MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH

T a g u n g s b e r i c h t 44/1992

Funktionalanalysis

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The meeting was organized by K. D. Bierstedt (Paderborn), R. Meise (Düsseldorf) and D. Vogt (Wuppertal). In 42 lectures recent results and methods were presented and discussed, mainly coming from the following branches of functional analysis: operator theory and operator ideals, partial differential operators, Fréchet-spaces and their duals, splitting theorems, Banach- and C^*-algebras, Banach space theory and hyperfunctions.

49 mathematicians from Belgium, Brasil, Finland, Germany, Great Britain, Italy, Japan, Poland, Romania, Russia, Spain, Switzerland, Turkey and the United States enjoyed the pleasant atmosphere of the "Mathematische Forschungsinstitut Oberwolfach". The lectures and many interesting discussions stimulated further research and contributed to a fruitful exchange between various branches of functional analysis.

ABSTRACTS

E. ALBRECHT

Invariant subspaces for some representations of $H^\infty(G)$

The following invariant subspace result has been obtained in joint work with B. Chevreau (Bordeaux). We consider representations $\Phi : H^\infty(G) \longrightarrow \mathcal{L}(\mathcal{H})$, where $\mathcal{H}$ is an infinite dimensional Hilbert space, $H^\infty(G)$ has the Gleason property (which is fulfilled for strictly pseudo–convex domains with sufficiently smooth boundary and for poly–domains in $\mathbb{C}^N$). In addition we suppose that Φ is of type C_{00}, i.e. $\Phi(f_n) \to 0$, $\Phi(f_n)^* \to 0$ in the strong operator topology for each weak* null sequence in $H^\infty(G)$. If, moreover, $\sigma_e(T) \cap G$ is dominating for G, where $\sigma_e(T)$ denotes the essential Taylor spectrum of $T = (\Phi(z_1), \ldots, \Phi(z_N))$, then $\operatorname{ran}\Phi$ has a rich invariant subspace lattice (i.e. $\operatorname{Lat}\Phi$ contains a sublattice, which is isomorphic to the lattice of all closed subspaces of $\mathcal{H}$). In the case $N = 1$ some of these assumptions can be weakened or even omitted and we obtain a strengthened version of a result of Chevreau, Pearcy, and Shields.

J. BONET

Weighted spaces of holomorphic functions (joint work with K. D. Bierstedt, A. Galbis, A. Peris)

The following abstract result is presented: Let $E = \operatorname{ind} E_n$ be an inductive limit of Banach spaces with compact linking maps, i.e., a (DFS)–space. If the linking maps are even approximable, then $E \otimes_\varepsilon X = \operatorname{ind}(E_n \otimes_\varepsilon X)$ holds topologically for every Banach space X. A. Peris (Valencia) has given the first example of a (DFS)–space E such that $E \otimes_\varepsilon X$ does not coincide with $\operatorname{ind}(E_n \otimes_\varepsilon X)$ topologically for some Banach space X.
As a consequence of the theorem we obtain the following results on inductive limits of spaces of holomorphic mappings:
(1) Let $\mathcal{V} = (v_n)_{n\in\mathbb{N}}$ be a decreasing sequence of strictly positive radial continuous weights on a balanced open subset G of $\mathbb{C}^N$. If $H(v_n)_0(G)$ contains all the polynomials and $\mathcal{V}$ satisfies the condition:

(S) $\forall\, n\ \exists\, m > n$ such that v_m/v_n vanishes at infinity on G,

then $\operatorname{ind} H(v_n)_0(G,X) = (\operatorname{ind} H(v_n)_0(G))\hat{\otimes}_\varepsilon X$ holds algebraically and topologically for every Banach space X. This implies a vector–valued projective description of the inductive limit.
Let K be a balanced compact subset of a Fréchet–Schwartz space F such that all the local Banach spaces have the approximation property. Let $(U_n)_{n\in\mathbb{N}}$ be a basis of balanced neighbourhoods of K. Then $H(K,X) := \operatorname{ind} H^\infty(U_n,X) = (\operatorname{ind} H^\infty(U_n))\varepsilon X$

holds algebraically and topologically for every Banach space X. This implies that the topologies τ_0 and τ_ω coincide on $H(K, X)$.

R. W. BRAUN

Geometric aspects of Phragmén–Lindelöf conditions

If $A(\Omega)$ denotes the set of all real analytic functions on an open convex set Ω in $\mathbb{R}^N$, then Hörmander has characterized the surjectivity of a partial differential operator $P(D) : A(\Omega) \longrightarrow A(\Omega)$ with constant coefficients by a Phragmén–Lindelöf condition. Starting from there, we show:

Theorem: For Ω convex and open in $\mathbb{R}^3$, the operator $P(D) : A(\Omega) \longrightarrow A(\Omega)$ is surjective if and only if the variety V_h of the principal part of P satisfies

for all $\theta \in V_h \cap \mathbb{R}^3$, $|\theta| = 1$, and all irreducible components W_θ of the germ V_θ,

$$_{\mathbb{R}}\dim_\theta W \cap \mathbb{R}^3 = 2 \text{ and } W \text{ is regular in } \theta.$$

The proof is based on Puiseux series expansion. An analogue for Gevrey classes Γ^d is presented together with the following example: The operator

$$\frac{\partial^4}{\partial x^4} + \frac{\partial^2}{\partial x^2} + i\frac{\partial}{\partial z} : \Gamma^d(\mathbb{R}^3) \longrightarrow \Gamma^d(\mathbb{R}^3)$$

is surjective if and only if $1 \leq d < 2$ or $d \geq 6$.

B. CARL

On realizations of solutions of the KdV–equation

Let $A : E \longrightarrow E$ be a bounded linear operator on a Banach space E and let $\mathcal{A} : E'\tilde{\otimes}_\pi E \longrightarrow E'\tilde{\otimes}_\pi E$ be defined by $\mathcal{A} := I_{E'}\tilde{\otimes}_\pi A + A'\tilde{\otimes}_\pi I_E$, where I_E is the identity operator on E.
If E has the approximation property and $0 \notin \sigma(A) + \sigma(A)$, where $\sigma(A)$ is the spectrum of A, then

$$u = 2\frac{\partial^2}{\partial x^2}(\log\det(I_E + \mathcal{K}))$$

is a solution of the Korteweg–de Vries equation

$$u_t = u_{xxx} + 6uu_x \quad (t, x \in \mathbb{R}),$$

where

$$\mathcal{K} := e^{\mathcal{A}x + \mathcal{A}^3 t}\mathcal{A}^{-1}(a \otimes c), \quad a \in E',\ c \in E.$$

G. DALES

Homomorphisms and derivations from $\mathcal{B}(E)$

There are two "automatic continuity" problems for a Banach algebra $\mathcal{A}$: (I) are all homomorphisms from $\mathcal{A}$ into a Banach algebra $\mathcal{B}$ continuous? (II) are all derivations from $\mathcal{A}$ into a Banach $\mathcal{A}$–bimodule continuous? A special case of (II) is (III): are all point derivations from $\mathcal{A}$ continuous? We have "all homomorphisms continuous" $\Rightarrow$ "all derivations continuous" $\Rightarrow$ "all point derivations continuous".

