

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

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**“Theory of Invariants”**

is the subject of the First 1982 C.I.M.E. Session.

The Session, sponsored by the Consiglio Nazionale delle Ricerche, will take place under the scientific direction of Prof. FRANCESCO GHERARDELLI (Università di Firenze, Italy), at the Villa «La Querceta», Montecatini Terme, Italy, *from June 10 to June 18, 1982.*

*Courses*

- a) *Classical Theory of Invariants and Compactifications of Algebraic Symmetric Spaces.* (8 lectures in English).  
Prof. Corrado DE CONCINI (Università di Pisa, Italy).
- b) *Geometric Invariant Theory and Applications to Moduli Problems.* (8 lectures in English).  
Prof. David GIESEKER (IAS, Princeton, USA).
  - 1. Introduction to geometric invariant theory.
  - 2. Moduli of stable bundles on a smooth curve.
  - 3. Moduli of stable curves.
  - 4. Degeneration techniques in the study of the moduli space of stable vector bundles on a smooth curve.

**References:**

- 1. MUMFORD, D., Stability of Projective Varieties. *L'Enseignement Mathématique XXIII* fasc. 1-2, 1977.
- 2. NEWSTEAD, P.E., Lectures on Introduction to Moduli Problems and Orbit Spaces, New Delhi: Narosa Pub. House, 1978 (Tata Lecture Notes).
- c) *Infinite Root Systems, Representations of Quivers and Invariant Theory.* (8 lectures in English).  
Prof. Victor KAC (MIT, Cambridge, USA).

**Contents:**

Infinite root system and Weyl group.  
Rosenlicht theorem, Vinberg's lemma and Weil conjectures.  
Quivers and their representations, reflection functors, description of dimensions of indecomposable representations.  
Schur representations and the problem of classification of prehomogeneous vector spaces.

**References:**

- 1. GABRIEL P., Unzerlegbare Darstellungen, *Manuscripta Math.* **6**, 71-103 (1972)
- 2. KAC V.G., Infinite root systems, representations of graphs and invariant theory, *Inventiones Math.* **56**, 57-92 (1980).
- 3. RINGEL C.M., Representations of K-species and bimodules, *J. of Algebra.* **41**, 269-302 (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

## “Thermodynamics and Constitutive Equations”

is the subject of the Second 1982 C.I.M.E. Session.

The Session, sponsored by the Consiglio Nazionale delle Ricerche, will take place under the scientific direction of Prof. GIUSEPPE GRIOLI (Università di Padova, Italy) at Noto, Italy, *from June 23 to July 2, 1982.*

### Courses

a) *Thermodynamics and Constitutive Relations* (8 lectures in English).

Prof. Bernard D. COLEMAN (Carnegie-Mellon University, USA).

**Lect. 1.** Elementary applications of the Clausius-Duhem inequality: theories of elastic and viscous materials, various types of heat conductors, and materials with internal variables.

#### References:

1. B.D. COLEMAN & W. NOLL, *Arch. Rational Mech. Anal.* **13**, 167-178 (1963).
2. B.D. COLEMAN & V.J. MIZEL, *Arch. Rational Mech. Anal.* **13**, 245-261 (1963); *J. Chem. Phys.* **40**, 1116-1125 (1964).
3. B.D. COLEMAN, *Proprietà di Media e Teoremi di Confronto in Fisica Matematica*, C.I.M.E. Session at Bressanone, 1963.
4. B.D. COLEMAN & M.E. GURTIN, *J. Chem. Phys.* **47**, 597-613 (1967).
5. C. TRUESDELL, *Rational Thermodynamics*, McGraw-Hill, New York, (1969).

**Lect. 2.** Viscoelastic materials and theories of fading memory.

#### References:

1. B.D. COLEMAN & W. NOLL, *Arch. Rational Mech. Anal.* **6**, 355-370 (1960); *Rev. Modern Phys.* **33**, 239-249 (1961).
2. B.D. COLEMAN & V.J. MIZEL, *Arch. Rational Mech. Anal.* **23**, 87-123 (1966); *ibid.* **29**, 18-31 (1968); *ibid.* **30**, 172-196 (1968).
3. B.D. COLEMAN & D.R. OWEN, *Arch. Rational Mech. Anal.* **55**, 275-299 (1974).

**Lect. 3.** Thermodynamics of materials with memory.

#### References:

1. B.D. COLEMAN, *Arch. Rational Mech. Anal.* **17**, (1964); *ibid.* **17**, 230-254 (1964).
2. B.D. COLEMAN & V.J. MIZEL, *Arch. Rational Mech. Anal.* **27**, 255-274 (1967).
3. W.A. DAY, *The Thermodynamics of Simple Materials with Fading Memory*, Springer Tracts in Natural Philosophy, Vol. 22, Springer-Verlag, Berlin, (1962).

