W. Arendt (Ulm)

**Gaussian estimates for Schrödinger operators**

ABSTRACT: In this talk we will consider elliptic operators with unbounded drift. In order to obtain a generator of a semigroup the coefficient of order 0 has to be unbounded to compensate the effect of the unbounded drift. For this reason we call these operators Schrödinger operators. In the talk precise conditions will be given which imply Gaussian estimates for the semigroup. Roughly, they say that the potential has to be negative enough.

In the second part, we will show that, given any positive semigroup with Gaussian estimates, one may add potentials of the Kato class and keep Gaussian estimates. The proof is based on an unusual Hölder’s inequality for positive semigroups perturbed by a potential, which is admissible in the sense of Voigt. If we take, as a particular case, a semigroup with unbounded drift as discussed in the first part, we see that the admissibility condition is optimal.

**References**


P. Auscher (Paris-Sud)

**Maximal estimates and Riesz transforms for Schrödinger operators with absorbing potentials**

ABSTRACT: We present some new maximal estimates in $L^p$ for Schrödinger operators $-\Delta + V$ with nonnegative potentials on $\mathbb{R}^n$ and their square roots whenever $V$ satisfies reverse Hölder estimates.

This is joint work with Besma Ben Ali.

M. van den Berg (Bristol)

**Heat content and Hardy inequality for complete Riemannian manifolds**

ABSTRACT: Upper bounds are obtained for the heat content of an open set $D$ in a complete Riemannian manifold, provided the Dirichlet Laplace-Beltrami operator satisfies a strong Hardy inequality, and the distance function on $D$ satisfies an integrability condition.
Ph. Briet (Toulon)
ABSTRACT: In this talk, we give a variant of the usual analytic perturbation theory for the Gibbs semigroups of operators in the case of magnetic perturbation. We apply these results to prove the existence of the thermodynamic limit of the pressure and of magnetic susceptibilities for charged perfect quantum gases.

V. Cachia (Genève)
Convergence at the origin of integrated semigroups
ABSTRACT: Integrated semigroups are a very efficient tool for the regularization of ill posed Cauchy problems. We show how their behaviour at the origin is related to the singularity of the associated Cauchy problem. By an improved generation theorem we characterize the \( \kappa \)-times integrated semigroups \( S(t) \) with the convergence rate \( S(t) \leq O(t^\alpha) \) near the origin \( (0 \leq \alpha \kappa) \). For \( \kappa - 1 < \alpha \leq \kappa \) this leads to an integrated version of Euler’s exponential formula. For integrated semigroups with holomorphic extension to a half-plane we show that the convergence rate at the origin corresponds to some growth bounds for the associated holomorphic semigroup, and to the existence of boundary values at some integration order. An example will illustrate all these situations.

J.A. van Casteren (Antwerpen)
Feynman-Kac propagators and viscosity solutions
ABSTRACT: Our aim is to study viscosity solutions to the following terminal value problem on \([0, t] \times E\):
\[
\begin{cases}
\frac{\partial u}{\partial \tau}(\tau, x) + [A(\tau)u(\tau)](x) - V(\tau, x)u(\tau, x) = 0 \\
u(t, x) = f(x),
\end{cases}
\]
where \( E \) is a locally compact second countable Hausdorff topological space equipped with a reference measure \( m \), \( f \in L^\infty(m) \), and \( V \) satisfies a Kato type condition. It is assumed that a transition probability density \( p \) is given, and the family of operators \( A(\tau) \) is defined by
\[
A(\tau)h(x) = \lim_{\epsilon \to 0^+} \frac{Y(\tau + \epsilon, \tau)h(x) - h(x)}{\epsilon},
\]
where \( Y \) denotes the free backward propagator associated with \( p \). It is shown in the paper that under some restrictions on \( p, V, \tau_0 \in [0, t] \), and \( x_0 \in E \), the backward Feynman-Kac propagator \( Y_V \) associated with \( p \) and \( V \) generates a viscosity solution to the terminal value problem above at the point \((\tau_0, x_0)\). Similar result holds in the case where the function \( V \) is replaced by a time-dependent family \( \mu \) of Borel measures on \( E \).