We discuss these problems for $\mathcal{A} = \mathcal{B}(E)$, where E is a Banach space. The classic result is due to Johnson (1967): Suppose that $E \simeq E \oplus E$. Then all homomorphisms from $\mathcal{B}(E)$ are continuous. We discuss the situation when $E \not\simeq E \oplus E$.

An example of Read constructs a Banach space E_0 such that there are discontinuous point derivations on $\mathcal{B}(E_0)$.

I now explain an example – which is joint work with R. J. Loy and G. A. Willis (J. London Math. Soc., to appear) – of a Banach space E such that, on the one hand, there are discontinuous homomorphisms from $\mathcal{B}(E)$ (with CH) but that all derivations from $\mathcal{B}(E)$ are continuous. The example involves the l^1–sum of a sequence of James–type spaces.

A. DEFANT

Asymptotic estimates for s–numbers of tensor product operators

Denote by s the approximation numbers, the Gelfand numbers or the Kolmogorov numbers. For the identities

$$I_1 : l_2^n \otimes_2 l_2^n \longrightarrow l_p^n \otimes_\alpha l_p^n, \qquad I_2 : l_p^n \otimes_\alpha l_p^n \longrightarrow l_2^n \otimes_2 l_2^n$$

We calculate the number $\alpha(p,q) \in \mathbb{R}$ $(1 \le p, q \le \infty)$ such that asymptotically in n

$$s_{[n^2/2]}(I_1) \asymp n^{\alpha(p,q)}, \qquad s_{[n^2/2]}(I_2) \asymp n^{\alpha(p,q)},$$

where $\otimes_2$ stands for the Hilbert Schmidt norm and $\otimes_\alpha$ for the projective or injective norm. As an application we reprove some volume estimates for the unit ball $B_{l_p^n \otimes_\alpha l_q^n}$ (cf. C. Schütt, 1982) and give asymptotically correct estimates of the cotype 2 constants of $l_p^n \otimes_\varepsilon l_q^n$. Joint work with B. Carl.

S. DIEROLF

Factorization through Fréchet Montel spaces (joint work with P. Domański)

In order to investigate the problem whether every Montel map between Fréchet spaces factorizes through a Fréchet Montel space, we investigate the following dual problem: Given a complete LB-space E and a compact disk K in E, does the inclusion $[K] \hookrightarrow E$ factorize through a (DFM)-space?

We call a compact disk K in E with this property factorizable and present a "hierarchy" $(\mathcal{L}_\alpha)_{\alpha \leq \Omega}$ of subsets of the set $\mathcal{L}_f$ of all factorizable sets in E. As consequences we obtain:

i) an example of an LB-space F whose Mackey-derivatives $F^{(\alpha)}$ $(\alpha \leq \Omega)$ are pairwise different;

ii) the following interrelations with classical problems:

- If there exists a complete LB-space E containing a compact disk not belonging to $\mathcal{L}_\Omega$, then there exists a regular noncomplete LB-space;
- If in every LB-space every compact disk is factorizable, then for every complete LB-space E the space $C(\beta\mathbb{N}, E)$ is bornological.

P. DOMAŃSKI

Injectivity of spaces of operators

A general method is provided to prove that for a large class of closed operator ideals A the following holds: the lcs $A(F,E)$ equipped with the strong topology is an injective space iff F' and E are injective and id_F or id_E belongs to A (in particular, $A(F,E) = L(F,E)$). The result holds both in the Banach case and in the Fréchet case (i.e., when E is a Fréchet space and F is a complete LB-space) and covers known facts for compact and weakly compact operators. The same method is used in order to show that under some quite general assumptions if $A \subseteq B$ are two closed operator ideals and $A(F,E)$ is complemented in $B(F,E)$, then $A(F,E) = B(F,E)$.

J. ESCHMEIER

Index formulas for systems of Toeplitz operators

Let Ω be a strictly pseudoconvex domain in $\mathbb{C}^n$. Then for each tuple $f \in C(\overline{\Omega})^m$ the system of Toeplitz operators $T_f = (T_{f_1}, \dots, T_{f_m})$ on the Bergman space $L^2_a(\Omega)$ is essentially normal and possesses the essential spectrum $\sigma_e(T_f) = f(\partial\Omega)$. More generally, each essentially normal system $T \in L(H)^n$ of Hilbert space operators has a "continuous functional calculus $C(\sigma_e(T)) \to L(H)$, $f \to T_f$, modulo the compact operators" such that $\sigma_e(T_f) = f(\sigma_e(T))$ for all $f \in C(\sigma_e(T))^m$. Using a multidimensional analytic index formula one can compute the index of $w - T_f$, $w \in \varrho_e(T)$, in the case $n = m$. In the special case of Toeplitz operators one obtains an analogue of the classical index formula of Gohberg–Krein proved for Toeplitz operators on H^2.

S. GEISS

Vector–valued martingales and geometry of Banach spaces

The following general kind of martingale transform of vector–valued martingales is considered. Given a sequence of martingale differences $\{d_k\}_{k=1}^n \subseteq L_p^X(\Omega)$ with values in a Banach space X and a sequence of operators $T_k \in \mathcal{L}(X,Y)$ then

$$\phi = \phi(T_1, \ldots, T_n) : L_p^X(\Omega) \longrightarrow L_p^Y(\Omega)$$

can be defined such that $\phi(\sum_1^n d_k) = \sum_1^n T_k d_k$. Choosing $T_1, \ldots, T_n$ in several ways one can describe for example UMD–properties and convexity properties of a Banach space. Sometimes it is important to know the behaviour of

$$\|\phi\|_p = \|\phi(T_1, \ldots, T_n) : L_p^X \longrightarrow L_p^Y\|$$

as a function of p. Here one can prove

$$\frac{1}{K}\|\phi\|_2 \leq \|\phi\|_p \leq K \max(p, p')\|\phi\|_2$$

which is important in the cases $X = l_\infty^n$ or $X = l_1^n$.

