and economics. His research interests include the application of engineering economy to the nuclear fuel cycle, nuclear power generation, electric power generation, and environmental considerations in the electric power area. He is co-author of GEM (presently GEM Version 6), a nuclear fuel cycle cost code. He set up engineering economic courses for Commonwealth Edison Company, Illinois Bell Telephone, Illinois Power Company, and Argonne National Laboratory.

Plasma Transport, Heating and MHD Theory
(Proceedings from the Varenna International School of Plasma Physics Workshop, September 1977)

Editors	T. Stringer, R. Pozzoli, E. Sindoni, J. Carnihan, and G. Leotta
Publisher	Pergamon Press, Inc., Maxwell House, Fairview Park, Elmsford, New York (1978)
Pages	440
Price	$48.40 paperbound
Reviewer	Chan K. Choi

This is one of three closely related proceedings from the 16-day meeting in September 1977, held at Varenna International School of Plasma Physics.[a] *Plasma Transport, Heating and MHD Theory* is, like the two other companion proceedings, a collection of review-type papers that were presented at the workshop. The entire 16-day meeting, which included ten half-days course and workshop and five full-days workshop, focused mainly on toroidal fusion systems, especially on tokamak systems, and virtually no attention was given to open-ended mirror systems. In this regard, the title of the current workshop proceedings could have been more properly called the "*Toroidal*" *Plasma Transport, Heating and MHD Theory*.[b]

The subject areas in this proceedings are divided into five subgroups: Modes and Instabilities; MHD Theory, Transport Phenomena and Codes; Heating; Blanket; and Experimental.

Modes and Instabilities covered mostly electron phenomena in tokamaks (such as trapped-electron modes discussing mode stabilization), runaway electron dynamics in the French tokamak Fontenay-aus-Roses (TFR) causing bump-in-tail instability, nonthermal radiation, etc. The stabilizing effect of magnetic shear is still controversial. The question is whether the shear will actually help the stabilization or remove it. Discussion of this subject is very penetrating and timely. [Additional information for readers on other modes and instabilities associated with ions (e.g., ion mixing mode) and drift-tearing instabilities in tokamaks, etc. can be found in the companion Proceedings I mentioned in footnote a. On the other hand, finite-beta equilibria, macroscopic stability, and collective modes such as high-beta tokamak instabilities, ballooning modes, etc. are discussed in Proceedings II, also referred to in footnote a.]

Mercier's MAKOKOT, a one-dimensional numerical simulation code, described in the plasma transport phenomena section, shows good agreement between the measured and computed profiles, while at the same time Stringer's "Anomalous Transport Theory," described via quasi-linear theory, also predicts an encouraging agreement between the anomalous energy loss observed in tokamaks and the calculations from the quasi-linear analysis. Though this analysis is not fully applicable to the real situation of a confined plasma (since the flux derived by this analysis is not a true diffusion), it provided a useful first approximation. It is desirable however that more appropriate theory be developed to describe the dispersion and transport; drift wave scalings of diffusion coefficient (D) are still uncertain as to temperature (T) dependence whether $D \approx T^{-1}$ or $T^{-1/2}$ (cf., Mercier) or $D \approx T$ (cf., Düchs).

Thorough discussions following these two lectures by Mercier and Stringer are the integral parts of the main lectures and they are so interestingly documented that reading text materials alone makes one feel like he is sitting in the middle of the conference room. Comments, questions and answers, and further discussions throughout the proceedings are of extreme pedagogical value for serious students in this field. One comment is that there is no description of the neoclassical transport phenomena, which is very important in understanding tokamak transport; however, Proceedings I deals, though in a simplified way, with this subject along with neutral atoms in transport, etc. Classical diffusion (with theory and simulation codes) and the transport phenomena for high-density tokamaks can also readily be found in Proceedings II.

Resistive magnetohydrodynamic (MHD) equations, MHD equilibrium (Grad-Shafranov equation), energy principle, circular cylindrical instability, toroidal instability, etc. are addressed in one way or another in the MHD Theory section. However, disruptive instability, which is of current interest among the INTOR tokamak community, was not addressed.

As for the heating mechanism, this volume mainly covered wave heatings (e.g., radiofrequency, electron, and ion cyclotron waves). Turbulent heating was addressed by Kock on p. 319; however, neutral beam injection, one of the leading technologies in plasma heating, was not mentioned here. [A simple theoretical description of neutral beam heating of toroidal plasma can be found on p. 323 of Proceedings I. For extensive coverage on the heating in toroidal plasmas, the two-volume *Proc. Heating in Toroidal Plasmas* from the 1978 Joint Varenna-Grenoble Int. Symp., T. CONSOLI, Ed., Pergamon Press, Inc., New York (1979) is available.]

Out of 440 pages in the current procedings, 126 pages were devoted to the "Blanket" and "Experimental" sections. Although they do not represent the main portion of

[a]The other two proceedings are *Proc. Course Theory of Magnetically Confined Plasmas*, EUR 5737e, B. COPPI et al., Eds., Pergamon Press (Apr. 1979) (called Proceedings I in this text) and *Proc. Finite Beta Theory Workshop*, Varenna, Italy, September 1977, CONF-7709167, B. COPPI and W. SADOWSKI, Eds., U.S. Department of Energy (Sep. 1978) (called Proceedings II). Other proceedings from the 1979 Varenna conference were scheduled to be available in the early part of 1981 through the U.S. Department of Energy.

