

Zeitschrift: L'Enseignement Mathématique
Herausgeber: Commission Internationale de l'Enseignement Mathématique
Band: 17 (1971)
Heft: 1: L'ENSEIGNEMENT MATHÉMATIQUE

Artikel: ON THE EXISTENCE AND THE REGULARITY OF SOLUTIONS OF LINEAR PSEUDO-DIFFERENTIAL EQUATIONS

Autor: Hörmander, Lars

Bibliographie

DOI: <https://doi.org/10.5169/seals-44576>

Nutzungsbedingungen

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften auf E-Periodica. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Das Veröffentlichen von Bildern in Print- und Online-Publikationen sowie auf Social Media-Kanälen oder Webseiten ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. [Mehr erfahren](#)

Conditions d'utilisation

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. La reproduction d'images dans des publications imprimées ou en ligne ainsi que sur des canaux de médias sociaux ou des sites web n'est autorisée qu'avec l'accord préalable des détenteurs des droits. [En savoir plus](#)

Terms of use

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. Publishing images in print and online publications, as well as on social media channels or websites, is only permitted with the prior consent of the rights holders. [Find out more](#)

Download PDF: 19.08.2025

ETH-Bibliothek Zürich, E-Periodica, <https://www.e-periodica.ch>

REFERENCES

- AGMON, S., A. DOUGLIS and L. NIRENBERG. [1] Estimates near the boundary for solutions of elliptic partial differential equations satisfying general boundary conditions. I. *Comm. Pure Appl. Math.*, 12 (1959), pp. 623-727. II. *Comm. Pure Appl. Math.*, 17 (1964), pp. 35-94.
- ANDERSSON, K. G. [1] Propagation of analyticity of solutions of partial differential equations with constant coefficients. *Ark. för Matematik*, 8 (1970), pp. 277-302.
- BONY, J. M. [1] Une extension du théorème de Holmgren sur l'unicité du problème de Cauchy. *C. R. Acad. Sci. Paris* 268 (1969), pp. 1103-1106.
- BORELLI, R. L. [1] A priori estimates for a class of second order non-regular boundary problems. Thesis, U. of California, Berkeley (1963).
- CARATHÉODORY, C. [1] Variationsrechnung und partielle Differentialgleichungen Erster Ordnung. Berlin, Teubner, 1935.
- DUISTERMAAT, J. J. and L. HÖRMANDER. [1] Fourier integral operators, II. In preparation.
- EGOROV, Yu. V. [1] On canonical transformations of pseudo-differential operators. *Uspehi Mat. Nauk*, 25 (1969), pp. 235-236.
- [2] On subelliptic pseudo-differential operators. *Dokl. Akad. Nauk SSSR*, 188 (1969), pp. 20-22. Also in *Soviet Math. Dokl.*, 10 (1969), pp. 1056-1059.
- [3] Non-degenerate subelliptic pseudo-differential operators. *Mat. Sbornik*, 82 (124) (1970), pp. 324-342.
- and V. A. Kondrat'ev. [1] The oblique derivative problem. *Mat. Sbornik*, 78 (120) (1969), pp. 148-176. Also in *Math. USSR Sbornik*, 7 (1969), pp. 139-169.
- EŠKIN, G. I. [1] Degenerating elliptic pseudodifferential equations of principal type. *Mat. Sbornik*, 82 (124) (1970), pp. 585-628.
- FLASCHKA, H. and G. STRANG. [1] The correctness of the Cauchy problem. To appear.
- GABRIELOV, A. M. [1] On a theorem of Hörmander. *Funkt. anal. i evo pril.*, 4 (1970), pp. 18-22.
- GRUŠIN, V. V. [1] The extension of smoothness of solutions of differential equations of principal type. *Dokl. Akad. Nauk SSSR*, 148 (1963), pp. 1241-1244. Also in *Soviet Math. Dokl.*, 4 (1963), pp. 248-252.
- HÖRMANDER, L. [1] Linear partial differential operators. *Grundl. d. Math. Wiss.*, 116, Springer Verlag, 1963.
- [2] Pseudo-differential operators. *Comm. Pure Appl. Math.*, 18 (1965), pp. 501-517.
- [3] Pseudo-differential operators and non-elliptic boundary problems. *Ann. Math.*, 83 (1966), pp. 129-209.
- [4] Pseudo-differential operators and hypoelliptic equations. *Amer. Math. Soc. Symp. on Singular Integral Operators*, 1966, pp. 138-183.
- [5] Hypoelliptic second order differential equations. *Acta Math.*, 119 (1967), pp. 147-171.
- [6] The spectral function of an elliptic operator. *Acta Math.*, 121 (1968), pp. 193-218.
- [7] On the singularities of solutions of partial differential equations. *Comm. Pure Appl. Math.*, 23 (1970), pp. 329-358.
- [8] On the index of pseudo-differential operators. Elliptische Differentialgleichungen II, Koll. Aug. 1969, in Berlin. Schriftenreihe der Inst. für Math. Deutsch. Akad. d. Wiss. zu Berlin Reihe A, Heft 8.
- [9] Fourier integral operators I. *Acta Math.*, 127 (1971), pp. 79-183.
- [10] The calculus of Fourier integral operators. In *Prospects in Mathematics* to be published by Princeton University Press.
- [11] Uniqueness theorems and wave front sets for solutions of linear differential equations with analytic coefficients. *Comm. Pure Appl. Math.*, 24 (1971).

