MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH

T a g u n g s b e r i c h t 6/1990

Funktionentheoretische Methoden bei partiellen Differential- und Integralgleichungen

4.2. bis 10.2.1990

Die Tagung stand unter der Leitung von H. BEGEHR (Berlin) und E. MEISTER (Darmstadt).

Von 27 Teilnehmern hielten 23 einen Vortrag. An der internationalen Zusammensetzung waren erfreulicherweise diesmal viele Kollegen aus den Staaten des Ostblocks beteiligt. Die eingeschränkte Teilnehmerzahl ermöglichte intensive persönliche Kontakte auch außerhalb des Vortragsprogramms. Weniger eng waren die fachlichen Berührungen mit der parallel tagenden Gruppe "Nukleare FRÉCHET-Räume", jedoch wurde der Mittwoch zu einem gemeinsamen Vortrags- und Ausflugsprogramm gestaltet.

Im Mittelpunkt der Tagung standen elliptische Systeme, Pseudodifferentialoperatoren sowie singuläre Integralgleichungen. Neben abstrakten standen angewandte Fragestellungen, neben linearen wurden insbesondere nichtlineare Probleme untersucht, neben analytischen wurden auch numerische Methoden angewandt. Es zeigte sich, daß neben den funktionentheoretischen, insbesondere bei nichtlinearen Problemen, immer mehr funktionalanalytische Methoden notwendig werden. Dieser Aspekt soll in der wiederum nach etwa vier Jahren zu veranstaltenden Folgetagung stärker berücksichtigt werden.

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A.V. BITSADZE

Function-theoretic methods for singular integral equations

The basic content of the lecture is an assertion about inversion formulas:

1) for systems of integral equations

$$\phi_2(x) = -\frac{1}{2\pi}\int_{-\infty}^{\infty} cth\frac{\pi}{2q}(t-x)\phi_1(t)\,dt + \frac{1}{2q}\int_{-\infty}^{\infty} th\frac{\pi}{2q}(t-x)\varphi_1(t)\,dt\,,$$

$$\varphi_2(x) = -\frac{1}{2\pi}\int_{-\infty}^{\infty} th\frac{\pi}{2q}(t-x)\phi_1(t)\,dt + \frac{1}{2q}\int_{-\infty}^{\infty} cth\frac{\pi}{2q}(t-x)\varphi_1(t)\,dt\,,$$

and

$$\phi_2(\vartheta_0) = -\frac{1}{\pi}\int_0^{2\pi}\zeta(\vartheta-\vartheta_0)\phi_1(\vartheta)\,d\vartheta + \frac{1}{\pi}\int_0^{2\pi}\zeta_3(\vartheta-\vartheta_0)\varphi_1(\vartheta)\,d\vartheta + \frac{\zeta(\pi)}{\pi^2}\int_0^{2\pi}\vartheta[\phi_1(\vartheta)-\varphi_1(\vartheta)]\,d\vartheta\,,$$

$$\varphi_2(\vartheta_0) = -\frac{1}{\pi}\int_0^{2\pi}\zeta_3(\vartheta-\vartheta_0)\phi_1(\vartheta)\,d\vartheta + \frac{1}{\pi}\int_0^{2\pi}\zeta(\vartheta-\vartheta_0)\varphi_1(\vartheta)\,d\vartheta + \frac{\zeta(\pi)}{\pi^2}\int_0^{2\pi}\vartheta[\phi_1(\vartheta)-\varphi_1(\vartheta)]\,d\vartheta\,,$$

where ζ and ζ_3 are WEIERSTRASS zeta-functions,

2. for equation with NEUMANN kernel $N(x_0, y)$

$$f(x_0) - \frac{1}{\omega_n}\int_S f(y)\, ds_y = \int_S N(x_0, y)\varphi(y)\, ds_y$$

on the ball $|x| = 1$ of EUCLIDean space E_n, $n \geq 3$, and for equation

$$\frac{\Gamma(n/2)}{(n-2)\pi^{n/2}} \int_{E_{n-1}} \frac{\varphi(y)\, dy}{|y-x|^{n-2}} = f(x)$$