[b]For mirror enthusiasts, there is the *Proc. Driven Magnetic Fusion Reactors*, Erice-Trapani, Italy, September 1978, BRUNO BRUNELLI, Ed., Pergamon Press, Inc., New York (1979), which includes subjects ranging from tandem mirror to mirror hybrid reactors.

the proceedings (at least not in the title), the various experimental discussions provide a well-balanced viewpoint on both analytical and experimental observations. As an editorial comment, I find that only the "blanket" paper by Ohlsson on p. 289 and the "Point Model Evaluations of EBT Performance" by McBride et al. on p. 379 in the "Experimental" section could perhaps have appeared in sections of the "Modes and Instabilities" and the "MHD Theory, Transport Phenomena and Codes," respectively.

Results and status reports of eight papers appearing in the "Experimental" section are highly informative—as if one were taking a general tour around European tokamak facilities, although major sites for JET, TFR, ZEPHYR, etc. were not included. Interpretation of some of the results (e.g., density/temperature scalings) is still debatable and in this sense some of the papers should be viewed as progress reports rather than any definitive experimental findings. (Readers should note that Proceedings I has a very comprehensive two-part review article on tokamak experiments by Bickerton on p. 423.)

I think that the materials in this proceedings are original and that theories and simulation studies are highly usable, although some of the first approximations and physical assumptions may eventually have to be modified. The materials covered would be of direct interest to plasma physicists (both theoreticians and experimentalists) and to fusion plasma engineers engaged in various toroidal systems. They are certainly not on the introductory level, but the materials were organized to cover ongoing research topics in an effort to exchange views and ideas. This effective exchange of information extended to researchers in these highly active areas of fusion plasma research, making the original effort by the editors highly successful.

The materials are reasonably well organized within given subject areas; especially the original texts of questions and discussion sessions are of high value for the wealth of information flow. I would like to suggest, however, that this volume and Proceedings I and II be combined into one three-volume proceedings.

In all, I would recommend this proceedings highly, not only to tokamak fusion researchers but also to serious graduate students who are in these relatively new and exciting areas of plasma physics. In fact, I had already adopted this proceedings as a reference for my graduate course on Magnetic Confinement Fusion Systems last spring, and based on my experience with that class, I may use this proceedings again for a future one.

Chan K. Choi is an assistant professor in nuclear engineering at the University of Illinois at Urbana-Champaign. Dr. Choi's current research interest is in charged-particle slowing down theory as applied to plasma engineering, advanced-fuel fusion reactors including the D-^{3}He satellite approach, advanced-fuel inertial confinement fusion pellets, radiation transport and impurity effects in toroidal fusion devices, and plasma buildup in mirror reactors. He was actively involved in the studies of advanced-fuel fusion reactors and made a significant contribution to the Electric Power Research Institute supported project, "Exploratory Studies of High-Efficiency Advanced-Fuel Fusion Reactors." He has presented several key papers on these subjects at national and international meetings. Dr. Choi has published over 30 articles and technical reports in fusion areas.

The (*p*,*n*) Reaction and the Nucleon-Nucleon Force

Editors Charles D. Goodman, Sam M. Austin, Stewart D. Bloom, J. Rapaport, and G. R. Satchler

Publisher Plenum Press, New York (1980)

Pages 539

Price $55.00

Reviewer D. A. Bromley

This volume presents the proceedings of a conference, held in Telluride, Colorado, March 29-31, 1979, that focused on the question of what we now know about the force between nucleons and, specifically, on what new information concerning that force can be obtained from studies of (p,n) reactions.

In very large measure, this book represents the realization of at least a decade of hard work by the senior editor who, having become convinced of the importance of this route to new information on the nucleon-nucleon force, had first to design the appropriate experiments and then to evolve the appropriate experimental techniques, cooperations, and facilities to pursue his original conclusions. The success of this entire venture has been closely tied to use of the Indiana University cyclotron facility, which has turned out to be uniquely suited to the required experimental studies.

It would be pointless to attempt to review the 35 review contributions presented at the conference and included in this volume. Suffice it to say that the volume represents a convenient and definitive treatment of present knowledge of the nucleon-nucleon force. While attention is focused on the free nucleon-nucleon force, extensive effort has been devoted to deriving *effective* nucleon-nucleon interactions for use in calculations of the structure of finite nuclei. This is a longstanding and central problem in nuclear physics, since it is obvious that nucleons within nuclear matter will have different interactions from those interacting *in vacuo*, and it is impressive to see the progress that has been made in placing what were once essentially empirical nucleon-nucleon interactions used in these structure calculations on a much more fundamental footing.

As Goodman had originally postulated, the (p,n) reaction has indeed been demonstrated to be a most effective probe for the characteristics for the nucleon-nucleon interaction, and this book provides all the data now available on this entire branch of nuclear science. In particular, charge exchange reaction calculations are traced from energies below 100 MeV—where a G-matrix approach to the effective interaction is used—to energies above 100 MeV—where the impulse approximation is suitable and a t-matrix approach is used to connect the force with the free nucleon-nucleon phase shifts.

This book will be required reading for any active scientist working on the determination of nucleon-nucleon interactions, or their use, in calculations of either nuclear structure or dynamics.

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