M. Combescure (Lyon)
Classical, quantum and semiclassical fidelity
RESUME: La notion de "fidélité" a été introduite en mécanique classique ou quantique pour mesurer la sensibilité des dynamiques par rapport à de (petites) perturbations du Hamiltonien;
H. Cornean (Aalborg)

**On the thermodynamic limit of large magnetic systems**

ABSTRACT: Our work is motivated by the theory of Faraday effect in solids, which amounts to the study of the conductivity tensor of noninteracting electrons, subjected to a periodic scalar potential and a constant magnetic field. Thermodynamic limit here means that the box where the particles live tends to fill the whole space. Working in the grand-canonical ensemble, we rigorously formulate and prove the existence of the thermodynamic limit for the conductivity.

This is joint work with G. Nenciu.

Th. Coulhon (Cergy-Pontoise)

**Characterization of sub-Gaussian heat kernel estimates on strongly recurrent graphs**

ABSTRACT: Sub-Gaussian estimates for random walks are typical of fractal graphs. We characterize them in the strongly recurrent case, in terms of resistance estimates only, without assuming elliptic Harnack inequalities.

This talk relies on a joint work with Martin Barlow and Takashi Kumagai.

M. Crouzeix (Rennes)

**Numerical range and functional calculus in Hilbert space**

ABSTRACT: In this talk we will present the following inequality: \( \|p(A)\| \leq 31 \text{sup}\{\|p(z)\|; z \in W(A)\} \), which is valid for any polynomial \( p \) and any square matrix \( A \) with complex entries, here \( W(A) \) denotes the numerical range of \( A \). We will illustrate this with some applications to the functional calculus, and will give some insights of the proof.

M. Demuth (Clausthal)

**Dynkin’s formula and large coupling rates**

ABSTRACT: Let \( L \) be a nonnegative self-adjoint operator in \( L^2(\mathbb{R}^d) \), and \( H_0 = L + 1 \). Perturb \( H_0 \) by a compact operator \( J \) mapping \( \text{dom}(H_0^{1/2}) \) into \( L^2(\mathbb{R}^d, \mu) \), i.e. \( J \) is a perturbation by the measure \( \mu \). Setting \( H_\beta = H_0 + \beta \mu \), \( \beta > 0 \), then \( H_\beta \) tends to a self-adjoint operator \( H_\infty \) in strong resolvent sense as \( \beta \to \infty \). A generalized Dynkin’s formula for \( H_0^{-1} - H_\infty^{-1} \) is studied. Moreover optimal rates are given for the operator norm convergence of \( H_\beta^{-1} \) to \( H_\infty^{-1} \) for large \( \beta \).

P. Duclos (Toulon)

**Dynamical localization in periodically driven quantum systems**

ABSTRACT: Given a periodically time dependent Hamiltonian \( H(t) \) and \( \psi(t) \) the solution at time \( t \) of the Schrödinger equation \( (-i\partial_t + H(t))\psi(t) = 0 \), we shortly review what is known
on the time behaviour of \( E_{\psi(0)}(t) := (H(t)\psi(t), \psi(t)) \) as \( t \) tends to infinity. We give sufficient conditions to insure that \( E_{\psi(0)} \) remains bounded in the course of time, a phenomenon that we call dynamical localization of the quantum trajectory, \( \{\psi(t), t \in \mathbb{R}\} \). We also deduce bound, uniform in time, on transition probabilities for such systems.

A.F.M. ter Elst (Eindhoven)

The uniform Hörmander condition and global estimates
ABSTRACT: We analyze second-order operators \( H = \sum_{i=1}^{N} X_i^* c_{ij} X_j \) in divergence form on \( \mathbb{R}^d \) where the coefficients are real-valued \( L_{\infty}(\mathbb{R}^d) \)-functions with \( C = (c_{ij}) \) symmetric and \( C \geq \mu I > 0 \) almost everywhere. The \( X_i \) are vector fields with coefficients in \( C^\infty_b(\mathbb{R}^d) \) which are assumed to satisfy the Hörmander condition uniformly over \( \mathbb{R}^d \). The operator \( H \) generates a self-adjoint submarkovian semigroup \( S \) on \( \mathbb{R}^d \). We prove that the operator is uniformly subelliptic, the balls corresponding to the intrinsic distance defined by \( H \) satisfy the global doubling property and the Poincaré inequality is globally valid. As a result the kernel of the semigroup \( S \) has Gaussian upper and lower bounds determined by the intrinsic subelliptic geometry globally on \( \mathbb{R}^d \) for all \( t > 0 \).

This is joint work with Derek Robinson.

