

LASER AND PARTICLE BEAMS

Volume 10 1992

Cambridge University Press

40 West 20th Street, New York, NY 10011, USA

The Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU

10 Stamford Road, Oakleigh, Melbourne 3166, Australia

Laser and Particle Beams

Pulse Power and High Energy Densities

Editor in Chief:

G. H. MILEY
Director, Fusion Studies Laboratory,
University of Illinois,
103 S. Goodwin Ave, Urbana, IL 61801, USA

Emeritus Editor in Chief: HEINRICH HORA

Head, Department of Theoretical Physics
University of New South Wales
Kensington 2033, Australia

Associate Editors:

R. DAUTRAY (for Europe)
Scientific Director, CEA Limeil, B.P. 27
94190 Villeneuve St. Georges, France
A. H. GUENTHER (for Pulse Power)
Scientific Advisor (Lab. Development)
Sandia National Laboratories
Albuquerque, NM 87115
C. YAMANAKA (for Japan)
Director, Institute of Laser Engineering,
Osaka University, Suita,
565 Osaka, Japan

Editorial Board

N. G. Basov (Moscow)
D. Cartwright (Los Alamos)
P. van Devender (Albuquerque)
S. Eliezer (Soreq, Israel)
G. Kessler (Karlsruhe)
M. H. Key (Rutherford Appleton Lab.)
M. Kristiansen (Pulse Power Lab,
Texas Tech)
R. L. McCrory (Rochester)
G. A. Mesyats (USSR)
P. Mulser (Darmstadt)
S. Nakai (Osaka)
K. Niu (Nagatsuta)
A. A. Offenberger (Albuquerque)
A. M. Prokhorov (Moscow)
B. Ripin (Washington)
D. D. Ryutov (Novosibirsk)
E. Storm (Livermore)
J. P. Wetteau (CEA Limeil)

Laser and Particle Beams is an international journal which covers the generation, and the interaction with matter, of high intensity laser and particle beams. It also covers the physics of systems with high energy densities. Specific fields of interest include nuclear fusion, especially inertial confinement, magnetic confinement, diagnostics, material treatment, laboratory astrophysics, plasmas and spectroscopy at extreme conditions, physical properties of hot dense matter and intense particle beams and optical (laser) beams from the microwave to the X-ray region. The exploration of these fields and their new physics, including nonlinear and nonclassical phenomena, should find a forum in this journal.

As well as publishing original articles the journal also publishes occasional review articles, surveys of research at particular laboratories and reviews of recent books.

©Cambridge University Press 1992

Copying: This journal is registered with the Copyright Clearance Center, 27 Congress St., Salem, Mass. 01970. Organizations in the USA who are also registered with C.C.C. may therefore copy material (beyond the limits permitted by sections 107 and 108 of US copyright law) subject to payment to C.C.C. of the per copy fee of \$05.00. This consent does not extend to multiple copying for promotional or commercial purposes. Code 5/0263-0346/92/\$5.00 + 00.

ISI Tear Sheet Service, 3501 Market Street, Philadelphia, Pennsylvania 19104, USA, is authorized to supply single copies of separate articles for private use only.

For all other use, permission must be sought from Cambridge University Press.

Subscriptions: *Laser and Particle Beams* (ISSN 0263-0346) is published quarterly. The subscription price (which includes postage) of Volume 10, 1992 is US \$260 for the US and Canada (£132 elsewhere). Single parts cost US \$67 for the US and Canada (£36 elsewhere) plus postage. Four parts form a volume. Orders, which must be accompanied by payment, may be sent to a bookseller, subscription agent, or direct to the publishers: Cambridge University Press, Journals Department, 40 West 20th Street, New York, NY 10011-4211, USA; orders outside the US or Canada may be sent to Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU, England. Claims for missing issues should be made immediately after receipt of the next issue. POSTMASTER: Send address changes in the US and Canada to *Laser and Particle Beams*, Cambridge University Press, 110 Midland Avenue, Port Chester, NY 10573-9864.

Second Class Postage paid at New York, NY and at additional mailing offices.

CONTENTS OF VOLUME 10

TABLE OF CONTENTS LASER AND PARTICLE BEAMS Vol. 10 1992

NUMBER 1

| | |
|--|-----|
| W. Tan (Shanghai Inst. of Optics, China), C. S. Liu, P. N. Guzdar, and Y. C. Lee (Univ. of Maryland, College Park, MD, USA): Parametric instabilities due to multiwavelength excitation | 1 |
| W. Tan (Shanghai Inst. of Optics, China) and C. S. Liu (Univ. of Maryland, College Park, MD, USA): Raman and Brillouin scattering in the filaments in laser-irradiated plasma | 15 |
| H. Szichman and S. Eliezer (Soreq Nuc. Res. Center, Yavneh, Israel): Scaling laws for pressure, temperature, and ionization with two-temperature equation-of-state effects in laser-produced plasmas | 23 |
| B. A. Shiwai, A. Djaoui, S. J. Rose (Rutherford Appleton Lab., Oxon, UK), T. A. Hall and G. J. Tallents (Univ. of Essex, Colchester, UK): Improvements to ion-correlation experiments in dense plasmas | 41 |
| W. Jiang, K. Masugata and K. Yatsui (Nagaoka Univ. of Tech., Niigata, Japan): Analytical modeling of a self-magnetically insulated plasma focus diode | 53 |
| L. Gizzi, D. Batani, V. Biancalana, A. Giulietti, and D. Giulietti (Ist. di Fisica Atom. e Mol., Pisa, Italy): X-ray emission from thin-foil laser-produced plasmas | 65 |
| S. J. Karttunen (Technical Research Centre, Helsinki, Finland) and R. R. E. Salomaa (Helsinki Univ. of Tech., Espoo, Finland): Simultaneous stimulated Raman forward and backward scattering in hot, well-underdense plasmas | 75 |
| D. Schirmann, D. Juraszek (CEL-V, Villeneuve Saint-Georges, France), S. M. Lane and E. M. Campbell (LLNL, Livermore, CA, USA): Scaling model for high-aspect-ratio microballoon direct-drive implosions at short laser wavelengths | 91 |
| V. Kumar and R. K. Thareja (Indian Inst. of Tech., Kanpur, India): Laser-induced breakdown of argon gas near a metal surface | 109 |
| D. Ximing (Shanghai Inst. of Optics, China): Intrinsic angular momentum of the electromagnetic field | 117 |
| Z. Henis and S. Eliezer (Soreq Nuc. Res. Center, Yavneh, Israel): Semiclassical study of the muon transfer process between hydrogen isotopes in strong electromagnetic fields | 135 |
| P. Pieruschka, L. Cicchitelli, R. Khoda-Bakhsh, E. Kuhn, H. Hora (Univ. of New South Wales, Kensington, Australia), and G. H. Miley (Univ. of Illinois, Urbana, IL, USA): Volume ignition of inertial confinement fusion of deuterium-helium(3) and hydrogen-boron(11) clean fusion fuel | 145 |
| M. Aydin, G. Min, and H. Hora (Univ. of New South Wales, Kensington, Australia): 10-ps pulsation of laser plasma explained hydrodynamically by self-generated Bragg ripples and their decay and avoidance by smoothing | 155 |

