FONDAZIONE C.I.M.E.
CENTRO INTERNAZIONALE MATEMATICO ESTIVO
INTERNATIONAL MATHEMATICAL SUMMER CENTER

"Complete Intersections"

in the subject of the First 1983 C.I.M.E. Session.

The Session, sponsored by the Consiglio Nazionale delle Ricerche and the Ministero della Pubblica Istruzione, will take place under the scientific direction of Prof. SILVIO GRECO (Politecnico di Torino, Italy) at the Azienda Regionale delle Terme, Acireale (Catania), Italy, ***from June 13 to June 21, 1983.***

Courses

a) ***Complete intersections in affine-algebraic spaces and Stein spaces.*** (8 lectures in English).
Prof. Otto FORSTER (Ludwig-Maximilians-Universität, München, BRD).

1. Estimate of the number of generators of ideals in non-local rings. Proof of the Forster-Eisenbud-Evans conjecture.
2. Estimate of the number of equations necessary to describe algebraic (analytic) sets. Proof of the theorem of Storch-Eisenbud-Evans.
3. The role of the normal bundle.
4. Topological conditions for ideal-theoretical complete intersections in Stein spaces.
5. The Ferrand construction. Set theoretical complete intersections.

References

1. BANICA-FORSTER, Complete intersection in Stein manifolds. Manuscr. Math. 37 (1982), 343-356.
2. EISENBUD-EVANS, Every algebraic set in n-space is the intersection of n hypersurfaces. Inv. Math. 19 (1973), 107-112.
3. FERRAND, Courbes gauches et fibrés de rang 2. CR Acad. Sci. Paris 281 (1975), 345-347.
4. FORSTER, Uber die Anzahl der Erzeugenden eines Ideals in einem Noetherschen Ring. Math. Z. 84 (1964), 80-87.
5. FORSTER-RAMSPOTT, Analytische Modulgarben und Endromisbündel. Inv. Math. 2 (1966), 145-170.
6. KUNZ, Einführung in die kommutative Algebra und algebraische Geometrie, Kap. V., Vieweg 1980.
7. MOHAN KUMAR, On two conjectures about polynomial rings. Inv. Math. 46 (1978), 225-236.
8. SATHAYE, On the Forster-Eisenbud-Evans conjecture. Inv. Math. 46 (1978), 211-224.
9. SCHNEIDER, Vollständige, fast-vollständige und mengentheoretischvollständige Durchschnitte in Steinschen Mannigfaltigkeiten. Math. Ann. 260 (1982), 151-174.
10. STORCH, Bemerkung zu einem Satz von M. Kneser. Arch. Math. 23 (1972), 403-404.
11. SWAN, The number of generators of a module. Math. Z. 102 (1967). 318-322.
12. SZPIRO, Equations defining space curves. Tata Institute Bombay, Springer 1979.

b) ***Work of Zak and others on the geometry of projective space.*** (8 lectures in English).
Prof. Robert LAZARSFELD (Harvard University, USA).

A conjecture of Hartshorne, to the effect that any smooth subvariety of sufficienty small codimension in projective space must be a complete intersection, has sparked a considerable body of work over the past decade. We will survey some of these results, focusing on Zak's recent solution of a related problem of Hartshorne's on linear normality. Specifically, the course will be organized as follows:

1. Historical Introduction; theorems of Barth, Fulton-Hansen, et. al.
2. Work of Zak.
3. Further results; open problems.

References:

1. R. HARTSHORNE, Varieties of small codimension in projective space, Bull. A.M.S. 80 (1974), 1017-1032.
2. W. FULTON and R. LAZARSFELD, Connectivity and its applications in algebraic geometry, in Libgober and Wagreich (eds), Algebraic geometry, Proceedings, Chicago Circle (1980), Lecture notes in math. no. 862, Springer Verlag.

c) ***Complete intersections in weighted projective spaces.*** (4 lectures in English).
Prof. Lorenzo ROBBIANO (Università di Genova, Italy).

The purpose of this course is to give a brief account of some results relating classical theorems on complete intersections in projective spaces to new results in weighted projective spaces.

The first part will treat some basic facts on weighted projective spaces, while the second one will be concerned with more specialized facts, such as Lefschetz-type theorems. In particular, problems of factoriality and semifactoriality will be studied.