P. Exner (Prague)

Reflections on Zeno and anti-Zeno
ABSTRACT: In this talk we address two questions related to repeated measurements performed in unstable systems in the limit of infinite frequency limit. The first one concerns the Zeno dynamics discussed in several contributions to this conference. Given an unstable system we have two ways to achieve that its state will remain within its state Hilbert space, either by switching off the interaction responsible for the decay or by a permanent Zeno-type system monitoring. A natural question is about the time scale at which these two dynamics remain similar; we will answer it in the framework of a simple solvable model. The second problem concerns the opposite situation when in the limit of permanent observation the unstable system disappears immediately. We will derive sufficient condition for this anti-Zeno effect and show that the gap between it and the Zeno effect is in fact very narrow.

M. Hieber (Darmstadt)

\( L^p \)-theory of the Navier-Stokes low. Past rotating obstacles
ABSTRACT: In this talk we consider the equations of Navier-Stokes in the exterior of a rotating domain. It is shown that, after rewriting the problem on a fixed domain \( \Omega \), the solution of the corresponding Stokes equation is governed by a \( C_0 \)-semigroup on \( L^p_\sigma(\Omega) \), \( 1 < p < \infty \), with generator

\[
Au = P(\Delta u + Mx \cdot \nabla u - Mu).
\]

Here \( P \) denotes the Helmholtz projection. Moreover, for \( p \geq n \) and initial data \( u_0 \in L^p_\sigma(\Omega) \), we prove the existence of a unique local mild solution to the Navier-Stokes problem.

This is joint work with M. Geissert and H. Heck.
F. Germinet (Cergy-Pontoise)
Large Localization for the Schrödinger operator with a large Poisson random potential
ABSTRACT: We prove exponential localization for the Schrödinger operator with a Poisson random potential at the bottom of the spectrum in any dimension. We also prove exponential localization in a prescribed interval for all large Poisson densities. In addition, we obtain dynamical localization and finite multiplicity of the eigenvalues.
Joint work with P. Hislop and A. Klein.

B. Helffer (Paris)
Spectral theory for the Schrödinger operator with magnetic field and applications to superconductivity
ABSTRACT: Accurate eigenvalues asymptotics for the Neumann magnetic Laplacian in the semi-classical regime are combined with fine non linear estimates for getting a rather good description of the onset of superconductivity in a generic domain.
This is joint work with S. Fournais.

T. Ichinose (Kanazawa)
Recent results on the Trotter product formula and related topics
ABSTRACT: We review recent results on the Trotter product formula in operator norm with optimal error bound for the self-adjoint semigroup generated by the sum of two nonnegative self-adjoint operators $A$ and $B$ which is self-adjoint, as well as for the unitary group, and also some related topics. Some recent results are also mentioned on the Schrödinger semigroup with nonnegative potentials growing at infinity, and on the one with the Dirichlet boundary condition.
This talk is mainly based on joint works with Hideo Tamura (Okayama University).

B. Iochum (Marseille-U1)
Dixmier traces on noncompact Connes–Landi spaces
ABSTRACT: The $*$-products play an important role in quantization by deformation. The case of Moyal planes was an example where this approach totally fits the noncommutative geometry. After the presentation of this general framework, the case of a large class of Riemannian manifolds endowed with an isometric action of abelian Lie groups will be exposed where the main purpose is to use spectral geometry of manifolds to compute Dixmier traces using heat kernel techniques.

A. Klein (Irvine)
On Mott’s formula for the ac conductivity in the Anderson model
ABSTRACT: We prove that the ac conductivity at small frequency $\nu$ is bounded by $C\nu^2|\log \nu|^{d+2}$. This should be compared to the celebrated Mott’s formula, which predicts the leading term to be $C\nu^2|\log \nu|^{d+1}$. 

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A. Laptev (Stockholm)

Geometric many-particle Hardy inequalities

ABSTRACT: We prove some inequalities of Hardy type. In $\mathbb{R}^{3N}$ we show that

$$-\Delta \geq C(N) \sum_{1 \leq i < j \leq N} \frac{1}{|x_i - x_j|^2}$$

in the quadratic form sense for some $C(N)$. Here the $x_i$ are points in $\mathbb{R}^3$. For $N \leq 4$ we obtain a sharp result for $C(N)$. For larger $N$ we run into a very interesting geometrical problem. Other related inequalities are derived.

A. McIntosh (Canberra)

The Kato square root problem on Lipschitz domains

ABSTRACT: This is joint work of Axelsson, Keith and myself. We solve the Kato square root problem for elliptic systems with mixed boundary conditions on Lipschitz domains. This answers a question posed by J.-L. Lions in 1962. To do this we develop a general theory of quadratic estimates and functional calculi for complex perturbations of Dirac-type operators.