**Lect. 4.** Thermodynamics of electromagnetic fields in dissipative media: magnetically active and electrically polarizable materials exhibiting dispersion and absorption, and various non-linear generalizations of them.

#### References:

1. B.D. COLEMAN & E.H. DILL, *Arch. Rational Mech. Anal.* **51**, 1-53 (1973); *Z.A.M.P.* **22**, 691-702 (1971).

**Lect. 5.** A theory of thermodynamics in which the existence and regularity of entropy and free energy as functions of state are proved rather than assumed, and conditions necessary and sufficient for the uniqueness of these functions can be given.

#### References:

1. B.D. COLEMAN & D.R. OWEN, *Arch. Rational Mech. Anal.* **54**, 1-104 (1972).

**Lect. 6 & 7.** Examples of materials for which the regularity of entropy and free energy functions is not *a priori* evident and requires verification.

#### References:

1. B.D. COLEMAN & D.R. OWEN, *Arch. Rational Mech. Anal.* **59**, 25-51 (1975); *ibid.* **70**, 339-354 (1979); *Rendiconti dell'Accademia Nazionale dei Lincei* (VIII) **61**, 77-81 (1976); *Annali di Matematica pura ed applicata* (IV) **108**, 189-196 (1976).
2. B.D. COLEMAN, M. FABRIZIO, & D.R. OWEN, On the Thermodynamics of Second Sound in Dielectric Crystals, *Arch. Rational Mech. Anal.*, in press.

**Lect. 8.** Approaches to thermodynamics in which «absolute temperature» is a derived concept.

**References:**

1. C. TRUESDELL, *The Tragicomical History of Thermodynamics*, 1822-1854, New York, Springer-Verlag, (1980)
2. C. TRUESDELL & S. BHARATHA, *The Concepts and Logic of Classical Thermodynamics as a Theory of Heat Engines*, New York, Springer-Verlag, (1977).
3. J. SERRIN, *Arch. Rational Mech. Anal.* **70**, 355-371 (1979); *Lectures on Thermodynamics*, University of Naples.
4. B.D. COLEMAN, D.R. OWEN, & J. SERRIN, *Arch. Rational Mech. Anal.* **77**, 103-142 (1982).
- b) Title to be communicated.  
Prof. C.W. DAFERMOS (Brown University, USA).
- c) ***Rational Thermodynamics of Mixtures*** (8 lectures in English).  
Prof. I. MULLER (TU Berlin).
1. Basic Concepts  
1.1 Thermodynamic Fields; 1.2 Equations of Balance; 1.3 Constitutive Equations.
2. Thermodynamics  
2.1 Entropy Principle; 2.2 Chemical Potentials; 2.3 Diffusion and Thermal Diffusion.
3. Sound Propagation in Mixtures  
3.1 The Speed of Diffusion; 3.2 First and Second Sound.
4. Application to Liquid Helium  
4.1 Status of Landau's Theory; 4.2 Helium in Rotation.
5. Kinetic Theory  
5.1 Boltzmann Equation and Equations of Transfer; 5.2 Maxwellian Iteration; 5.3 Speed of Heat Conduction, Entropy Flux and Material Objectivity.
6. Outlook.

**Literature:**

- On Equation of Balance:  
TRUESDELL, C. & TOUPIN, *The Chemical Field Theories*, *Handbuch der Physik* III/1, Springer 1960  
TRUESDELL, C., *Rational Thermodynamics*, McGraw-Hill (1969).
- On the Entropy Inequality:  
MULLER, I., *Thermodynamik, Grundlagen der Materialtheorie*, Bertelsmann Universitätsverlag, Dusseldorf (1973).  
LIU, I-SHIH, *Method of Lagrange Multipliers for Exploitation of the Entropy Principle*, *Arch. Rat. Mech. Anal.* **40**, (1972).  
MULLER, I., *Thermodynamics and Statistical Mechanics of Fluids and Mixtures of Fluids*, Lecture Notes of CNR Summer School in Bevi and Canana.
- On Liquid Helium:  
LANDAU, L.D., *The Theory of Superfluidity of Helium II*, *J. Phys.* (V.S.S.R.) **5**, (1941).  
LANE, C.T., *Superfluid Physics*, McGraw-Hill (1962).
- On the Kinetic Theory:  
CHAPMAN, S. & COWLING, T.G., *Mathematical Theory of non-uniform Gases*, Cambridge University Press (1961).  
MULLER, I., *On the Frame Dependence of Stress and Heat Flux*, *Arch. Rat. Mech. Anal.* **45**, (1972).
- On the Speed of Heat Conduction:  
CATTANEO, C., *Sulla conduzione del calore*, *Atti del seminario mat. e fis. Univ. Modena.* **3**, (1948).  
MULLER, I., *Zur Ausbreitungsgeschwindigkeit von Störungen in kontinuierlichen Medien*, Aachener Dissertation (1966).