B. GRAMSCH

Fréchet algebras in the operator theory and an application to the propagation of singularities

The theory of Ψ^*–algebras in the pseudodifferential analysis has been extended considerably in the work of Schrohe (habilitation thesis, Mainz 91/92) and of Lorentz (thesis, Mainz 91/92) and also in some recent contributions (e.g. Adv. Appl. OT vol. 57, Birkhäuser 1992, 71–98, 255–269). Connections to analytic bundles with special Fréchet–Lie groups are discussed concerning the Oka principle. For a "noncommutative" approach to Hörmander's result on the propagation of singularities we use ideas of Helton (1977) and also of Cordes (1968,1986) and of M. Taylor (1976). Let X be a Banach space with dense inclusions $E \subset X \subset F$ for the locally convex vector spaces E and F. Let A be a subalgebra of $\mathcal{L}(X) \cap \mathcal{L}(E) \cap \mathcal{L}(F)$ with unit $e = \mathrm{Id}$ and B the norm closure of A in $\mathcal{L}(X)$; let $\pi : B \longrightarrow B/J$ be the homomorphism for the closed two sided ideal J of B. With respect to the duality of the Banach spaces $(B/J)'$ and B/J we define the set $\mathcal{M}$ of extreme points

$$\mathcal{M} := \text{extr}\{\mu \in (B/J)' \mid \|\mu\| \leq 1, \langle \mu , \pi(e) \rangle = 1\}$$

and relative to A, $E \subset X \subset F$ and J the generalized wave front $\widetilde{W}F(u)$ for $u \in F$ with $J_u := \{a \in A \mid au \in E\}$,

$$\widetilde{W}F(u) := \{m \in \mathcal{M} \mid \langle m , M_u \rangle = 0\}$$

where M_u denotes the norm closure of $\pi(J_u)$ in B/J. Instead of $\mathcal{M}$ we may consider the weak closure of $\mathcal{M}$. If the parametrized family α_t of isometric automorphisms of B/J has M_u as an invariant set, $\alpha_t(M_u) \subset M_u$, then with $m \in \widetilde{W}F(u)$ the generalized bicharacteristic strip $t \mapsto \alpha_t'(m)$ is contained in $\widetilde{W}F(u)$. For an appropriate unbounded operator T on X, $T : D(T) \longrightarrow X$ we have in some cases the following realization of α_t through a strongly continuous group $e(t) := \exp(itT)$ on E, X and F. For $u \in D_F(T)$ we obtain $e(-t)a(e(t))u \in E$ under the assumption $Tu \in E$ and $a \in J_u$. If we assume the representation $\alpha_t(\pi(b)) = \pi[e(-t)be(t)]$, $b \in B$ or A, we get for the singularity $m \in \widetilde{W}F(u)$ and for $Tu \in E$ the "propagation" $\alpha_t'(m) \in \widetilde{W}F(u)$ given by the above dynamics. A Weyl–lemma for localized Ψ^*–algebras gives some further explanations.

H. JARCHOW

Absolutely summing composition operators

Composition with any analytic self–map ϕ on $D = \{z \in \mathbb{C} \mid |z| < 1\}$ defines a bounded linear operator $C_\phi : H^p \longrightarrow H^p$ between classical Hardy spaces, regardless of the choice of $0 < p \leq \infty$. In the lecture, results were presented related to the question when C_ϕ is order bounded (majorized) as an operator $H^p \longrightarrow L^{\beta p}(m)$ (m: normalized Lebesgue measure on ∂D, $0 < \beta < \infty$ fixed). For example, if $1 \leq \beta < \infty$ and $p \in [1/\beta, 1 + 1/\beta]$, then this happens iff C_ϕ^* is βp–summing, or even βp–nuclear. On the other hand, there are, for each $1 < \beta \leq 2$, composition operators which are absolutely summing as maps $H^{2/\beta} \longrightarrow H^2 \subset L^2(m)$ but which fail to be order bounded. Examples can be obtained by solving a certain analytic moment problem.

H. JUNEK

Factorization of operator ideals and bounded sets in tensor products of Fréchet spaces

Operator ideals on Banach spaces admit in general several different extensions to locally convex spaces. Among these extensions there are a smallest and a largest one, and the coincidence of both would give uniqueness. Under some additional assumptions concerning the geometry of the underlying locally convex spaces we prove a factorization and a uniqueness theorem for operator ideal components, mapping DF–spaces into F–spaces. This leads also to a characterization of the bounded subsets of operators. In a second part of the lecture the results will be used to get a characterization of the bounded subsets of the α–tensor products of certain Fréchet spaces. In particular, this applies to the π–tensor product. The problem of the characterization of the bounded subsets of the π–tensor product of F–spaces, known as Grothendieck's "problème des topologies" was answered in the negative by J. Taskinen in 1986, and after that several papers appeared to get positive results in particular cases.

A. KANEKO

The unique continuation property of hyperfunctions with analytic parameters

Let $f(x,t)$ be a hyperfunction defined on $\Omega \times T$, a neighborhood of $(0,0)$ in $\mathbb{R}^n \times \mathbb{R}^m$. f is said to contain t as real analytic parameters if SSf $(= WF_A f)$ is free from the directions $\theta\, dt$, $\theta \in S^{m-1}$. For this, the restriction data $\partial_t^\alpha f|_{t=0}$, $\alpha \in \mathbb{N}_0^m$, are meaningful. A form of unique continuation problem asks if these countable data determine f itself on a neighborhood of $t = 0$. M Sato gave a counterexample long ago. Recently, however, J. Boman proved that it is true if f is a distribution. His proof applies to any non–quasianalytic ultradistributions. It has been hoped, on the other hand, that counter example exists for any quasi–analytic ultradistributions. For the moment, we have an example whose defining function satisfies $|F(x+iy,t)| \le C \exp(\exp(\frac{1}{|y|\chi(|y|)}))$ with any preassigned $\chi(t)$ such that $\chi(t) \to 0$ as $t \to 0$.

S. KISLIAKOV

Interpolation phenomena for Hardy spaces on polydiscs

If $1 \le p < r < \infty$ and θ is defined by $\frac{1}{r} = \frac{1-\theta}{p} + \frac{\theta}{\infty}$, then $(H^p(\mathbf{T}^2), H^\infty(\mathbf{T}^2))_{\theta,r} = H^r(\mathbf{T}^2)$. No similar statement is known if $\mathbf{T}^2$ is replaced by $\mathbf{T}^n$, $n \ge 3$. Nevertheless it is possible to prove that if $w > r$, then the subspace of $L^w(\mathbf{T}^2)$ consisting of functions with spectrum in a certain set somewhat smaller than $\mathbf{Z}_+^n$ does imbed into $(H^p(\mathbf{T}^2), H^\infty(\mathbf{T}^2))_{\theta,r}$. This has some applications to Taylor coefficients of functions in $H^\infty(\mathbf{T}^n)$.