B. BOJARSKI

Natural differential operators on RIEMANN surfaces

On a RIEMANN surface M with a given projective structure let λ be the "square root" of the canonical line bundle x, $\lambda^n = x$, and $\overline{\lambda}$ the conjugate line bundle. Let $\xi_{\mu,\nu}$ be the tensor line bundles $\xi_{\mu,\nu} = \lambda^{1-\mu} \otimes \overline{\lambda}^{1-\nu}$. Then the local formula $L_{\mu,\nu} f = \frac{\partial^{\mu+\nu} f}{\partial z^\mu \partial \overline{z}^\nu}$ in any local projective coordinate z leads to a globally defined differential operator $L_{\mu,\nu}$ on the sections of $\xi_{\mu,\nu}$ with values in $\xi_{-\mu,-\nu}$. The operators $L_{\mu,\nu}$ are invariants of the projective or MÕBIUS structure on M. By uniformisation they are meaningfull on any RIEMANN surface. The operators $L_{\mu,\nu}$ define the sheaf homomorphism of local sections of $\xi_{\mu,\nu}$ with values in $\xi_{-\mu,-\nu}$ and lead to a global theory of elliptic operators on compact surfaces and to a corresponding cohomology theory in the general case. The case $\xi_{\mu,0} = \lambda^{1-\mu}$ restricted to locally holomorphic sections of $\lambda^{1-\mu}$ is related to EICHLER cohomology. In general they lead to a DOLBEAULT type modification of EICHLER cohomology. The operators $L_{\mu,\nu}$ are also viewed as intertwining operators for the representations $T_{\mu,\nu}$ and $T_{-\mu,-\nu}$ of the MÕBIUS group M_2 of fractional transformations $\varphi(z) = \frac{az+b}{cz+d}$, $ad - bc = 1$. $T_{\mu,\nu} f = f(\varphi(t)) e_\varphi^{\mu-1} \overline{e}_\varphi^{\nu-1}$, $e_\varphi \equiv cz + d$: $L_{\mu,\nu}(T_{\mu,\nu} f) = T_{-\mu,-\nu}(L_{\mu,\nu} f)$.

Analogous constructions are discussed for the n-dimensional orientation preserving MÖBIUS group M_n with powers of EUCLIDean or relativistic DIRAC operators D^{μ} , acting on CLIFFORD algebra valued functions as intertwining operators for corresponding representations T_{μ} and $T_{-\mu}$ of the MÖBIUS group or LORENTZ groups.

L.R. BRAGG

The ascent method for a class of abstract differential equations

Relatively recent studies on the solution structure of the CAUCHY problem for the abstract wave and EPD equations show that one possible approach to the ascent method is to form real convolutions of solution operators of lower dimensional problems to obtain the solution operator for the higher dimensional one. In this paper, we examine this approach for the abstract DIRICHLET problem that involves the LAPLACE and GASPT equations. This leads to a procedure for construction the GREEN's function for the higher dimensional DIRICHLET problem from the GREEN's function for the lower dimensional ones by means of complex convolutions. The resulting formula may also be viewed as a "factorization" of the higher dimensional GREEN's function. Some formulas involving hypergeometric functions of operators that are pertinent to the ascent method are also developed.

R. Carroll

On the determinant theme for tau functions, dressing, Grassmannians, vertex operators, and inverse scattering

One considers first the tau functions and dressing kernels for KdV hierarchies obtained via determinant methods for example and gives criteria for the resulting situation to be "spectral" in the sense of arising from a "nice" potential via classical inverse scattering. A number of apparently new relations involving tau functions, dressing kernels, and spectral data are derived and some new features of the vertex operator equation are established. Then the conceptual equivalence of completeness for half plane analytic wave functions and the Hirota bilinear identity is indicated for KP and KdV. Finally the Grassmannian viewpoint of scattering for KdV is related to vertex operator action for determinant constructions and a geometrical formulation of Baker-Akhiezer functions is obtained in this context, leading to the Hirota formula.

R. Delanghe

Clifford analysis and the Radon transform in weighted L_2 -spaces

The aim of this talk is to characterize the Radon transform on weighted L_2 -spaces using Clifford analysis.
Using the Dirac operator in Euclidean space, generalized Gegenbauer polynomials may be defined in the unit ball of $\mathbb{R}^m$. They are the cornerstone in constructing an orthonormal basis for the weighted L_2 -space $L_2(B(1)\,;\,1-r^2)^{-\alpha})$. This space, in its turn, provides an interesting example of a weighted L_2 -space on which the classical Radon transform may act.