**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

## “Fluid Dynamics”

is the subject of the Third 1982 C.I.M.E. Session.

The Session, sponsored by the Consiglio Nazionale delle Ricerche, will take place under the scientific direction of Prof. HUGO BEIRAO DA VEIGA (Università di Trento, Italy) at the «Villa Monastero», Varenna, Italy, *from August 22 to September 1, 1982.*

### Courses

- a) **Construction of weak solutions for Hyperbolic Problems** (6 lectures in English).  
Prof. C. BARDOS (Université Paris-Nord, France)
1. Study of a single conservation law and of the Hamilton-Jacobi equation by the viscosity method.
  2. Hyperbolic systems. The Rankine Hugoniot condition and the different forms of the Entropy condition.
  3. The construction of Di Perna of the solution of a two by two conservation Law in one space variable.
  4. Numerical method. The Courant-Friedrichs-Lewy condition and the order of numerical method.  
Examples of numerical schemas.

### Basic references

1. WHITHAM, Linear and non linear waves.
2. COURANT AND HILBERT, Methods of Mathematical Physics.
3. RITCHINGER AND MORTON, Difference Methods of Initial Value Problems.
4. P.L. LIONS, Generalized solutions of the Hamilton Jacobi equation, Pitman.

On the other hand many articles can be used as

1. R.J. DI PERNA, Convergence of approximate solution to conservation law (preprint).
  2. P.D. LAX, Shock waves and entropy. In «*Contribution to non linear functional analysis*» (ZARANTONELLO), Academic Press, 603-634 (1971).
  3. A. MAJDA and S. OSHER, Numerical viscosity and the entropy condition, *Comm. Pure Appl. Math.* **32**, 797-838 (1979).
  4. S.N. KRUCKOV, First order quasi linear equation with several independent variables, *Math. U.S.S.R. Sbornik*, **10**, 217-249 (1970).
  5. C. DAFERMOS, The entropy rate admissibility criterion for solutions of hyperbolic conservation law, *J. Diff. Eq.*, n. 2 (1973).
  6. A.Y. LEROUX, A numerical conception of entropy for quasi linear equations.
  7. A. HARTE, J.M. HYMAN and P.D. LAX, On finite difference approximation and entropy condition for shocks, *Comm. Pure Appl. Math.* **29**, 297-322 (1976).
- b) **Compressible Fluids** (8 lectures in English).  
Prof. Andrew MAJDA (University of California, Berkeley, USA)
1. The local existence of smooth solutions to the compressible equations
  2. Compressible and incompressible fluids
  3. Formation of shock waves in smooth solutions
  4. Existence and stability of multidimensional shock fronts.

### References

- for 1)-2) 1. T. KATO, *Arch. Rat. Mech. Anal.* **58**, (1975), 181-205  
2. S. KLAINERMAN-A. MAIDA, *C.P.A.M.*, **24** (1981), 481-524
- for 3) 3. P.D. LAX, S.I.A.M. Regional Conf. Series, 13  
4. S. KLAINERMAN-A. MAJDA, *C.P.A.M.*, **23** (1980), 241-263
- for 4) 5. A. MAJDA, *Bull. A.M.S.*, **4** (1981), 342-344  
3. A. MAJDA, *Memoirs A.M.S.*, (to appear).
- c) **The concepts of Continuum Thermomechanis** (8 lectures in English).  
Prof. J. SERRIN (University of Minnesota, USA)
1. Thermodynamical structure
  2. Laws of thermodynamics

3. Accumulation theorem
4. Continuum thermomechanics and invariance
5. Balance laws of continuum thermomechanics
6. The Clausius-Duhem inequality
7. Example: The Navier-Stokes equations
8. Example: The shock layer in gas dynamics.

*The basic literature reference for the subject would be:*

1. Mathematical theory of Fluid Dynamics, Handbuch der Physik, Vol. 8/1
2. Notes on Thermodynamics, University of Minnesota, 1981.

### *Seminars*

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