H. KÖNIG

An explicit formula for fundamental solutions of linear partial differential equations with constant coefficients

The existence theorem for fundamental solutions is due to Ehrenpreis and Malgrange 1953/54, later improvements came from Hörmander and Lojasiewicz. We shall present an explicit formula for fundamental solutions. The method is adapted from Malgrange. Let λ_n denote Lebesgue measure on $\mathbb{R}^n$ and $\tau_n := \tau \times \cdots \times \tau$ on T^n, where τ is arc length on the unit circle T normalized to $\tau(T) = 1$. In addition define $< \cdot >: \mathbb{C} \longrightarrow \mathbb{C}$ to be $< z >= \bar{z}/z$ for $z \neq 0$ and $= 0$ for $z = 0$. We consider a polynomial P in n variables with complex coefficients of precise degree $m \geq 0$

$$P(z) = \sum_{|\alpha|\leq m} c(\alpha)z^\alpha \quad \text{with} \quad P_m(z) := \sum_{|\alpha|=m} c(\alpha)z^\alpha \quad \text{and} \quad S(P) := \sum_{|\alpha|=m} |c(\alpha)|^2 > 0 .$$

Fix a natural number N with $2N > n$. For $\varepsilon > 0$ and an n–index α define $I^\varepsilon_\alpha : \mathbb{R}^n \times T^n \longrightarrow \mathbb{C}$ to be

$$I^\varepsilon_\alpha(\xi, s) = \frac{< (i\xi + \varepsilon s)^\alpha P(i\xi + \varepsilon s) >}{(1 + |i\xi + \varepsilon s|^2)^N} P_m(s) \quad \text{for} \quad (\xi, s) \in \mathbb{R}^n \times T^m .$$

I^ε_α is integrable for $\lambda_n \times \tau_n$. Then define $K^\varepsilon_\alpha : \mathbb{R}^n \longrightarrow \mathbb{C}$ to be

$$K^\varepsilon_\alpha(x) = \int_{\mathbb{R}^n \times T^n} I^\varepsilon_\alpha(\xi, s) e^{\langle i\xi + \varepsilon s, x\rangle} \, d(\lambda_n \times \tau_n)(\xi, s) \quad \text{for} \quad x \in \mathbb{R}^n .$$

K^ε_α is continuous with $|K^\varepsilon_\alpha(x)| \leq C \exp(\varepsilon n |x|)$ for $x \in \mathbb{R}^n$, in particular locally integrable for λ_n.

Theorem. For $\varepsilon > 0$ the distribution

$$E^\varepsilon := \frac{1}{(2\pi)^n S(P) \varepsilon^m} \sum_{|\alpha|\leq N} \frac{N!}{(N - |\alpha|)! \alpha!} \partial^{2\alpha} K^\varepsilon_\alpha$$

satisfies $P(\partial) E^\varepsilon = \delta$.

H. KOMATSU

Elementary theory of microfunctions

In place of Sato's sophisticated definitions of hyperfunctions and microfunctions as higher cohomology groups, we gave elementary definitions of hyperfunctions as boundary value of harmonic functions, and of microfunctions as singularities of holomorphic functions near the surface of the tube domain $D\mathbb{R}^n = \{x + iy \mid x, y \in \mathbb{R}^n, |y| < 1\}$. Then we characterized ultradistributions and ultradifferentiable functions by the behavior of defining harmonic functions or holomorphic functions.

At the end we discussed on the suppleness of sheaves of microfunctions corresponding to distributions and C^∞ functions, and showed a little weaker result based on the Whitney extension theorem and the Szegö projection.

M. LANGENBRUCH

Splitting of the $\overline{\partial}$–complex

Let $W = \{W_n \mid n \geq 1\}$ be an increasing weight system on a pseudoconvex open set $\Omega \subset \mathbb{C}^N$ and let

$$L(W) := \{f \in L^2_{\text{loc}}(\Omega) \mid \; \exists\, n : \|f\|_n^2 := \int |f(z)|^2 e^{-2W_n(z)}\, dz < \infty\}.$$

Then the associated weighted $\overline{\partial}$–complex is split iff the following holds: For any $t \in \Omega$ there are plurisubharmonic functions ϕ_t on Ω and for any $n \geq 1$ there are $I(n)$ and $A(n)$ such that

$$\phi_t(z) - \phi_t(t) \leq W_{I(n)}(z) - W_n(t) + A(n). \qquad (*)$$

Explicit continuity estimates for the projections in the complex can be given. A similar condition characterizes the exactness of the complex. A parallel result holds for decreasing weight systems. $(*)$ can be evaluated for many concrete weight systems, especially for systems coresponding to Fourier transforms of ultradifferentiable test functions. This can be used to solve the Whitney–problem for these functions.

F. MANTLIK

Fundamental solutions for PDO's depending analytically on a parameter

We consider a family $P(\lambda; D) = \sum_{|\alpha| \leq m} a_\alpha(\lambda) D^\alpha$ of constant coefficients PDO's in $\mathbb{R}^n$, where each a_α is an analytic function on a complex manifold Λ. Assuming that $P(\lambda; D)$ is equally strong for all $\lambda \in \Lambda$ we prove the existence of fundamental solutions $F(\lambda)$ (with optimal regularity properties) for $P(\lambda; D)$, which also depend analytically on the parameter λ. This result answers a question of L. Hörmander. It has been shown by F. Treves that the assumption of constant strength is necessary and sufficient for a local result of this kind.

Our method of proof also yields analytic solutions for the more general equation $P(\lambda; D) f(\lambda) \equiv g(\lambda)$, where g is a given analytic function with values in some distribution space. As a principal tool we use a theorem of J. Leiterer on sheaves of Banach–valued analytic functions.

S. MOMM

Solution operators for partial differential equations on spaces of analytic functions

In the 60's Martineau proved that for a given bounded convex domain G of $\mathbb{C}^N$ and an entire function $P(z) = \sum_\alpha a_\alpha z^\alpha$ on $\mathbb{C}^N$ of order one and minimal type, the partial differential operator $P(D) : A(G) \longrightarrow A(G)$, $P(D)f = \sum_\alpha a_\alpha f^{(\alpha)}$ on the Fréchet space of all analytic functions on G is continuous and surjective. We consider the "linearized" problem of the existence of a continuous linear map R: $A(G) \longrightarrow A(G)$ such that $P(D) \circ R = \mathrm{id}_{A(G)}$. Assuming $0 \in G$, an answer is given in terms of appropriate lower bounds for the plurisubharmonic function v_G which is the largest plurisubharmonic function on $\mathbb{C}^N$ with $v_G(z) \leq \sup_{w \in G} \mathrm{Re} \sum_{j=1}^N w_j \bar{z}_j$ and $v_G(z) \leq \log^+ |z| + O(1)$ for all $z \in \mathbb{C}^N$.

J. MUJICA

Extension of multilinear mappings on Banach spaces

Following an idea of Nicodemi we study certain sequences of extension operators for multilinear mappings on Banach spaces starting from any given extension operator for linear mappings. In this way we obtain several new properties of the extension operators previously studied by Aron, Berner, Cole, Davie and Gamelin. As an application of our methods we show the existence of plenty of unbounded scalar valued homomorphisms on the locally convex algebra of all continuous polynomials on each infinite dimensional Banach space. This improves a result of Dixon.

R. NAGEL

What can positivity do for stability?