R. DUDUCHAVA

BESSEL potential operators for LIPSCHITZ domains

BESSEL potential operators B^r_Ω ($r \in I\!R$) for a plain LIPSCHITZ domain $\Omega \subset I\!R_2$ are constructed, arranging the isomorphisms $B^r_\Omega : X^s(\Omega) \to X^{s-r}(\Omega)$ between BESSEL potential $X^s(\Omega) = H^s_p(\Omega)$ and BESOV $X^s(\Omega) = B^s_{p,q}(\Omega)$ -spaces ($1 < p < \infty$, $1 \leq q \leq \infty$, $s \in I\!R$).
Pseudodifferential operators $A(x, D) : \tilde{X}^s(\Omega) \to X^{s-r}(\Omega)$ (Pd0's) with the symbols $a(x, \xi)$ discontinuous in ξ are defined and for a compact LIPSCHITZ domain $\Omega \subset I\!R_2$ their investigation is equivalently reduced to the investigation of singular integral operators (SI0's) $A_x : L_p(\sum_1) \to (L_p(\sum_1)$ for all fixed $x \in \overline{\Omega}$ and the quarter plane $\sum_1 = I\!R^+ \times I\!R^+$. Class of Pd0's, defined here generalize the class of classical Pd0's and in their case A_x represent the CALDERON - ZYGMUND SIO's.

A. DZHURAEV

Kernel matrices and degenerating elliptic problems

To solve the CAUCHY problem for the inhomogeneous CAUCHY - RIEMANN equation the condition of the orthogonality for the right hand side arises and the problem to describe the subspace of the right hand side.
Analogous problems are considered for higher order elliptic systems.
It is well known that there are differential equations without solutions, for example the HANS LEWY equation. In this talk we consider also the problem to describe the subspace for the right hand side of the inhomogeneous equation to have a unique solution in a HILBERT space.

J. EDENHOFER

Theorie des freien Grundwasserspiegels

In einem homogenen Boden über einer wasserundurchlässigen Schicht ($X - Y$ Ebene) befinde sich ein Grundwassersee der Tiefe f_0 . Seine Oberfläche werde mit der Flächendichte $N = N(x,t)$ bewässert. Zu bestimmen ist die Gleichung $z = f_o + f(x,t)$ der freien Oberfläche.
Das Problem wird mittels konformer Abbildung auf die Lösung einer nichtlinearen singulären Integralgleichung reduziert. Es lassen sich explizit Funktionenpaare (f, N) angeben, die durch Parameteranpassung praktisch verwendet werden können.

J. ELSCHNER

Boundary integral equations for LAPLACE's equation in polyhedral domains

We consider the equation $(\lambda - K)u = f$ $(*)$, where K is the double layer (harmonic) potential operator on the boundary of a bounded polyhedron in $I\!R^3$ and $\lambda, |\lambda| \geq 1$, a complex constant. Using the theory of elliptic boundary problems in non-smooth domains, V.G. MAZ'YA [Equadiff 6 Proceed., Brno 1985] obtained solvability results for the boundary integral equations of $3D$ -elasticity in weighted HÖLDER spaces. Our aim is to study the mapping properties of $\lambda - K$ in certain weighted SOBOLEV spaces, applying MELLIN transformation techniques directly to Eq. $(*)$. After localising near each corner to an infinite polyhedral cone, say Γ , we regard K as an operator-valued MELLIN convolution operator on Γ and investigate the symbol of this operator as an analytic operator function. Another ingredient of our analysis is the a priori estimate $\int_\Gamma (1 \pm K)Vu \cdot \overline{u}\, d\Gamma \geq c \, \| u \|^2$, where V is the single layer potential on Γ and

$\|\cdot\|$ denotes the norm in the SOBOLEV space $H^{-1/2}(\Gamma)$. A version of this estimate can be used to obtain another proof of VERCHOTA's theorem on the invertibility of the operators V and $1-K$ on the boundary of a LIPSCHITZ domain.

R.P. GILBERT

Anisotropic HELE - SHAW Flows

Function theoretic methods are used to solve the problem of viscous flow through a two-dimensional porous material.

E. LANCKAU

BERGMAN-Operatoren für dreidimensionale Probleme und nichtlineare Gleichungen

Die komplexen Integraloperatoren von S. BERGMAN und I.N. VEKUA sind komplexe Kurvenintegrale, die holomorphe Funktionen in Lösungen elliptischer Differentialgleichungen in der Ebene transformieren.
Es wird ein analoger Integraloperator für die Konstruktion der Lösungen von partiellen Differentialgleichungen im dreidimensionalen Raum angegeben. Damit kann die Transformation holomorpher Funktionen von zwei Veränderlichen in Lösungen elliptischer, hyperbolischer, parabolischer und anderer Gleichungen (wie gemischten oder zusammengesetzten Typs) mit einheitlichen Methoden erfolgen.

