SOCIETA ITALIANA DI FISICA

RENDICONTI
DELLA
SCUOLA INTERNAZIONALE DI FISICA
« ENRICO FERMI »

XLVIII Corso

Fisica delle alte densita di energia

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SCUOLA INTERNAZIONALE DI FISICA «ENRICO FERMI»

XLVIII Corso

a cura di P. Caldirola
Direttore del Corso
e di H. Knoepfel

VARENNA SUL LAGO DI COMO
VILLA MONASTERO
14-26 LUGLIO 1969

Fisica delle alte densità di energia

1971

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PROCEEDINGS

OF THE

INTERNATIONAL SCHOOL OF PHYSICS « ENRICO FERMI »

Course XLVIII

edited by P. Caldirola
Director of the Course
and by H. Knoepfel

VARENNA ON LAKE COMO
VILLA MONASTERO
14th - 26th - JULY 1969

Physics of High Energy Density

1971

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Introduction.

P. CALDIROLA

Istituto di Scienze Fisiche dell'Università - Milano

Ladies and Gentlemen,

the 3rd course of this year of the International Summer School organized in Varenna by the «Società Italiana di Fisica» has as its subject the Physics of high energy density.

Before saying a few introductory words about the content of the Course that I have been charged to organize, I have the pleasure of giving to all the participants the welcome of the President of the «Società Italiana di Fisica», Prof. Giuliano Toraldo di Francia.

On account of his heavy duties, Prof. TORALDO DI FRANCIA, is not here to say the few, traditional opening words.

At the same time I would like to express my deep gratitude to him and to the Società Italiana di Fisica for having accepted a course on the Physics of High Energy Density in the program of the Varenna Summer School.

I really think that this enterprise will be extremely useful, especially for our young students, because I know that there are no high-level Courses on this topic among the European Universities.

During the last two decades the Physics of Plasmas, or, in other words, the physics of fully ionized gases, has grown in a spectacular way. This grow is mainly due to the fact that people has become aware of the possibility of obtaining a controlled release of energy from the so-called nuclear fusion reactions, as, for instance, the hydrogen-helium transformation.

To this aim it is necessary to heat the material to a temperature of the order of several hundreds of millions of degrees. Obviously, one must concentrate an extremely high energy quantity in a relatively small portion of the material.

This Course is precisely intended to face the two basic problems relevant to the afore-mentioned process. The first is how one can practically obtain such concentrations of energy, and the second is how the material will react to such enormous energy densities.

The interest in this field of the modern physical research is also due to the fact that, in this way, in the laboratory we can be faced with physical situations in which matter acquires unusual and fascinating properties.

The same properties are also verified in cosmic spaces and this is the reason why plasma physics has attracted the interest of astrophysicists.

The thorough analysis of these properties will certainly be extremely useful for an understanding of the fundamental behaviour of matter and for the technical applications, which will surely come out of our enlarged knowledge. The program of the Course has been prepared by Dr. Knoepfel who, through his well-known personal competence in this field of physical research, has made a skilfull choice of all the relevant topics. The arguments chosen, though apparently diverse, are in reality strictly closely linked with the main subject of the Course, as will be evident at the end of the various groups of lectures.

A first set of lectures will be dedicated, as we have already said, to the study of the concentration of high quantities of energy in small portions of the material.

This topic will be treated in two series of lectures: in the first by Prof. R. E. KIDDER of the Lawrence Laboratory California University, and in the second one by Prof. O. N. KROKHIN of the Lebedev Institute of Moscow.

Both these lecturers will talk about the use of gigantic light pulses produced, during extremely short time intervals, by high-power lasers. The energy is focused upon solid materials in order to achieve conditions suitable to the triggering of thermonuclear reactions.

Prof. KIDDER will describe the properties of intense laser beams emphasizing their capability to concentrate energy in small portions of the material.

As a consequence the temperature and pressure will reach extremely high levels.