By Liapunov's theorem the stability of $(e^{tA})_{t \geq 0}$, i.e., $\lim_{t \to \infty} \|e^{tA}\| = 0$, for a $n \times n$–matrix A is equivalent to the existence of a positive semidefinite matrix X satisfying

$$AX + XA^* = -\,\mathrm{Id}\ .$$

This and other stability criteria are immediate consequences of the following abstract theorem.
Let E be an ordered Banach space with normal and generating cone E_+. If $(A, D(A))$ is a linear operator on E having positiv resolvent then the following properties are equivalent.

(a) $s(A) := \sup\{\mathrm{Re}\,\lambda \mid \lambda \in \sigma(A)\} < 0$.

(b) $0 \in \varrho(A)$ and $A^{-1} \leq 0$.

If, in addition, E_+ has an interior point u then the above conditions are also equivalent to

(c) There exists $0 < v \in D(A)$ such that $Av = -u$.

This is joint work with A. Rhandi.

N. NIKOLSKI

A functional analysis proof of the Bieberbach conjecture

The approach starts with the well known subordination principle by Littlewood ($\|f \circ B\|_G \leq \|f\|_G$ for a univalent mapping $B : \mathbf{D} \longrightarrow \mathbf{D}$, $B(0) = 0$, where G stands for the Dirichlet space, $\|f\|_G^2 = \sum_{k \geq 1} |\widehat{f}(w)|^2 k$). The principle gives rise an operator valued measure $\mathcal{E}(\delta) : G \longrightarrow G$, $\delta \subset \mathbf{D}$ defined by the quadratic form $(\mathcal{E}(\delta)f, f) = \pi^{-1} \int \int_\delta |f'|^2 \, dxdy$. The main claim of the talk is as follows: the Bieberbach–de Branges inequality $|\widehat{f}(n)| \leq n$ (for a normalized univalent function $f : \mathbf{D} \longrightarrow \mathbb{C}$, $f(0) = 0$, $f'(1) = 1$) is a partial case of Cauchy–Bouniakowski–Schwarz inequality $\|\mathcal{E}(X)^{-1/2} \int_X d\mathcal{E} f\|^2 \leq \int_X (d\mathcal{E} f, f)$ which is true for an arbitrary operator valued measure $\mathcal{E}$. Some estimates of an evoluton equation $x' = \Omega x - g$ are also involved in the proof.

V. PALAMODOV

On Liouville property of section spaces of coherent analytic sheafs

Let $\mathcal{F}$ be a coherent analytic sheaf on a complex space X such that $\operatorname{supp} \mathcal{F}$ is a Stein space. A criterium for $\Gamma(X, \mathcal{F})$ to be a DN-space is given in terms of the Liouville property of the Lasker–Noether components of $\operatorname{supp} \mathcal{F}$.

A. PEŁCZYŃSKI

Molecular decomposition of functions in Sobolev spaces; vector valued analogues

Let $L^1_{(1)}(\mathbb{R}^d; E)$ denote the closure of C^∞–functions with compact supports with values in a Banach space E in the norm

$$\|f\|_{(1),1} = \int_{\mathbb{R}^d} \|f(x)\|_E \, dx + \int_{\mathbb{R}^d} \left(\sum_{j=1}^{d} \|\frac{\partial f}{\partial x_j}(x)\|_E^2 \right)^{\frac{1}{2}} dx$$

Theorem. There exist absolute constants $a > 0$, $b > 0$ such that for every Banach space E for every $f \in L^1_{(1)}(\mathbb{R}^d; E)$ there exists a sequence $(g_m) \subset L^1_{(1)}(\mathbb{R}^d; E)$ such that

$$f = \sum g_m \quad ; \quad \sum_m \|g_m\|_1 \le a\|f\|_1 \quad ; \quad \sum_m \|\nabla g_m\|_1 \le a\|\nabla f\|_1$$

$$\|g_m\|_\infty^{\frac{1}{d}} \|g_m\|_1^{\frac{d-1}{d}} \le b\|\nabla g_m\|_1 \quad (m = 1, 2, \ldots)$$

where $\|\phi\|_\infty = \sup_{x\in\mathbb{R}^d} \|\phi(x)\|_E$; $\|\phi\|_1 = \int_{\mathbb{R}^d} \|\phi(x)\|_E \, dx$; $\nabla\phi = (\partial\phi/\partial x_j)_{j=1}^m$. In the case $E = \mathbb{R}$ the best constants a, b depending on d are evaluated. The results are obtained jointly with M. Wojciechowski.

A. PIETSCH

Some new operator ideals

Let $L(X,Y)$ denote the set of all (bounded linear) operators acting from a Banach space X into a Banach space Y. For $0 < p \le \infty$, we define $\mathcal{G}_p(X,Y)$ to be the collection of all $T \in L(X,Y)$ which admit a representation

$$T = \sum_{n=1}^{\infty} T_n$$

such that

$$\sum_{n=1}^{\infty} \operatorname{rank}(T_n)^{1/p} \|T_n\|$$

is finite. It easily turns out that $\mathcal{G}_p = \bigcup_{X,Y} \mathcal{G}_p(X,Y)$ becomes a Banach operator ideal under the norm

$$\|T|\mathcal{G}_p\| = \inf \sum_{n=1}^{\infty} \operatorname{rank}(T_n)^{1/p} \|T_n\| \, ,$$

where the infimum ranges over all representations described above.

Among others, the following results can be proved:

(1) If $0 < p \le 1$, then $\mathcal{G}_p$ coincides with $\mathcal{N}$, the Banach ideal of nuclear operators.

(2) $\mathcal{G}_\infty$ consists of all operators which are approximable by finite rank operators with respect to the operator norm.

(3) If $1 \le p < \infty$, then $\mathcal{G}_p$ is the Banach enveloppe of

$$\mathcal{A}_{p,1} = \{T \mid \sum_{n=1}^{\infty} n^{1/p-1} a_n(T) < \infty\} \, ,$$

where $a_n(T)$ denotes the n-th approximation number of T.

M. POPPENBERG

A tame splitting theorem and structure theory of power series spaces (joint work with Dietmar Vogt)

In structure theory of power series spaces, D. Vogt and M. J. Wagner have characterized the subspaces, quotient spaces and complemented subspaces of stable power series spaces by conditions (DN), (Ω) and $\Lambda_{\mathbb{N}}(\alpha)$–nuclearity in the infinite type case and by conditions ($\underline{\mathrm{DN}}$), $(\overline{\Omega})$ and $\Lambda_1(\alpha)$–nuclearity in the finite type case; the main technical tools are splitting theorems, standard exact sequences of power series spaces and imbedding theorems of Komura type. The purpose of this lecture is to obtain corresponding results with (linear-) tame estimates. Main results are the following:

(1) A (linear-) tame splitting theorem for exact sequences of Fréchet–Hilbert spaces.