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Es wird weiter über einen Versuch berichtet, die BERGMANsche Operatorenmethode auf die Konstruktion von Lösungen nichtlinearer elliptischer Differentialgleichungen in der Ebene auszudehnen.

LE HUNG - SON

Some properties of solutions of overdetermined systems in several complex variables

In this talk we consider the overdetermined system

$$\frac{\partial w}{\partial \bar{z}_j} = A_j(z)\varphi(w) , \qquad j = 1, \ldots, n ,$$

in $\mathbb{C}^n$, where $A_j(z) \in C^\infty$ and $\varphi(w)$ is a holomorphic function of w .

The following problems are studied:

1. The conditions for the existence of non trival solutions of this system.
2. The generalized CAUCHY integral formula.
3. The extension theorems.
4. The generations of maximum modulus theorem, of MITTAG - LEFFLER and WEIERSTRASS theorems for solutions of this system.

V.G. MAZ'YA

Maximum principles for elliptic and parabolic systems

The MIRANDA - AGMON maximum modulus principle holds for linear strongly elliptic arbitrary order operators in any plane polygon and three dimensional polyhedron. This property fails for higher dimensions. Necessary and sufficient condition for the validity of the MIRANDA - AGMON maximum modulus principle for equations in a multidimensional cone is obtained (MAZ'YA, ROßMANN). We formulate also criteria for the validity of the classical relative maximum modulus principle for the second order linear strongly elliptic systems as well as criteria for the validity of the classical global maximum modules principle for the second order parabolic systems with time-independent coefficients (KRESIN, MAZ'YA).

L.G. MIKHAILOV

Function-theoretic method for some quasi-linear overdetermined and singular partial differential equations (P.D.E.)

I. Generalized CAUCHY- RIEMANN system in many variables. A more general system $\mathbf{P}_j w = \alpha_j(x) \cdot \overline{w} + \beta_j(x) \cdot w + \gamma_j(x)$, $j = 1, \ldots, n$, $\mathbf{P}_j w \equiv \sum_{k=1}^{2n} a_j^k(x) \left(\partial w / \partial x^k \right)$, $x = (x^1, \ldots, x^{2n})$, x^k are real and $\alpha_j, \beta_j, \gamma_j, a_j^k$ are complex. Quasi-linear system $\partial_{\overline{z}} w = p[z, \zeta; w]$, $\partial_{\overline{\zeta}} w = q[z, \zeta; w]$, $p, q \in C^2$, analytic in w and $p_{\overline{\zeta}} + q p_w = q_{\overline{z}} + p q_w$.

II. A singular system of ordinary differential equations: $y \frac{d\mathbf{y}}{dx} = \frac{\mathbf{F}[x; \mathbf{y}]}{x}$, $0 \leq x \leq 1$, $\mathbf{y} \equiv [y_1, \ldots, y_n]$, $\mathbf{F}[x; \mathbf{y}] \equiv \{f_1[x; y_1, \ldots, y_n], \ldots, f_n[x; y_1, \ldots, y_n]\}$. A singular linear and quasi-linear total-differential systems and quasi-linear singular generalized C–R system.

E. OBOLASCHVILI

Nonlocal boundary value problems for some partial differential equations

There are posed some nonlocal boundary value problems for the equations which have important applications in the theory of elasticity. For example one of such problems is:
find in the half-plane $y > 0$ ($z = x+iy$) a biharmonic function $U(x,y)$ vanishing at infinity for which there are given: $\frac{\partial U}{\partial y} = g(x)$, for $y = 0$, $x \in \mathbb{R}$ (real axis) and one of the conditions:

a)
$$U(x,0) = f(x) , \quad x < 0 ;$$
$$U(x,0) = U(x,h) + f(x) , \quad x > 0 ;$$

b)
$$U(x,0) = U(x,h_1) + f(x) , \quad x < 0 ;$$
$$U(x,0) = U(x,h) + f(x) , \quad x > 0 ,$$

where $h \neq h_1$ are positive constants.
When there are given the conditions only of the type a) or b) for both U and $\frac{\partial U}{\partial y}$ the consideration is more complicated.
Using WIENER - HOPF equations and convolution type of dual integral equations many of the considered problems are explicitly solved.