- [12] A remark on Holmgren's uniqueness theorem. To appear in *J. Diff. Geom.*, 5 (1971).
- [13] Linear differential operators. *Actes Congrès Intern. Math. Nice 1970*, 1.
- JOHN, F. [1] Continuous dependence on data for solutions of partial differential equations with a prescribed bound. *Comm. Pure Appl. Math.*, 13 (1960), pp. 551-585.
- KAWAI, T. [1] Construction of elementary solutions for I-hyperbolic operators and solutions with small singularities. *Proc. Jap. Acad.*, 46 (1970), pp. 912-915.
- [2] Construction of a local elementary solution for linear partial differential operators, I-II. *Proc. Jap. Acad.*, 47 (1971), pp. 19-23, and to appear.
- KLINE, M. and I. W. KAY. [1] Electromagnetic theory and geometrical optics. *Pure and Applied Mathematics XII*, Interscience Publ., New York, 1965.
- KOHN, J. J. and L. NIRENBERG. [1] On the algebra of pseudo-differential operators. *Comm. Pure Appl. Math.*, 18 (1965), pp. 269-305.
- KUMANO-GO, H. [1] Algebras of pseudo-differential operators. *J. Fac. Sci. Univ. Tokyo*, 17 (1970), pp. 31-50.
- LAX, P. D. [1] Asymptotic solutions of oscillatory initial value problems. *Duke Math. J.*, 24 (1957), pp. 627-646.
- and L. NIRENBERG. [1] On stability for difference schemes; a sharp form of Gårding's inequality. *Comm. Pure Appl. Math.*, 19 (1966), pp. 473-492.
- LEWY, H. [1] An example of a smooth linear partial differential equation without solutions. *Ann. Math.*, 66 (1957), pp. 155-158.
- MALGRANGE, B. [1] Existence et approximation des solutions des équations aux dérivées partielles et des équations de convolution. *Ann. Inst. Fourier Grenoble*, 6 (1955-1956), pp. 271-355.
- [2] Sur les ouverts convexes par rapport à un opérateur différentiel. *C. R. Acad. Sci. Paris*, 254 (1962), pp. 614-615.
- MASLOV, V. P. [1] Theory of perturbations and asymptotic methods. *Moskov. Gos. Univ.*, Moscow 1965 (Russian).
- MELIN, A. [1] Lower bounds for pseudo-differential operators. *Ark. för Matematik*, 9 (1971).
- MIZOHATA, S. [1] Solutions nulles et solutions non analytiques. *J. Math. Kyoto Univ.*, 1 (1962), pp. 271-302.
- and Y. OHYA. [1] Sur la condition de E. E. Levi concernant des équations hyperboliques. *Publ. Res. Inst. Math. Sci. Kyoto Univ. A*, 4 (1968), pp. 511-526.
- NIRENBERG, L. and F. TRÈVES. [1] Solvability of a first order linear partial differential equation. *Comm. Pure Appl. Math.*, 14 (1963), pp. 331-351.
- [2] On local solvability of linear partial differential equations. Part I: Necessary conditions. Part II: Sufficient conditions. *Comm. Pure Appl. Math.*, 23 (1970), pp. 1-38 and pp. 459-510.
- RADKEVIČ, E. V. [1] On a theorem of L. Hörmander. *Uspehi Mat. Nauk SSSR*, 24, 1 (145) (1969), pp. 199-200.
- [2] A priori estimates and hypoelliptic operators with multiple characteristics. *Dokl. Akad. Nauk SSSR*, 187 (1969), pp. 274-277.
- SATO, M. [1] Hyperfunctions and partial differential equations. *Proc. Int. Conf. on Funct. Anal. Tokyo 1969*, pp. 91-94.
- [2] Regularity of hyperfunction solutions of partial differential equations. To appear in *Actes Congrès Intern. Math. Nice 1970*.
- and T. KAWAI. [1] Structure of hyperfunctions. *Symp. Alg. Geom. and Hyperfunction Theory*. Katata 1969 (Japanese).
- and M. KASHIWARA. [1] Structure of hyperfunctions. *Sugaku no Ayumi*, 15 (1970), pp. 9-72 (Japanese).