G. Metafune (Lecce)

Global properties of heat kernels for diffusions with unbounded coefficients

ABSTRACT: We consider a second order differential operator on $\mathbb{R}^N$

$$A = \sum_{i,j} D_i (a_{ij} D_j) + \sum_i F_i D_i - V$$

with $a_{ij} \in C^1_b(\mathbb{R}^N)$ and $F_i, V$ smooth but unbounded in $\mathbb{R}^N$ and the (minimal) semigroup $T_t$ generated by $A$ in $C_b(\mathbb{R}^N)$. We investigate global properties of the heat kernel $p(x, y, t)$ with respect to the variables $(y, t)$, such as Sobolev regularity, exponential decay. These results are then used to establish functional analytic properties of $T_t$.

P. Müller (Göttingen/Irvine)

Continuous integral kernels for unbounded Schrödinger semigroups and their spectral projections

ABSTRACT: A suitably extended Feynman-Kac-Ito formula is derived to study one-parameter semigroups generated by (negative) Schrödinger operators, which include a magnetic vector potential and are allowed to be unbounded from below and. In particular, the domain of a such, in general unbounded, semigroup is investigated. It turns out that each member of the semigroup is a maximal Carleman operator with a continuous integral kernel given by a Brownian-bridge expectation. The results are used to show that the spectral projections of the generating Schrödinger operator also act as integral operators with continuous kernels. Applications to Schrödinger operators with rather general random scalar potentials include a rigorous justification of an integral-kernel representation of their integrated density of states - a relation frequently used in the corresponding physics literature.
This is joint work with Kurt Broderix and Hajo Leschke.

References

H. Neidhardt (Berlin)

Zeno product formula and continual observations in Quantum Mechanics
ABSTRACT: Let $H$ be a non-negative self-adjoint operator on some separable Hilbert space $\mathcal{H}$ and let $P$ be an orthogonal projection on $\mathcal{H}$. Closely related to the problem of continual observations in quantum mechanics is the so-called Zeno product formula

$$T(t) := s - \lim_{n \to \infty} \left(P e^{-itH/n} P\right)^n, \quad t \in \mathbb{R}.$$  

It is still an open problem whether this limit exists under the assumption that $\text{dom}(\sqrt{H}) \cap P\mathcal{H}$ is dense in the subspace $P\mathcal{H}$. However, if the limit exists for $t \in \mathbb{R}$, then $T(t)$ performs a unitary group on the subspace $P\mathcal{H}$ such that $T(t) = e^{-itK}$ where $K$ is associated with the sesquilinear form

$$\tau(f, g) = (\sqrt{H}f, \sqrt{H}g), \quad f, g \in \text{dom}(\sqrt{H}) \cap P\mathcal{H}.$$  

In the following it is shown that for the modified Zeno product formula

$$\tilde{T}(t) = s - \lim_{n \to \infty} \left(P e^{-itH/n} E_{H}([0, \pi n/t]) P\right)^n, \quad t \in \mathbb{R},$$  

the limit exists $\tilde{T}(t)$ and coincides with $T(t)$ where $E_{H}(\cdot)$ is the spectral measure of $H$. Some extensions of that problem as well as applications to the recurrent measurement problem in quantum mechanics are discussed.

This is a joint work with P. Exner, T. Ichinose and V. A. Zagrebnov

D. Pallara (Lecce)

Global properties of invariant measures
ABSTRACT: Consider the second-order elliptic partial differential operators in $\mathbb{R}^N$

$$A = \sum_{i,j=1}^{N} D_i(a_{ij}D_j) + \sum_{i=1}^{N} F_iD_i,$$

where neither the matrix $(a_{ij})$ nor the drift $F = (F_1, \ldots, F_N)$ are assumed to be bounded. Assume that there exists a Borel probability measure $\mu$ on $\mathbb{R}^N$ such that

$$\int_{\mathbb{R}^N} A\phi \, d\mu = 0$$

for every $\phi \in C_c^\infty(\mathbb{R}^N)$, i.e., $\mu$ is a distributional solution of $A^*u = 0$. If the operator $A$, endowed with a certain domain $D(A)$, generates a semigroup $(T(t))_{t \geq 0}$ in a suitable function space $X$, then $A^*\mu = 0$ holds if and only if