(2) Construction of (linear-) tamely exact sequences of the form

$$0 \longrightarrow \Lambda_R^p(\alpha) \longrightarrow \Lambda_R^p(\alpha) \longrightarrow \Lambda_R^p(\alpha)^{\mathbb{N}} \longrightarrow 0\,, \quad R \in \{0,\infty\}\,.$$

As an application we obtain a theorem for (linear-) tame imbeddings into $\Lambda_R^2(\alpha)$; similar results can be proved for quotient spaces and direct summands of $\Lambda_R^2(\alpha)$. In contrast to the topological case (where a general splitting theorem for power series spaces of finite type fails), the proofs of the above (linear-) tame theorems simultaneously work for power series spaces of infinite and of finite type.

M. S. RAMANUJAN

Strongly nuclear subsets of $C(X)$

The classical Ascoli theorem characterizes precompact subsets $H \subset C(X)$ in terms of equivariation of H. Abstract generalizations of this, still in the realm of precompactness, are due to Kakutani and to Vala. Here we present a generalization (to all the above three set-ups), in which precompactness is replaced by strong nuclearity; notice, in a metric space, a bounded set M is precompact $\Leftrightarrow \varepsilon_n(M) \in c_0 \Leftrightarrow e_n(M) \in c_0$, where ε_n and e_n are the n-th entropy and diadic entropy numbers. For a bounded $f : X \times Y \longrightarrow \mathbb{K}$ we define

$$\begin{aligned} v_{n,m} = \inf\{r > 0 \ \mid \ & \exists\ X = \bigcup^n A_i,\ Y = \bigcup^m B_j \ni |f(x_1,y_1) - f(x_2,y_2)| < r \\ & \text{for} \quad x_1, x_2 \in A_i,\ y_1, y_2 \in B_j\}. \end{aligned}$$

Equivariation is equivalent to $(v_{n,n}) \in c_0$. We are interested in the situation when (c_0) is replaced by (s) or stable $\Lambda_\infty(\alpha)$. Basic inequalities of the type

$$\varepsilon_{2(n^2)}(H) \leq 2v_n + 2\sup_{a\in A} \varepsilon_{2^n}(A) \quad \text{and} \quad v_{2(n^2)} \leq 2\varepsilon_n(H) + 2\sup_{h\in H} \varepsilon_{2^n}(hA)$$

are established; these yield necessary conditions and sufficient conditions on v_n to conclude s-nuclearity of H. The lack of a single necessary and sufficient condition is illustrated by $H \subset C[0,1]$. H is the set of all functions of Hölder class-1 for which $(v_{2^n}) \in s$, $(v_n) \notin s$ and $e_n(H) \sim 1/n$ and H is not s-nuclear.

W. RUESS

The solution operator for nonlinear delay differential equations

The nonlinear functional differential equation with infinite delay

$$\text{(FDE)} \begin{cases} \dot{u}(t) \in Bu(t) + F(u_t), \ t \geq 0 \\ u|_{\mathbb{R}^-} = \phi \in E = BUC(\mathbb{R}^-, X) \end{cases}$$

is considered with $B \subset X \times X$ (generally) nonlinear and multivalued such that $(-B + \alpha I)$ is m-accretive for some $\alpha \in \mathbb{R}$, and $F : D(F) \subset E \longrightarrow X$ a Lipschitz-continuous history responsive function, X a Banach (state) space. For the case of single-valued $B : D(B) \subset X \longrightarrow X$, and globally Lipschitz $F : E \longrightarrow X$, a solution-operator semigroup $(s(t))_{t \geq 0}$ has been constructed on the initial history space E such that, for certain $\phi \in E$

$$x_\phi(t) = \begin{cases} \phi(t) & \text{for} \quad t \leq 0 \\ (s(t)\phi)(0) & \text{for} \quad t \geq 0 \end{cases}$$

is the unique solution to (FDE) (Brewer, Flaschka/Leitman, G. F. Webb and others, starting from 1974).
It is shown that the above representation of the solution also can be achieved for the case of multivalued $B \subset X \times X$ and locally Lipschitz continuous $F : D(F) \subset E \longrightarrow X$, thus allowing for application, to problems of temperature control in materials with memory, where $B \subset X \times X$ typically is multivalued of the form $B = \Delta - \tilde{\beta}$, with $\tilde{\beta} \subset L^2(\Omega) \times L^2(\Omega)$ the realization of a maximal monotone graph $\beta \subset \mathbb{R} \times \mathbb{R}$ (Duvant/Lions, Brézis).

T. RUNST

Mapping properties of superposition operators in generalized Sobolev spaces

The aim of the talk is to give a survey on some recent results of a joint work with W. Sichel concerning the mapping properties of nonlinear operators $T_G : H_p^{s_0}(\mathbb{R}_n) \longrightarrow H_p^{s_1}(\mathbb{R}_n)$, $s_0 \geq s_1$, defined by $T_G : f \mapsto G(f)$, where G is a given nonlinear function and f belongs to the scale of generalized Sobolev spaces H_p^s. We describe conditions such that T_G is a mapping from $H_p^{s_0}(\mathbb{R}_n)$ into $H_p^{s_1}(\mathbb{R}_n)$, where the nonlinearity is generated by $G(t) = t^m$, $m = 2, 3, \ldots$, and $G(t)$ is a real-valued smooth function, respectively.

Theorem: Let G be a smooth real-valued function with $G(0) = 0$.

(i) Let $s > 0$. Then there exists a constant c_G such that

$$\|G(f)|H_p^s\| \leq c_G(\|f|H_p^s\| + \|f|H_p^s\|\|f|L_\infty\|^{\max(0,s-1)})$$

holds for all $f \in H_p^s(\mathbb{R}_n) \cap L_\infty(\mathbb{R}_n)$.

(ii) Let $1 < s < n/p$ and $\varrho(s, n/p) = \frac{n/p}{n/p-s+1}$. Then there exists a constant c_G such that

$$\|G(f)|H_p^\varrho\| \leq c_G(\|f|H_p^s\| + \|f|H_p^s\|^\varrho)$$

holds for all $f \in H_p^s(\mathbb{R}_n)$.

H. H. SCHAEFER

Semi-bornological spaces

Given a locally convex (top. vector) space (E, τ), when is it true that a sequentially continuous linear form on E is necessarily continuous? Clearly, this holds whenever E is bornological – but the condition is by no means necessary. Call an l.c.s. (E, τ) semi-bornological (SB) if E is a Mackey space on which sequential continuity of linear functionals (or equivalently, of linear maps into any l.c.s.) implies continuity, weakly semi-bornological (WSB) if the Mackey condition is dropped.

There exists a finest l.c. topology τ_c on E that has the same convergent *sequences* as E; it turns out that SB $\Leftrightarrow \tau = \tau_c$; WSB $\Leftrightarrow \tau_c$ is compatible (=has the same dual) with τ. Permanence properties with respect to initial and final l.c. topologies for SB-spaces are the same as for bornological spaces; in particular, a subspace of an SB-space is not, in general, WSB.