Basic references

1. C. DELORME, Espaces projectifs anisotropes, Bull. Soc. Math. France 103 (1975).
2. M. DEMAZURE, Anneaux gradués normaux, in Séminaire Demazure-Giraud-Teissier, Singularités des surfaces, Ecole Polytechnique 1979.
3. I. DOLGACHEV, Weighted projective varieties. Mimeographed notes. Moscow State University 1975/76.
4. R.M. FOSSUM, The divisor class group of a Krull domain, Ergeb. Math. Grenz. Bd. 74, Springer Berlin 1973.
5. S. MORI, On a generalization of complete intersections, J. Math. Kyoto Univ. 15 (1975).

d) ***On set-theoretic complete intersections.*** (4 lectures in English).
Prof. Giuseppe VALLA (Università di Genova, Italy).

The aim of this course is to give a comprehensive approach to some of the research frontiers in the topic of algebraic varieties which are set-theoretic complete intersections.

Focusing on the special case of affine or projective algebraic curves over a field of characteristic zero, the course will develop to include the most important and recent results on this subject, such as the theorems, given by D. Ferrand and M. Kumar, on affine curves which are locally complete intersections.

The final part of the course will be devoted to make some hints at the case of projective space curves.

Reference

1. J.P. SERRE, Sur le modules projectifs, Sem. Dubreil-Pisot 14 (1960/61).
2. P. MURTHY, Complete intersections, Conference on Commutative Algebra 1975, Queen's Unviersity, 196-211.
3. M. KUMAR, On two conjectures about polynomial rings, Inv. Math. 46 (1978), 225-236.

Seminars

A number of seminars and special lectures will be offered during the Session.

FONDAZIONE C.I.M.E.
CENTRO INTERNAZIONALE MATEMATICO ESTIVO
INTERNATIONAL MATHEMATICAL SUMMER CENTER

"Bifurcation Theory and Applications"

in the subject of the Second 1983 C.I.M.E. Session.

The Session, sponsored by the Consiglio Nazionale delle Ricerche and the Ministero della Pubblica Istruzione, will take place under the scientific direction of Prof. LUIGI SALVADORI (Università di Trento, Italy) at Villa «La Querceta», Montecatini Terme (Pistoia), Italy, ***from June 24 to July 2, 1983.***

Courses

a) ***Bifurcation Phenomena in Biomathematics.*** (6 lectures in English).
Prof. Stavros BUSENBERG (Harvey Mudd College, USA).

Lecture 1: Origins of bifurcation problems in biomathematics.
Nonlinear interactions in population dynamics, nerve pulse propagation, cell growth and morphogenesis.

Lecture 2: Bifurcation and stability in models with monotone properties.
Global bifurcation and stability of constant, periodic and almost periodic solutions. Applications to epidemic and other population models.

Lecture 3: Hopf type bifurcation.
Models in population dynamics and metabolic control with Hopf bifurcations. Periodic, quasiperiodic and chaotic behavior.

Lecture 4: Linear and nonlinear diffusion.
Spatial diffusion and pattern formation. Chemotaxis, strain guided diffusion and morphogenesis.

Lecture 5: Separable age-dependent processes.
A method for decomposing the equations of age-structured processes. Bifurcation phenomena in age-dependent population and cell growth models.

Lecture 6: Diffusion in age-dependent processes.
Spatial diffusion in age-dependent population and cell growth models. Bifurcation of spatially heterogeneous solutions and the development of spatial structure.

References

General background: Mathematics of Biology, M. Iannelli editor, CIME ciclo 1979, Liguori, Napoli (1981). Hoppensteadt, F., Mathematical Theory of Population, Demographics, Genetics and Epidemics, SIAM, Philadelphia (1975).

Population and epidemic models: Busenberg, S. and Cooke, K., «The effect of integral conditions in certain equations modelling epidemics and population growth», J. Math. Biol. 10 (1980), 13-22. Busenberg, S. and Cooke, K., «Models of vertically trasmitted diseases with sequential continuous dynamics», in Nonlinear Phenomena in Mathematical Science, V. Lakshmikantham, editor, Academic Press, New York (1982). Lajmanovich, A. and Yorke, J., «A deterministic model for gonorrhea in a nonhomogeneous population», Math, Biosc. 28 (1976), 221-236.

Diffusion an age-dependence: Busenberg, S. and Travis, C., «Epidemic models with spatial spread due to population migration», J. Math. Biol. (1983) (in press). Busenberg S. and Iannelli, M., «A class of nonlinear diffusion problems in age-dependent population dynamics», Nonlinear Analysis MTA, (1983) (in press). Okubo, A., Diffusion and Ecological Problems: Mathematical Models, Springer Verlag, New York (1980).

b) ***Bifurcation of periodic solutions near equilibria of Hamiltonian systems.*** (6 lectures in English).
Prof. I.J. DUISTERMAAT (State University of Utrecht, NL).