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F. PENZEL

Reduction of the factorization of DANIELE - KHRAPKOV matrices to scalar problems on hyperelliptic surfaces

(Joint work with E. MEISTER)

The problem to find an algorithm to factorize matrices G_K of DANIELE - KHRAPKOV type explicitely is stated. Here G_K is given by

$$G_K(t) := a_1(t)I + a_2(t)K(t) ,$$

where a_1, a_2 are piecewise HOELDER-continuous functions on the unit circle, K is a polynomial matrix with vanishing trace. A survey of papers dealing with this problem is given. The reduction to scalar RIEMANN boundary value problems on a RIEMANN hyperelliptic suface is demonstrated. An explicit solution of these problems is the class of functions having cuts and finitely many poles is worked out by use of a formula constructed by ZVEROVIC (1971) and RODIN (1988).

S. PRÖßDORF

A quadrature method for singular integral eqautions on closed curves

We consider a simple quadrature method for the numerical solution of singular integral equations with CAUCHY kernels which is based on the use of the rectangle rule with step-length $^1/_n$ $(n = 1, 2, ...)$ for approximating the integrals. It turns out that, in the case of the unit circle, our method is simply the trigonometric collocation method, combined with numerical quadrature for the compact term. We prove this method to be stable in L^2 provided the operator A of the equation is invertible. Moreover, we give a complete error analysis in the scale of SOBOLEV spaces H^s . The case of a non-invertible operator A is also considered. The talk is based on a joint paper with I. SLOAN.

N. RADZABOV

Linear hyperbolic equations with super-singular point

In a rectangle $R = \{0 < x < \alpha,\ 0 < y < \beta\}$ we consider the equations

$$Lu \equiv r^{2\gamma}\frac{\partial^2 u}{\partial x \partial y} + r^{\gamma}(ya(x,y)\frac{\partial u}{\partial x} + xb(x,y)\frac{\partial u}{\partial y} + cu = f , \qquad (1)$$

where γ = const., a, b, c are given functions in $\overline{R}$. Dependent upon $0 < \gamma < 2$, $\gamma = 2$ or $\gamma > 2$ we obtain an integral representation for the solutions of equation (1) by two arbitrary functions of a single variable. In two cases, when the coefficients are connected in a certain form, we obtain obvious formulas for the solutions of the equations. It is proved that solutions are limited at the origin. In the case when $\gamma = 2$ this solution has a singularity of power type and in case when $\gamma > 2$ it has a singularity of exponent type. These integral representations are applied for formulation of a DARBOU boundary valued problem and for its solutions similar results are obtained for system (1), where, a, b, c are quadratic matrices, f is a certain vector-function, u an unknown vector-function.

K.H. Schüffler

Zusammenhänge zwischen Minimalflächen und Funktionentheorie

Es werden Zusammenhänge: Minimalflächen ⟷ Funktionentheorie gegeben: Solche Zusammenhänge gibt es auf mehreren Ebenen:

1. Wie kann man in der Minimalflächentheorie die Variation des konformen Typs installieren — und zwar im Rahmen einer globalanalytischen Behandlung des PLATEAUschen Problems.
2. Die FREDHOLMtheorie des RIEMANN - HILBERT Operators findet äquivalente Anwendung in der Minimalflächentheorie.
3. Geeignete LAURENT-Entwicklung gestattet eine äußerst kurze Behandlung des RIEMANN - HILBERTschen Problems.
4. Harmonische Funktionen (bzw. Minimalflächen) auf MÖBIUSbändern lassen sich mit Hilfe geeigneter holomorpher Funktionen auf Halbkreisringen (unter Verwendung involutorischer Strukturen $z \to {}^{-1}/_{\bar{z}}$) beschreiben.

Tran Duc Van

The method of pseudodifferential operators with real analytic symbols in partial differential equations

The author presents a method for investigating partial differential equations and multidimensional integral equations of the first kind based on the technique of the algebra of pseudodifferential operators with analytic symbols which acts invariantly and continiously in the spaces $W_G^{\pm\infty}(\mathbb{R}^N)$.