Dual Characterization: Let E be any l.c.s., sequentially complete, let $\mathcal{L}$ denote the family of all closed, convex, circled hulls of the range of some null sequence.

Thm. E is WSB $\Leftrightarrow E'$ is complete under the $\mathcal{L}$-topology.

Are there interesting examples? An easy example for an SB-space which is not bornological, is the space $(l^\infty, \tau(l^\infty, l^1))$. A much more sophisticated example: K compact, metrizable, infinite, $B(K)$ = space of bounded Baire functions on K, $M(K)$ = Baire measures. Then $B(K)$ is SB (but not bornological) under $\tau(B(K), M(K))$, and sequentially complete.

This hinges on the fact that the $\tau(B(K), M(K))$ equicontinuous subsets of $M(K)$ are precisely the (relatively) weakly compact subsets of the Banach space $M(K)$.

J. SCHMETS

Domains of analyticity in real normed spaces (joint work with M. Valdivia)

We essentially prove that there is a C^∞ function f on the separable real normed space E which is analytic on $E \setminus M$, analytic at no point of M and such that its restriction to $E \setminus M$ has no analytic extension at any point of the border of M in the following two cases:

i) E satisfies the Kurzweil condition and M is a closed subset of E,

ii) M is a weakly closed subset of E.

In particular, if the real normed space E is separable

i) and satisfies the Kurzweil condition, every domain of E is a domain of analyticity,

ii) every weak domain of E is a domain of analyticity.

J. TASKINEN

On local Banach spaces of Schwartz spaces

We introduce a way to measure the distance of not necessarily isomorphic Banach spaces X and Y. It can be shown that a compact operator $T : X \longrightarrow X$ factors "densely" through Y, if the spaces are separable and reflexive, and the distance of X^* and Y^* is small enough, and some technical assumptions are satisfied. The result can be applied to the study of the local Banach spaces of locally convex spaces. An example: If a Schwartz space E has a system of local Banach spaces isomorphic to a L_p–space X (separable, reflexive), then, for every separable L_p–space Y, E has a system isomorphic to Y.

T. TERZIOGLU

Density conditions and subspaces of Fréchet spaces

According to a theorem due to Bierstedt and Bonet, a Fréchet space E has the density condition (dc) if and only if every bounded subset of E'_b is metrizable. Every Fréchet–Montel space and every space of the form $K^J \times$Banach has the property that every closed subspace satisfies the dc. (Here K is the field and $J \subseteq \mathbb{N}$.) In a recent work, Bonet and Diaz asked whether the converse is true. In a joint work with S. Önal we answer this question positively so that we have:

Proposition: Every closed subspace of a Fréchet space E has dc $\Leftrightarrow$ E is either Montel or $E \simeq K^J \times$Banach for some $J \subseteq \mathbb{N}$.

An immediate consequence is the following

Corollary: Every closed subspace of a Fréchet space is quasinormable $\Leftrightarrow$ E is either a Schwartz space or $E \simeq K^J \times$Banach for some $J \subseteq \mathbb{N}$.

H. G. TILLMANN

Equilibria in mathematical economic systems

We consider Private Ownership Economies (POE) $\mathcal{E}$, $\mathcal{E} = \mathcal{E}(X, X^i, \geq_i, a^i, Y^j \alpha_{ij})$ in the sense of G. Debren, but with infinite dimensional commodity space $X = l^\infty(F)$. There exists a topology τ_{SM} on X (defined by Brown–Lewis with economic arguments). $X' = X(\tau_{SM})' = l_b^1(F')$ and if X is a reflexive Banch lattice $\tau_\infty \supset \tau_{SM} = \tau_{MA}(X, X') = \beta \supset \sigma(X, X') := \sigma$. We assume standard conditions with a topology τ_1 for the consumption; τ_2 for the production sector together with condition .

(P) A strictly positive supply $s_0 = \sum y_0^j + \sum a^i$, $y_0^j \in Y^j$ exists and $\exists \lambda_0 \geq 1$ such that $\lambda_0 s_0 \geq \sum y^j + \sum a^i$ for all $y^j \in Y^j$.

Then:

Theorem I: Under these conditions, an equilibrium always exist if $\tau_{MA} = \tau_{SM} \supset \tau_1$, $\tau_2 \supset \sigma$.

Theorem II: If also F and F' are separable: If every POE $\mathcal{E}$ with the conditions of Thm. I and $\tau_\infty \supset \tau_1$, $\tau_2 \supset \sigma$ has an equilibrium, then τ_1 and τ_2 must be myopic: $\tau_{SM} = \tau_{MA} \supset \tau_1$, $\tau_2 \supset \sigma$.

Thus on $l^\infty(F)$ the myopic topologies are those for which a “”General Existence Theorem for Equilibria in POE with commodity space in $l^\infty(F)$” are valid.

M. VALDIVIA

Biorthogonal systems

It is given the two following results: a) Let X be a Banach Asplund space. Then there is a total biorthogonal system $(x_\gamma, u_\gamma)_{\gamma \in \Gamma}$ for X such that the closed linear hull of $\{x_\gamma \mid \gamma \in \Gamma\}$ is a weakly compactly generated Banach space. b) Let X be a nonseparable weakly compactly generated Banach space. If X has predual then there is in $X \oplus l_1$ an equivalent norm $|||\cdot|||$ such that $(X \oplus l_1, |||\cdot|||)$ has not a 1–norming Maskushevich basis.

F.-H. VASILESCU

Automorphism invariance of the operator–valued Poisson transform

This is joint work with R. Curto. The aim of this work is to find a vector version of the well-known result of function theory in the unit ball B of $\mathbb{C}^n$ asserting that the Poisson transform commutes with the automorphisms.

Let H be a complex Hilbert space and let $L(H)$ be the algebra of all bounded linear operators on H. If $T = (T_1, \dots, T_n) \in L(H)^n$ is a commuting multioperator, we set

$$M_T(X) = \sum_{j=1}^{n} T_j^* X T_j \quad , \quad X \in L(H) \quad ,$$

and

$$\Delta_T^{(m)} = (1 - M_T)^m(1) \quad , \quad m \geq 0 \quad \text{an integer.}$$

If $T \in L(H)^n$ is a commuting multioperator such that $\Delta_T^{(1)} \geq 0$ and $\Delta_T^{(n)} \geq 0$, we may define

$$P[f](T) = s - \lim_{\substack{r \to 1 \\ r<1}} \int_S f(w) P(rT, w)\, d\sigma(w)\,, \tag{$*$}$$

where σ is the Lebesgue measure on the unit sphere S,

$$P(rT, w) = C(rT, w)^* \Delta_{rT}^{(n)} C(rT, w) \quad , \quad w \in S\,,$$

and

$$C(rT, w) = (1 - r\overline{w}_1 T_1 - \cdots - r\overline{w}_n T_n)^{-n} \quad , \quad w \in S\,.$$

One can show that $(*)$ exists by some results due to V. Müller and F.-H. Vasilescu. The main result is the following.

