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Physics of Nonideal Plasmas

Edited by
Werner Ebeling, Andreas Förster, Rainer Radtke

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Stuttgart · Leipzig 1992

This book is based upon the invited lectures and some selected contributed papers of the VI. International Workshop on Physics of Nonideal Plasmas (PNP VI), Gosen (Germany), 1991. The main topics covered are molecular dynamics, Monte Carlo results, thermodynamics, phase transitions, kinetics of transitions, collective modes, transport properties, radiation and spectroscopy, astrophysics, laser and ion fusion. Leading experts from Austria, Belgium, France, Germany, Japan, the Netherlands, Poland, Russia, Switzerland, and the United States review the progress in theory as well as in diagnostics and measurement achieved during the last years. Additional papers discuss applications of strongly coupled plasma physics for, e.g., radiation sources or the determination of the structure of the giant planets and the sun.

Dieses Buch basiert auf den eingeladenen Hauptvorträgen und weiteren ausgewählten Beiträgen der 6. Internationalen Arbeitstagung für Physik Nichtidealer Plasmen (PNP VI), Gosen (Deutschland), 1991. Folgende Themengebiete werden behandelt: Molekulare Dynamik und Monte Carlo Resultate, Thermodynamik und Phasenübergänge, Kinetik von Übergängen, Kollektive Anregungen und Transporteigenschaften, Strahlung und Spektroskopie, Astrophysik und Laser- und Ionenfusion. Führende Experten aus Belgien, Deutschland, Frankreich, Japan, den Niederlanden, Polen, Österreich, Rußland, der Schweiz und den Vereinigten Staaten geben eine Übersicht zu den Fortschritten in der Theorie wie auch in den Meßmethoden und der Diagnostik, die in den letzten Jahren erreicht wurden. Weitere Artikel diskutieren Anwendungen der Physik stark gekoppelter Plasmen z.B. für Strahlungsquellen oder die Bestimmung der Struktur der großen Planeten und der Sonne.

Ce livre se fonde sur les discours principaux invités et d'autres exposés sélectionnés du 6. Congrès International pour la Physique des Plasmas Non-idéales (PNP VI), à Gosen (Allemagne), en 1991. Les sujets suivants sont traités: la dynamique moléculaire et les résultats Monte Carlo, la thermodynamique, le changement de phase, la cinétique des transitions, les excitations collectives, les propriétés du transport, le rayonnement et la spectroscopie, l'astrophysique, la fusion du laser et des ions. Spécialistes les plus renommés d'Allemagne, Autriche, Belgique, France, Pays Bas, Pologne, Russie, Suisse et États-Unis offrent une vue d'ensemble du progrès dans la théorie, le diagnostic et les méthodes de mesure, achevés dans les derniers ans. Il y a aussi d'autres articles dans lesquels les applications de la physique des plasmas fortement couplés sont discutées, par exemple la détermination de la structure des grandes planetes et du soleil.

В эту книгу включены материалы основных докладов, прочитанных на 6-ой Рабочей встрече по физике неидеальной плазмы (PNP VI) в Гозене (Германия) в 1991 г., а также некоторые другие сообщения, представленные на этой конференции. Главным образом освещается следующий круг вопросов: молекулярная динамика, моделирование методом Монте Карло, термодинамика, фазовые переходы, кинетика переходов, коллективные состояния, явления переноса, спектроскопия, астрофизика, лазерный и ионный термоядерный синтез. Ведущие специалисты из Австрии, Бельгии, Германии, Нидерландов, Польши, России, Соединенных Штатов, Франции, Швейцарии и Японии дают обзор новейших результатов как в области теории, так и в диагностике и методах измерения, полученных за последнее время. В книге также обсуждаются прикладные аспекты физики сильно связанной плазмы, в частности, создание источников излучения и определение структуры больших планет и солнца.

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PREFACE

The VI. International Workshop on Physics of Nonideal Plasmas (PNP VI) took place from November 18th to 21th, 1991, in Gosen (Germany) at the Science Communication & Conference Centre of the Humboldt University of Berlin. The workshop was organized by the Institute for Theoretical Physics of the Humboldt University and by the Central Institute of Electron Physics, Berlin, with financial support given by the Deutsche Forschungsgemeinschaft, Bonn, and the Robert-Bosch-Stiftung, Stuttgart. The workshop was attended by more than 100 scientists from 14 countries who presented about 120 papers, including 18 invited lectures.

The series of PNP workshops, which started in 1980, provides a biennial forum for both experimental and theoretical research in the field of nonideal plasmas. These meetings are organized alternately by the Central Institute of Electron Physics, Berlin, and/or by one of the universities of Berlin, Greifswald, and Rostock. They took place in Matzlow-Garwitz (1980), Wustrow (1982 and 1988), Biesenthal (1984), and Greifswald (1986). Since the beginning, the workshop has been concerned mainly with fundamental studies of the thermodynamic, transport, and radiative properties of nonideal plasmas. These fields were also covered at PNP VI in Gosen, but new topics such as high-pressure laser plasmas, dense astrophysical plasmas, molecular dynamics and Monte-Carlo results, and the kinetics of transitions have completed the programme. In particular, several papers addressed the role of nonideal plasmas for radiation sources, for inertial confinement fusion, for helio-seismology, and for the determination of the structure of the giant planets.

With the growing interest in nonideal plasmas the number of participants was also growing from workshop to workshop with the result that at the last meeting a critical number was exceeded allowing no longer to present all contributions orally. Therefore, we organized four poster sessions parallel to the afternoon sessions for the presentation of about 50% of all contributions. The present book is based upon the lectures and some selected contributed papers given by leading experts from plasma physics laboratories in Amsterdam, Belgrade, Berlin, Bochum, Boston, Brussels, Chernogolovka, College Park, Darmstadt, Dolgoprudny, Eindhoven, Gainesville, Graz, Greifswald, Heidelberg, Kiel, Lausanne, Livermore, Los Alamos, Los

Angeles, Lyon, Moscow, New York, Odessa, Orsay, Paris, Rostock, St. Petersburg, Tokyo, Troitsk, Tuscon, Vienna, and Warsaw. Although the book must be a small selection of the many papers which were presented, we think that it gives a representative survey of the workshop and shows the progress in theory as well as in diagnostics and measurement achieved during the last years.

The field of nonideal plasmas has developed rapidly over the past decade. As indicated by the papers at this workshop, it is now characterized by a better understanding of the fundamental processes, although essential properties are still not measured as systematically as under ideal conditions. Also, much work remains to be done on the development of theoretical tools until a quantitative understanding and control of nonideal plasmas is achieved.

We want to recommend the reader to visit the next PNP meeting, which will be hosted by the Rostock University in 1993, and see which problems will have been solved during the next two years, at least partially. In this connection we should mention also the series of Conferences on Strongly Coupled Plasma Physics (Orleans-la-Source, 1977; Les-Houches, 1982; Santa Cruz, 1986; Lake Yamanaka, 1989) which will be continued in 1992 at Rochester.

Finally, we would like to express our thanks to the members of the International Programme Committee, to the local organizing committee, and to the B.G. Teubner Verlagsgesellschaft mbH Stuttgart Leipzig, in particular to our reader Jürgen Weiß, for their support and cooperation.

Berlin, March 1992

W. Ebeling, A. Förster, and R. Radtke

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