$$\int_{\mathbb{R}^N} T(t)f \, d\mu = \int_{\mathbb{R}^N} f \, d\mu$$

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for every $f \in X$ and $t \geq 0$ and this means that the measure $\mu$ is an invariant distribution for the Markov process described by $(A, D(A))$. For this reason a probability measure $\mu$ as above is called \textit{invariant}, even though no semigroup explicitly appears. Under suitable hypotheses, the invariant measure $\mu$ is absolutely continuous and can thus be given in terms of a density, say $\mu = \rho dx$, with $\rho$ continuous, positive and $W_{1,p}^{1,\text{loc}}$ in $\mathbb{R}^N$. In this talk I present some results on \textit{global} boundedness and Sobolev regularity of $\rho$, under suitable integrability hypotheses on $F, a_{ij}$ with respect to $\mu$. Explicit conditions that allow to check these hypotheses are also described, as well as further global properties of $\rho$, such as (in particular cases) precise exponential decay.

L.A. Pastur (Kharkov)

\textbf{Moments of entries of random unitary semigroups and their applications}

\textbf{ABSTRACT:} Unitary semigroups whose generators are random symmetric or Hermitian matrices with independent (modulo the symmetry conditions) entries are considered. A method that allow one to find moments of entries of semigroups at the limit of infinite matrix size is proposed. Applications of these results to model the quantum evolution of complex systems is discussed.

K. Pankrashkin (Berlin)

\textbf{Lippmann-Schwinger equation and Schroedinger semigroups on manifolds}

\textbf{ABSTRACT:} For Schrödinger operators (including those with magnetic fields) with singular (locally integrable) scalar potentials on manifolds of bounded geometry, we study continuity properties of some related integral kernels: the heat kernel, the Green function, and also kernels of some other functions of the operator. In particular, we prove the joint continuity of the heat kernel and the continuity of the Green function. We discuss also $L^p$-properties of the semigroup, regularity of the eigenfunctions, off- and on-diagonal behavior of the Green function. The proof is based mainly on a Lippmann–Schwinger-type equation for resolvents.

\textbf{References}


V. Paulauskas (Vilnus)

\textbf{On some optimal error estimates in operator-norm approximations of semigroups}

\textbf{ABSTRACT:} In the talk we demonstrate that some results and methods of probability theory are useful to get optimal convergence rates in some approximation formulas for operators. As examples we provide a bound for Euler approximations of bounded holomorphic semigroups and a bound for the error in approximation of a power of operators by accompanying exponents. These problems are connected with Trotter–Kato type formulas and the so-called Chernoff $\sqrt{n}$-lemma”. The talk is based mainly on papers [1,2], but some new results will be presented.

\textbf{References}


C.-A. Pillet (Toulon)

Kubo formula and Onsager relations in open quantum systems

ABSTRACT: Asymptotic properties of evolution groups or semigroups play an important role quantum statistical mechanics. In particular, the construction of non-equilibrium steady states of a small quantum system coupled to infinite reservoirs can be reduced to such properties. It will also discuss applications to the linear response theory of such states.

D.W. Robinson (Canberra)

Degenerate second-order elliptic operators, reducibility and separation phenomena

ABSTRACT: Let $H = \sum_{i,j=1}^{d} \partial_i c_{ij} \partial_j$ be a second-order operator on $L_2(\mathbb{R}^d)$ with real symmetric coefficients $c_{ij} \in L_\infty(\mathbb{R}^d)$ satisfying the ellipticity condition $C = (c_{ij}) \geq 0$.

If $H$ is non-degenerate, i.e., if $C \geq \mu I > 0$, then Nash–De Giorgi–Aronson theory establishes that $H$ generates a submarkovian semigroup $S$ with a kernel $K$ satisfying upper and lower Gaussian bounds with the Gaussians defined by the corresponding Riemannian geometry.

If, however, $H$ is degenerate, i.e., if $C$ has zeros, then the situation can be quite different even if the degeneracy is mild and the Riemannian geometry is still equivalent to the Euclidean geometry. One still has a submarkovian semigroup $S$ but it can be reducible, e.g., one can have non-trivial $S$-invariant subspaces $L_2(\Omega)$. In particular the corresponding kernel $K$ cannot be strictly positive. Nevertheless $S$ satisfies off-diagonal Gaussian upper bounds and the corresponding wave equation has a finite speed of propagation. We discuss these phenomena, explain criteria for reducibility and give specific examples.

This is joint work with Tom ter Elst, Adam Sikora and Yueping Zhu.