W. TUTSCHKE

Weighted norms in the abstract CAUCHY - KOVALEVSKAYA theory

The lecture deals with three modifications of NIRENBERG's and NISHIDA's proof of the nonlinear abstract CAUCHY - KOVALEVSKAYA theorem saying that the initial value problem

$$\frac{du}{dt} = F(t,u)\,, \qquad u(t_0) = u_0$$

is solvable by the method of successive approximations provided the right-hand side $F(t,u)$ maps a given scale B_s , $0 < s < s_0$, of BANACH spaces into itself and satisfies suitable assumptions such as

$$\| F(t,v) - F(t,u) \|_{s'} \le \frac{C}{s-s'} \| v-u \|_s$$

where $0 < s' < s < s_0$ and C does not depend on s, s', u, v (cf. L. NIRENBERG's and T. NISHIDA's papers in Journ. Diff. Geom. 6, 561-576, 1972, and 12, 629-633, 1977, resp. and L. NIRENBERG's book "Topics on Nonlinear Functional Analysis", New York, 1974).
These modifications are

a) The infinite product $\prod_k \left(1 - \frac{1}{(k+1)^2}\right)$ occuring in the NIRENBERG - NISHIDA theory can be replaced by a more general one, $\prod_k (1-\delta_k)$, where $0 < \delta_k < 1$, $\sum_k \delta_k < +\infty$.

b) The weight $\left(\frac{a(s_0-s)}{t} - 1\right)$ of a norm can be replaced by

$$\left(\frac{a(s_0-s)}{t} - 1\right)^p , \qquad p > 0 .$$

c) An intermediate point between two scale parameters s_1 and s_2 , $s_1 < s_2$, can be choosen arbitrarily, i.e. as $s_1 + \lambda(s_2 - s_1)$ with $0 < \lambda < 1$, whereas $\lambda = \frac{1}{2}$ in the original proof.

The convergence interval turns out to be $\frac{4}{e}$ -times as large as in the NIRENBERG - NISHIDA case ($p = 1$, $\lambda = \frac{1}{2}$) . For details see the paper "Weighted norms in abstract scales of BANACH spaces" submitted for publication to the series "Pitman's Research Notes" (concerning the modification a) see the paper "On an abstract CAUCHY - KOWALEWSKI theorem — a variant of L. NIRENBERG's and T. NISHIDA's proof" in Zeitschr. Anal. Anwend. 5, 185-192, 1986, and the booklet "Solution of initial value problems in classes of generalized analytic functions" published by Teubner, Leipzig and Springer, Berlin etc., 1989).

L. VON WOLFERSDORF

Zur Behandlung einiger nichtlokaler Diffusionsgleichungen mit funktionentheoretischen Methoden

Von MIMURA und SATSUMA wurde eine Klasse nichtlokaler Diffusionsgleichungen mit singulären Integralen zur Beschreibung von Aggregationseffekten in der Populationsdynamik eingeführt. Diese werden mit Mitteln der komplexen Analysis einerseits auf HAMMERSTEINsche Integralgleichungen und andererseits auf komplexe BURGERS-Gleichungen zurückgeführt. Damit wird die Existenz der Lösung des CAUCHY-Problems für hinreichend kleine Zeiten nachgewiesen und das blow-up-Verhalten der Lösung studiert.
Die Methode der Zurückführung auf eine HAMMERSTEINsche Integralgleichung wird außerdem auf die zähe Modell-Wirbelgleichung angewendet, welche eine Erweiterung der Modell-Wirbelgleichung von CONSTANTIN, LAX und MAJDA darstellt.

XU ZHENYUAN

Fundamental solutions for operators which are polynomials in the DIRAC operator

Considering the CLIFFORD algebra $\mathbb{C}_m$ associated with the real orthogonal space $\mathbb{R}^{0,m}$, differential operators of the form $P(D) = \sum_{j=0}^{n} c_j D^j$, $c_j \in \mathbb{C}$, $n \in \mathbb{N}$, are the only ones to be invariant under the Spingroup $Spin(m)$, where D is the DIRAC operator $D = \sum_{j=1}^{m} e_j \frac{\partial}{\partial x_j}$. Obviously $P(D)$ may be rewritten in the form $P(D) = c \prod_{j=1}^{N} (D - \lambda_j)^{k_j}$, c and $\lambda_j \in \mathbb{C}$, $k_j \in \mathbb{N}$, λ_j being mutually different. Firstly distinguishing between the cases $Im\ \lambda > 0$; $Im\ \lambda < 0$ and $Im\ \lambda = 0$, the explicit formulae for the fundamental solutions of $D - \lambda$ are obtained. Secondly a fundamental solution for the operator $(D - \lambda)^n$ is given by recurrence formulae. Finally a method is presented for constructing a fundamental solution in the general case $P(D) = \prod_{j=1}^{n} (D - \lambda_j)^{k_j}$.

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