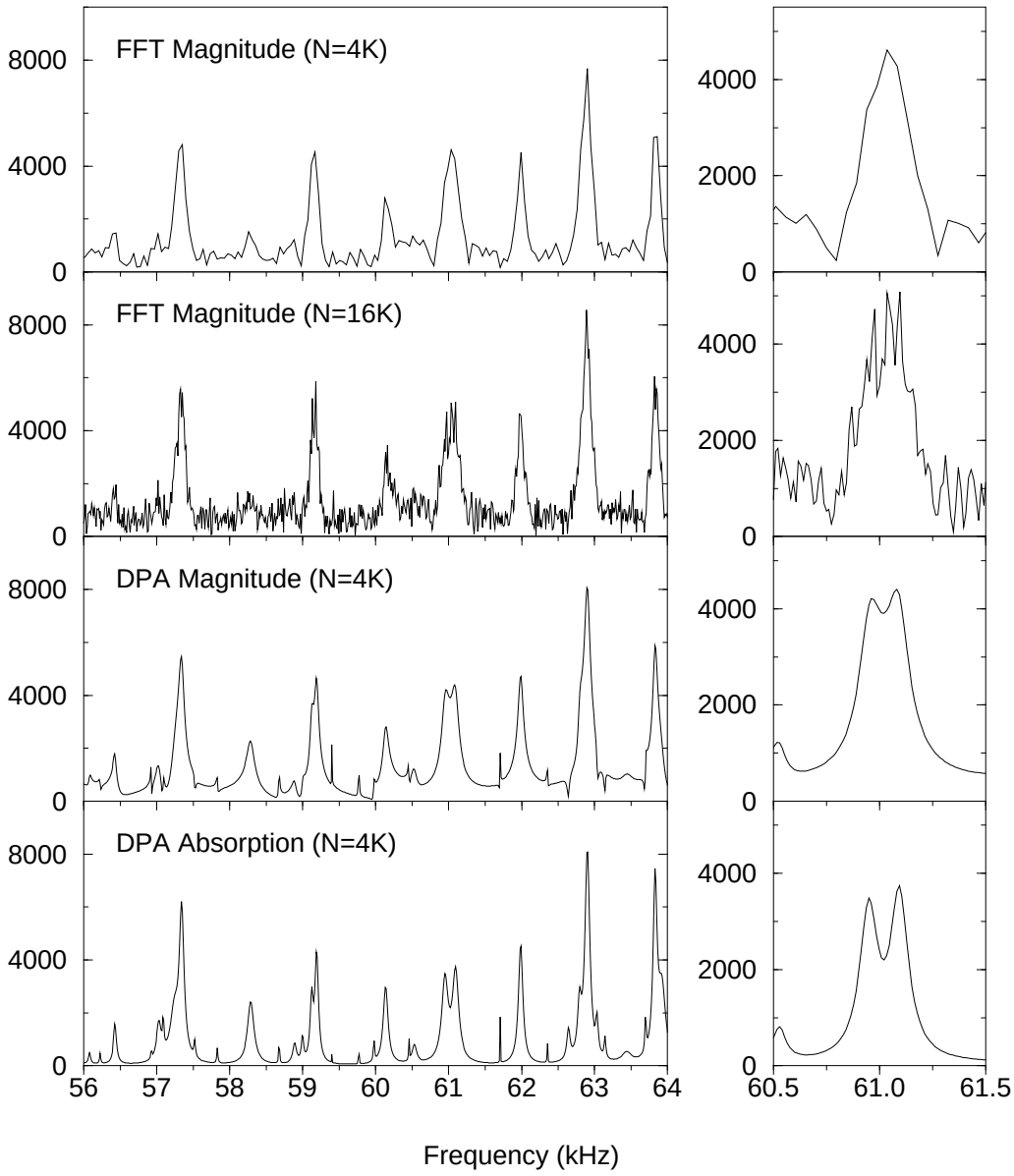


Frequency spectra of the isotopic fine structure of apotransferrin with mass close to 77 kDa. The experimental time signal has been measured by means of the FFT-ICR mass spectroscopy together with the so-called collisionally induced dissociation. This has been carried out at the Ångström Laboratory, Uppsala, and was kindly made available to us by Dr. Jan Axelsson. The panels in the right-hand column show magnifications of the spectra in the region of a doublet located at 61 kHz. The top two panels show the FFT magnitude spectra obtained using $N = 4\text{K}$ and $N = 16\text{K}$ of the measured signal points. The bottom panel depicts the corresponding DPA absorption spectrum obtained using only $N = 4\text{K}$. With the length $N = 4\text{K}$ and 8K (the latter not shown to avoit clutter), the FFT is unable to resolve the otherwise existing doublet around 61 kHz as evidenced more clearly on the magnification panel on the right hand side of the figure. *Moreover, the expected increase in FFT resolution is not obtained with further increasing the signal length to* $N = 16\text{K}$. Hence, in this case FFT cannot extract information from the measured time signal. In a sharp contrast to this, DPA resolves the doublet with only a quarter of the signal lengh, $N = 4\text{K}$.