Theorem: Let $T \in L(H)^n$ be a commuting multioperator such that $\Delta_T^{(1)} \geq 0$ and $\Delta_T^{(n)} \geq 0$. Then

$$P[f \circ \psi](T) = P[f](\psi(T))$$

for all $f \in C(S)$ and $\psi \in \mathrm{Aut}(B)$.

J. VOIGT

L_p–spectrum of Schrödinger operators

Let $H_p = -\frac{1}{2}\Delta$ in $L_p(\mathbb{R}^d)$, $D(H_p) = \{u \in L_p; \Delta u \in L_p\}$ $(1 \leq p \leq \infty)$, $V : \mathbb{R}^d \longrightarrow \mathbb{R}$ essentially bounded.

Theorem. $\sigma(H_p + V) = \sigma(H_2 + V)$ for all $p \in [1, \infty]$.

The idea of the (more difficult) inclusion $\varrho(H_2 + V) \subset \varrho(H_p + V)$ is to show that the L_2–resolvent is bounded as an operator in L_p, uniformly on compact subsets of $\varrho(H_2 + V)$.

This is achieved by using $L_p - L_q$–smoothing properties of the C_0–semigroup generated by $-(H_2 + V)$ and the resolvents of $H_2 + V$, in weighted L_p–spaces $L_p(\mathbb{R}^d, e^{\xi x}\,dx)$.
In fact, the assertion of the theorem holds for very general perturbations of H_p:
(a) V^- in the Kato class K_d, V^+ "admissible" (Hempel - Voigt, 1986);
(b) perturbations consisting of an H_2–form small "distributional part" plus suitable positive measures; in this case the L_p–operator is only defined for $p_0 \le p \le p_0'$, and the assertion holds for $p_0 < p < p_0'$ (Schreieck - Voigt, 1992).

W. WERNER

Differentiability of the norm in C^*–algebras

We report on some recent results concerning the differentiability structure of the unit sphere of C^*–algebras. A typical statement reads as follows:

Theorem: Let a be a point in the unit sphere of a C^*–algebra $\mathcal{A}$. Then TFAE:

(i) a is a (Fréchet–) smooth point.

(ii) There is a projection $p \in \mathcal{A}$, minimal in $\mathcal{A}^*$ such that

$$\|ap\| = 1 \text{ and } \|a(1-p)\| < 1\,.$$

(iii) There is $\pi \in \widehat{\mathcal{A}}$ so that $\pi(a)$ is F–smooth in $L(H_\pi)$, $1 = \|\pi(a)\| \ge \|\varrho(a)\| + \varepsilon_0$ for all $\varrho \in \widehat{\mathcal{A}} \setminus \{\pi\}$ and fixed $\varepsilon_0 > 0$.

(iv) There are a partial isometry $v \in \mathcal{A}^{**}$ and $\lambda \in \mathbb{C}$ so that v^*v is minimal and $\|a - \lambda v\| < 1$.

There are similar statements for (Gâteaux-) smooth points and points where the norm is strongly subdifferentiable. Interestingly the analogue of (iii) for G.–smooth points is wrong, a phenomenon that can be attributed to points in $\widehat{\mathcal{A}}$ which fail to be closed.
As an application, one can show that the points of strong subdifferentiability are dense in $\mathcal{A}$ iff all (not necessarily closed left) ideals contain idempotents, i.e. $\mathcal{A}$ is an I–ring.
All results have been obtained in collaboration with Keith F. Taylor as well as with M. Contreras and R. Payá, respectively.

G. WITTSTOCK

A functional calculus for divided differences and a proof of Loewner's theorem

Let $f \in C^3([\alpha,\beta]\mathbb{R})$, $x = x^*$, $y = y^*$, $h \in B(\mathcal{H})$, $\sigma(x) \cup \sigma(y) \subseteq (\alpha,\beta)$. L_x, L_y denote left and right multiplication by x and $M_y(h^*, h) := h^*yh$ denotes multiplication in the middle. With these operations on $B(\mathcal{H})$ we define divided differences $[x]_f := f(x)$, $[L_x, R_x]_f(h) := d/dt\, f(x+th)_{t=0}$ and a second divided difference $[L_x, M_x, R_x]_f(h^*, h)$. The second divided difference is a sesquilinear map such that

$$[L_x, M_x, R_x]_f(h,h) = d^2/dt^2\, f(x+th)_{t=0}\,.$$

This defines a functional calculus: we have the usual identities for divided differences and Newton's interpolation formula

$$L_{f(x)} = [\alpha]_f + [\alpha,\beta]_f(L_x - \alpha) + L_{r(x)}(L_x - \alpha)(L_x - \beta)\,,$$

$$L_{r(x)} = \Big([L_x,\alpha,R_x]_f(R_x - \alpha) + [L_x,\beta,R_x]_f(\beta - R_x)\Big)(\beta-\alpha)^{-1}\,.$$

The function f is operator convex if and only if the second divided difference is positive semidefinite. Based on this calculus we present a short proof of Loewner's theorem. It is also possible to define higher divided differences which are multilinear mappings on $B(\mathcal{H})$.

P. WOJTASZCZYK

Unconditional polynomial bases in L_p

We consider an unconditional basis $(f_n)_{n=0}^{\infty}$ in $L_p(\mathbf{T})$, $1 < p < \infty$, $p \neq 2$, consisting of trigonometric polynomials. We define

$$v_n = v_n(\{f_k\}_{k=0}^{\infty}) = \max\{\deg f_k \mid 0 \leq k \leq 2n\}\,.$$

Clearly $v_n \geq n$. We show that $\limsup_{n\to\infty} v_n/n > 1$. We also construct an unconditional basis $(\phi_n)_{n=0}^{\infty}$ such that $v_n(\{\phi_k\}_{k=0}^{\infty}) = n$ infinitely often.

V. ZAHARIUTA

Linear topological invariants and mixed (F,DF)–spaces

We introduce linear topological invariants by using of classical entropy or diameter–characteristics, for example

$$\beta(V,U) \stackrel{\text{def}}{=} \sup\{\dim L \mid U \cap L \subset V\}\,,$$

considered for synthetic neighbourhoods U, V, which are constructed by some invariant operations under neighbourhoods from a given basis of neighbourhoods of zero in LCS $\{U_p\}$. The simplest invariants of such kind can be obtained if we use, for example, $V = t^{-1}U_p \cap \tau U_r$ and $U = U_q$ or $V = U_q$ and $U = \overline{\text{conv}}(t^{-1}U_p \cup \tau U_r)$.
We apply this and more complicated linear topological invariants to give isomorphic classification of locally convex spaces with a mixed F,DF–nature, for example, of tensor products $E_\alpha(a) \otimes_\pi E'_\beta(b)$, where $\alpha, \beta = 0$ or ∞.

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