Prof. Krokhin's lectures will be devoted to the detailed study of all those physical transformations taking place in the material under the action of the high-energy laser radiation, and will thus complete, in a useful way, the first set of lectures.

All the other lessons will be likewise dedicated to a thorough and systematic analysis of the behaviour of matter when it is subjected to a strong energy concentration.

The most spectacular phenomenon is given by the rapid expansion of matter which, in turns, gives rise to an intense shock wave propagating in the material. Such a strong shock wave will be accompanied by release of heat and emission of electromagnetic radiation.

To all these problems will be devoted the lectures given by Prof. G. E. DUVALL, Washington State University, Prof. R. A. GROSS, Columbia University of New York, Prof. F. D. BENNETT, Maryland University and by Prof. R. N. KEELER and Prof. E. B. ROYCE both from California University.

Prof. KEELER will give a set of preliminary lectures about the state-equation of condensed media (particularly of solids) under conditions of extremely high pressure and temperature, with emphasis on the physical properties associated to the electron distribution in the material medium.

Prof. Bennett will add a set of lectures dealing with vaporization waves and with phase transitions.

Prof. Duvall will teach about shock-waves theory in dense media. He will also develop an extensive and detailed treatment of the dynamics and structure of a shock-wave propagating in a solid.

Particular attention will be given to the mechanical effects of shock-waves, which are relevant to some interesting technological applications.

Then Prof. Gross will give a set of lectures with the principal aim of describing the ionization effects which take place in the shock-wave.

Furthermore, he will present an analysis of the shock-wave structure, when one has to take into account the radiation of electromagnetic waves and when relativistic effects modify the mathematical treatment of the process.

Prof. Royce will deal with a particular problem, describing the properties of a magnetic material under the strong compressions induced by the passage of a shock-wave, and finally Prof. Schall will illustrate some relevant topics in the detonation theory.

Two particular problems will also be treated by one of the most famous physicist of our time, Prof. E. Teller of the California University. Prof. Teller will present the problem of the shock-waves formation in stars and develop a model, based on the Thomas-Fermi statistical theory of the atom, which describes the electronic properties of a strongly compressed solid.

As usual, the Course will be completed by a series of Seminars on various topics of the physics of the high-energy density.

I have on my list the names of Dr. Linhart, Dr. Knoepfel, Dr. Somon and Dr. Caruso of the «Laboratori Gas Ionizzati di Frascati» and of Prof. Winterberg of Las Vegas University. They will speak about some special topics of great interest in our programme.

We plan also to have sufficient time available for free discussions. I hope that the formal and informal lecture and discussion meetings at this enchanting Villa Monastero will be useful and pleasant for all of you.