G. Rozenbloum (Göteborg)

Zero modes of the Pauli operator and related problems in function theory

ABSTRACT: It has been a long-standing field of research in Function Theory to study, for a given function $\Psi(z)$ defined in the complex plane, the space of analytical entire functions $f(z)$ such that $\int_{\mathbb{C}} |f(z)|^2 \exp(-\Psi(z))$ is finite, in the terms of properties of $\mu = \Delta \Psi$. In particular, this problem is closely related to determining the spectral properties of the Pauli operator, arising in the description of an electron moving in the plane under the influence of a magnetic field. We present recent results in this direction, showing, among other things, that if $\mu$ is a measure, with $\mu(\mathbb{C}) = \infty$, then the space of such entire functions is infinite-dimensional. This result extends the famous Aharonov-Casher theorem on the dimension of the space of zero energy eigenfunctions of the Pauli operator to the case of the infinite flux of the magnetic field. Further analysis produces new results concerning signed and rather singular measures $\mu$.

J. Sjöstrand (Paris)

Projections on harmonic forms for high powers of line bundles and return to equilibrium

ABSTRACT: We obtain complete asymptotic expansions for the distribution kernels of the orthogonal projections onto the space of $(0,q)$-forms for high powers of complex line bundles. The method is based on the study of the large time asymptotics of an associated evolution equation of heat - type, very much in the spirit of some old work of A. Menikoff and the speaker.
This is strongly related to other semiclassical problems like interaction through non-resonant potential wells, the return to equilibrium for the Fokker-Planck operator and current work by J.F. Bony, S. Fujiie, T. Ramond and M. Zerzeri about scattering poles for multidimensional "dromadaire" shaped potentials.

**P. Stollmann** (Chemnitz)

**On the quantum percolation problem**

**ABSTRACT:** In this talk we will study spectral asymptotics of the Laplacian on random graphs defined by bond percolation.

**H. Tamura** (Okayama)

**Semiclassical analysis for magnetic scattering by two solenoidal fields**

**ABSTRACT:** We study the scattering by two solenoidal magnetic fields (point–like fields) in two dimensions and we analyze the behavior of scattering amplitudes in the semiclassical limit. We calculate the first three terms in the asymptotic formula. The second and third terms are involved with the trajectory joining the centers of two solenoidal fields. We also discuss an extension to the case of scattering by many solenoidal fields. The obtained result strongly depends on the location of fields and it is closely related to the Aharonov-Bohm effect.

**H. Vogt** (Dresden)

**Stability of Gaussian bounds for propagators under perturbation by a potential**

**ABSTRACT:** Let $U$ be a positive strongly continuous propagator on $L_1(\mathbb{R}^n)$, i.e., a family $(U(t,s))_{t \geq s}$ of bounded operators on $L_1(\mathbb{R}^n)$ describing the time evolution of a non-autonomous system. An important (autonomous) example is the “heat propagator” $U(t,s) = e^{(t-s)\Delta}$. More generally, we consider the propagator describing the solutions of the parabolic Cauchy problem

$$\partial_t u = \nabla \cdot (a(t,x)\nabla u), \quad u(s,\cdot) = f, \quad (*)$$

where $a: \mathbb{R} \times \mathbb{R}^n \to \mathbb{R}^{n \times n}$ is uniformly elliptic.

We explain what we mean by a perturbation of the propagator $U$ by a potential $V: \mathbb{R} \times \mathbb{R}^n \to \mathbb{R}$; in the case of the propagator belonging to $(*)$, the perturbed propagator $U_V$ describes the solutions of the perturbed Cauchy problem

$$\partial_t u = \nabla \cdot (a(t,x)\nabla u) - V(t,x)u, \quad u(s,\cdot) = f.$$ 

We show: If the potential satisfies certain Miyadera conditions and the unperturbed propagator $U$ has a kernel satisfying upper (lower) Gaussian bounds, then the perturbed propagator $U_V$ has a kernel satisfying upper (lower) Gaussian bounds, too.

**J. Voigt** (Dresden)

**The modulus semigroup, theory and examples**

**ABSTRACT:** For a $C_0$-semigroup $\{T(t)\}_{t \geq 0}$ on a Banach lattice $X$, the **modulus semigroup** $\{T^m(t)\}_{t \geq 0}$ - if it exists - is the smallest positive $C_0$-semigroup dominating $\{T(t)\}_{t \geq 0}$. Results on existence and computation of modulus semigroups and their generators will be presented.
In particular, the example of linear delay equations will be treated.

**References**


J.Voigt, *The modulus semigroups for linear delay equations II*, Note Mat. (to appear)