- SCHWARTZ, L. [1] Théorie des distributions à valeurs vectorielles, I. *Ann. Inst. Fourier Grenoble*, 7 (1957), pp. 1-141.
- SJÖSTRAND, J. [1] Sur une classe d'opérateurs pseudo-différentiels de type principal. *C. R. Acad. Sci. Paris*, 271 (1970), pp. 781-783.
- TRÈVES, F. [1] Linear partial differential equations with constant coefficients. Gordon and Breach, New York, 1966.
- [2] On the local solvability of linear partial differential equations in two independent variables. *Amer. J. Math.*, 92 (1970), pp. 174-204.
- [3] Local solvability in L^2 of first order linear PDE's. *Amer. J. Math.*, 92 (1970), pp. 369-380.
- [4] Hypoelliptic partial differential equations of principal type with analytic coefficients. *Comm. Pure Appl. Math.*, 23 (1970), pp. 637-651.
- [5] Analytic hypoelliptic partial differential equations of principal type. To appear in *Comm. Pure Appl. Math.*.
- [6] A new method of proof of the subelliptic estimates. *Comm. Pure Appl. Math.*, 24 (1971), pp. 71-115.
- [7] Hypoelliptic partial differential equations of principal type. Sufficient conditions and necessary conditions. To appear in *Comm. Pure Appl. Math.*.
- [8] Fundamental solutions of linear partial differential equations with constant coefficients depending on parameters. *Amer. J. Math.*, 84 (1962), 561-577.
- [9] Equations aux dérivées partielles inhomogènes à coefficients constants dépendant de paramètres. *Ann. Inst. Fourier Grenoble*, 13 (1963), pp. 123-138.
- VAILLANCOURT, R. [1] A simple proof of Lax-Nirenberg theorems. *Comm. Pure Appl. Math.*, 23 (1970), pp. 151-163.
- ZACHMANOGLOU, E. C. [1] Uniqueness of the Cauchy problem when the initial surface contains characteristic points. *Arch. Rat. Mech. Anal.*, 23 (1966), pp. 317-326.
- [2] Non-uniqueness of the Cauchy problem for linear partial differential equations with variable coefficients. *Arch. Rat. Mech. Anal.*, 27 (1968), pp. 373-384.
- [3] Propagation of zeros and uniqueness in the Cauchy problem for first order partial differential equations. *Arch. Rat. Mech. Anal.*, 38 (1970), pp. 178-188.
- ZERNER, M. [1] Solutions singulières d'équations aux dérivées partielles. *Bull. Soc. Math. France*, 91 (1963), pp. 203-226.

(Reçu le 8 juin 1971)

Lars Hörmander
Department of Mathematics
University of Lund (Sweden)