A short outline of the content

The problem of finding periodic solutions is formulated as an equation in the loop space. Using Lyapunov-Schmidt reduction this is equivalent to finding zeros of a vectorfield in a finite dimensional space, with a built-in circle invariance. Variants of this procedure work for discrete dynamical systems and for finding homoclinic orbits. If the original system is Hamiltonian then the reduced problem amounts to finding critical points of a circle-invariant

function. Near equilibrium points the problem is solved approximately up to any order using Birkhoff normal forms. If only two degrees of freedom are in resonance then, in the generic case, one can bring the equations into an exact normal form, using Wasserman's group invariant version of Mather's theory. If the system itself has two degrees of freedom then this also gives useful information about the other solutions near the equilibrium points. The course will be concluded with a discussion of the situation when more than two degrees of freedom are in resonance.

References

1. D.S. SCHMIDT, Periodic solutions near a reasonant equilibrium of a Hamiltonian system, Celestial Mechanics 9 (1974), 81-103.
2. J. MOSER, Periodic orbits near an equilibrium and a theorem by Alan Weinstein, Comm. Pure Appl. Math. 29 (1976), 727-747.
3. G. WASSERMAN, Classification of singularities with compact abelian symmetry, Regensburger Math. Schriften 1, 1977.

c) ***Topics in Bifurcation Theory***. (6 lectures in English).
Prof. Jack K. HALE (Brown University, USA).

The topics include:

Bifurcation from an equilibrium point with one zero or two pure imaginary roots, relations between the bifurcation function and the center manifold, and the extent to which the theory is valid in infinite dimensions. Nonlocal results and some codimension two bifurcations in R^2 and the role of symmetry. Generic theory, dynamic behavior and stable equilibria in a parabolic equation. Nonlinear oscillations and chaotic behavior in functional differential equations.

The basic references are:

1. S.N. CHOW and J.K. HALE, Methods of Bifurcation Theory, Grundlehren der Math. Wiss. 251, Springer-Verlag, 1982.
2. J.K. HALE, Topics in Dynamic Bifurcation Theory, NSF-CBMS Lectures 27, Am. Math. Soc., Providence, R.I. 1981.

d) ***Bifurcation and transition to turbulence in hydrodynamics***. (6 lectures in English).
Prof. Gérard IOOSS (Université de Nice, F).

Outline of the contents:

Physical motivation - Experimental results.
Navier-Stokes equations as a dynamical system, regularity properties of the solution. Poincaré map.
Specific examples: Taylor problem, plane Bénard problem.
Bifurcations which break symmetries, rotating waves, quasiperiodic solutions, frequency lockings.
Routes for transition to turbulence. Conjectures, open problems.

Basic literature references:

1. V.I. ARNOLD, Chapitres supplémentaires de la théorie des équations différentielles ordinaires, ed. MIR, Moscou 1980.
2. S.N. CHOW, J.K. HALE, Methods of bifurcation theory, Springer Verlag, 1982.
3. G. IOOSS, Arch. Rat. Mech. Anal., 64, 4 (1977), 339-369.
4. G. IOOSS, Bifurcation of maps and applications, North Holland Math. Stud. 36, 1979.
5. D.D. JOSEPH, Stability of fluid motions, vol. I and II, Springer Tracts in Phil., vol. 27, 28, 1976.
6. T. KATO, Perturbation theory for linear operators, Springer Verlag, 1966.
7. O.A. LADYZENSKAYA, The mathematical theory of viscous incompressible flow, Gordon and Breach, 1969.
8. J. MARSDEN, M. Mc CRACKEN, The Hopf bifurcation and its applications, Math. Applied Sciences, I, Springer Verlag 1976.

Seminars

A number of seminars and special lectures will be offered during the Session.

FONDAZIONE C.I.M.E.
CENTRO INTERNAZIONALE MATEMATICO ESTIVO
INTERNATIONAL MATHEMATICAL SUMMER CENTER

"Numerical Methods in Fluid Dynamics"

in the subject of the Third 1983 C.I.M.E. Session.