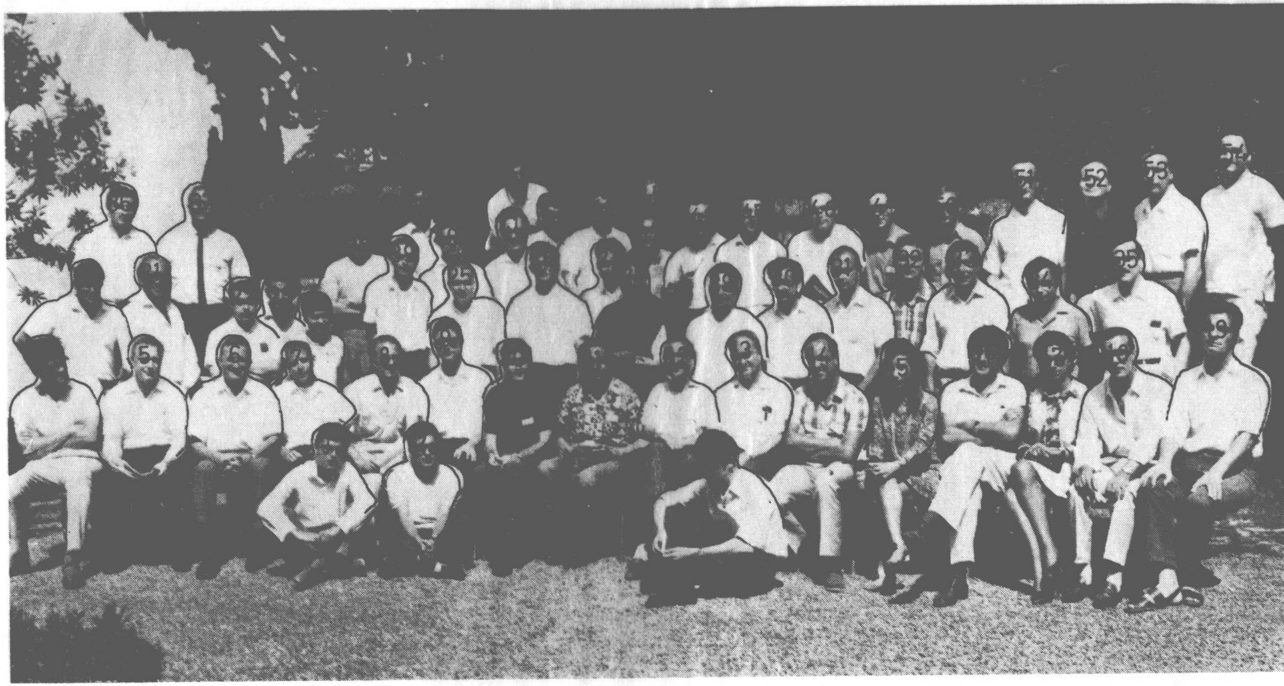
I cannot conclude this brief presentation, without saying that the major merit for arranging the whole Course goes to Dr. Knoepfel, who, with his authority, experience and unwielding work, has succeeded in gathering here such a number of distinguished lecturers. I am sure that all the guests of the Società Italiana di Fisica will join in thanking him for his precious and valuable collaboration.

I close my talk with the traditional expression: I open, here, this 3rd Course 1969, the 48th since the beginning of the School, and I hope it will be pleasant and successful.

SOCIETÀ ITALIANA DI FISICA

SCUOLA INTERNAZIONALE DI FISICA « E. FERMI »

XLVIII CORSO - VARENNA SUL LAGO DI COMO - VILLA MONASTERO - 14-26 Luglio 1969



1. K. Hornung
2. M. Gambarelli
3. J. Mrikwiczka
4. N. Gylden
5. G. Iernetti
6. F. D. Bennett
7. E. B. Royce
8. P. Caldirola
9. R. N. Keeler
10. O. N. Krokhin
11. E. Teller
12. R. A. Gross
13. R. E. Kidder
14. H. Knoepfel
15. M. Pilo
16. A. Caruso
17. L. Saitta
18. G. Poletti
19. A. Gervat
20. J. Braun
21. J. G. Linhart
22. C. Rioux
23. C. Maisonnier
24. F. Grossetête
25. R. B. Oswald
26. R. H. Huddlestone
27. C. Summa
28. N. Cerullo
29. A. Di Giorgio
30. A. Fisher
31. J. Leorat
32. P. Lagus
33. G. Besançon
34. M. Samuelli
35. R. Luppi
36. A. Jaworowski
37. A. Lowrey
38. F. Gratton
39. R. Fortin
40. D. Schallhorn
41. W. Wölfli
42. E. Sindoni
43. R. Pozzoli
44. A. Brahme
45. C. Fauquignon
46. C. Chiosi
47. A. Saggion
48. G. Frigerio
49. Y. Avni
50. L. Egardt
51. L. Brun
52. P. Berling
53. B. Brunelli
54. R. Gratton
55. J. P. Somon
56. C. Di Gregorio

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INDICE

F. D. Bennett – Vaporization-wave transitions.

R. Schall – Detonation physics.

ROBERT A. GROSS – The physics of strong shock waves in gases.

R. E. KIDDER – Interaction of intense photon and electron beams with plasmas.