The Session, sponsored by the Consiglio Nazionale delle Ricerche and the Ministero della Pubblica Istruzione, will take place under the scientific direction of Prof. FRANCO BREZZI (Università di Pavia, Italy) at «Villa Olmo», Como, Italy, ***from July 4 to July 12, 1983.***

Courses

a) ***Finite Elements Method for Compressible and Incompressible Fluids.*** (6 lectures in English).
Prof. Roland GLOWINSKI (INRIA, France).

1. Finite Elements Method for the Stokes problem.
2. Nonlinear least-square and applications to fluid flow problems.
3. Alternating directions methods for Navier-Stokes equations.
4. Upwinding methods for transonic flows.

References

1. GIRAULT, RAVIART, Finite Element Approximation of Navier-Stokes equations. Lecture Notes in Math. n. 749 (1979), Springer.
2. GALLAGHER, NORRIE, ODEN, ZIENKIEWICZ (Eds.), Finite Elements in Fluids. Vol. IV. J. Wiley, 1982.
3. GLOWINSKI, Numerical Methods in Nonlinear Variational Problems. Cap. VII, Springer, 1983.

b) ***Spectral methods for partial differentiation equations of fluid dynamics.*** (6 lectures in English).
Prof. David GOTTLIEB (NASA, USA).

Lecture 1 : Presentation of spectral methods - Fourier Chebyshev and others, survey of approximation results.
Lecture 2+3: Stability and convergence of spectral methods for parabolic and hyperbolic P.D.E.'s.
Lecture 4 : Time marching and iterative techniques.
Lecture 5 : Application - incompressible flows.
Lecture 6 : Application - compressible flows.

Literature

1. D. GOTTLIEB & S.A. ORSZAG, Numerical Analysis of Spectral Methods, Theory and Applications C.B.M.S.-S.I.A.M. No. 26, 1977.
2. B. MERCIER, Analyse numérique des Méthodes Spectrales. Note CEA-N-2278 Commissariat à l'Energie Atomique, Centre d'études de Limiel.

c) ***Transonic flow calculations for aircrafts.*** (6 lectures in English).
Prof. Antony JAMESON (Princeton University, USA)

— Review of mathematical models
— Potential flow methods
— Multigrid acceleration
— Solution of the Euler equations in 2 and 3 dimensions.

References

1. K.W. MORTON, R.P. RICHTMYER, Difference methods for initial value problems, New York, 1967.
2. A. BRANDT, Math. Comp. 31 (1977).

3. A. JAMESON, Comm. Pure & Appl. Math., 27 (1974).
4. A. JAMESON, «Steady state solution of Euler equation for Transonic Flow» in «Transonic, shock, and multidimensional flows: Advances in scientific computing», R.E. Meyer ed., Academic Press 1982.

d) ***An Analysis of Particle Methods***. (6 lectures in English).
Prof. P.A. RAVIART (Université P. et M. Curie, Paris).

By particle methods, one usually means numerical methods where some dependent variables of the problem are approximated by a sum of delta functions. This course intends to provide the mathematical basis of these methods which play an increasing role in Fluid Mechanics and in Physics. The following topics will be discussed:

1. Particle approximation of linear hyperbolic equations
2. Numerical approximation of Euler equations in two and three dimensions by vortex and vortex in cell methods.
3. Particle approximation of Vlasov-Poisson equations in plasma physics.

References

1. J.T. BEALE & A. MAJDA, Vortex methods I: Convergence in three dimensions, Math. Comp. 32 (1982), 1-27.
2. J.T. BEALE & A. MAJDA, Vortex methods II: Higher order accuracy in two and three dimensions, Math. Comp. 32 (1982), 29-52.
3. G.H. COTTET, Méthodes particulaires pour l'équation d'Euler dans le plan, Thèse de 3ème cycle, Université Pierre & Marie Curie, Paris 1982.
4. G.H. COTTET & P.A. RAVIART, Particle methods for the one-dimensional Vlasov-Poisson equations, rapport interne 82027, Laboratoire d'Analyse Numérique, Université Pierre & Marie Curie, Paris (to appear in SIAM J. Num. Anal.).
5. R.W. HOCKNEY & J.W. EASTWOOD, Computer simulation using particles, McGraw-Hill, New York, 1981.
6. A. LEONARD, Vortex methods for flow simulation, J. Comp. Physics, 37 (1980), 289-335.

Seminars

A number of seminars and special lectures will be offered during the Session.

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Vol. 846: Ordinary and Partial Differential Equations, Proceedings. Edited by W. N. Everitt and B. D. Sleeman. XIV, 384 pages. 1981.

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