| | |
|--|-----|
| R. H. Hora, H. G. L. Coster, C. J. Walter, and H. Hora (Univ. of New South Wales, Kensington, Australia): Self-focusing limits at the laser-plasma interaction for treatment of cataract with nanosecond and picosecond pulses | 163 |
| W. Xiong and S. L. Chin (Univ. Laval, Québec, Canada): Tunnel ionization of K and Xe atoms by an intense CO ₂ laser | 179 |
| M. M. Basko (Inst. of Theor. and Exp. Physics, Moscow, USSR): Preheating of heavy-ion-beam targets by secondary particles | 189 |
| L. J. Dhareshwar, P. A. Naik, H. C. Pant, and T. C. Kaushik (Bhabha Atomic Research Centre, Bombay, India): Study of laser-driven shock wave propagation in Plexiglas targets | 201 |
| Book Review by C.-G. Fälthammar | 213 |

NUMBER 2

| | |
|---|-----|
| Editor's Comments | 215 |
| Special Section: Selected Papers from the Physics of High Energy Density in Matter Conference | |
| C. Deutsch (Université Paris, France): Ion cluster interaction with cold targets for ICF: Fragmentation and stopping | 217 |
| B. Strege and W. D. Kraeft (Universitaet Greifswald, Germany): Stopping power of charged particles in a plasma | 227 |
| G.C. Pomranig (UCLA, Los Angeles, CA, USA): Multimode flux-limited diffusion theory | 239 |
| A. Förster, W. Ebeling (Inst. für Theor. Physik, Berlin, Germany), and T. Kahlbaum (Zentralinst. für Elektronenphys., Berlin, Germany): Equation of state and the phase diagram of dense fluid helium in the region of partial ionization | 253 |
| P. Fromy, C. Deutsch, and G. Maynard (Université Paris, France): Thomas-Fermi-like and average atom model equations of state for highly compressed matter at any temperature | 263 |
| L. Drska and M. Sinor (Czech Tech. Univ. in Prague, Czechoslovakia): Average atom model and EOS calculations: DFT approach | 277 |
| T. Błęński and B. Cichocki (École Polytechnique, Lausanne, Switzerland): Linear response of partially ionized, dense plasmas | 299 |
| B. W. Boreham (Univ. College of Central Queensland, Australia): High-intensity laser interactions with tenuous plasma and ionization processes in noble gases | 311 |
| J. J. MacFarlane and P. Wang (Fusion Tech. Inst., Univ. of Wisconsin, Madison, WI, USA): Numerical simulation of emission spectra from ion beam-heated aluminum plasmas | 349 |
| Regular Papers | |
| G. Armbrüster, B. Majer, U. Reimann, and C. Toepffer (Univ. Erlangen, Germany): Transient effects in strongly correlated non-equilibrium plasmas | 365 |
| W. A. Johnson and L. K. Warne (SNL, Albuquerque, NM, USA): Simple circuit models for the terminal properties of a nonlinear closing switch | 375 |
| Y. Y. Stoilov, O. A. Logunov, D. A. Nikolaenko, and A. V. Startsev (P. N. Lebedev Phys. Inst., Moscow, Russia): Development of dye lasers with bleaching wave | 387 |

NUMBER 3

| | |
|--|-----|
| Z. Guoliang, Y. Shusheng, N. Wanqing, D. Longlong, L. Mingfu, and J. Hong (Shanghai Inst. of Optics, China): GW-level high-power CO ₂ laser system | 413 |
| M. Nakamura, K. Kondo, H. Nishimura, T. Endo, H. Shiraga, S. Miyamoto, Y. Kato and S. Nakai (Inst. of Laser Eng., Osaka Univ., Osaka, Japan): Numerical method for finding uniform irradiation conditions of a fusion capsule driven by X-ray radiation | 421 |
| K. Mann and K. Rohr (Universität Kaiserslautern, Germany): Differential measurement of the absolute ion yield from laser-produced C plasmas | 435 |
| A. Caruso, V.A. Pais and A. Parodi (Assoc. EURATOM-ENEA sulla Fusione, Centro Ricerche Energia Frascati, Rome, Italy): Rayleigh-Taylor instability study for heavy-ion beam driven, high-gain ICF implosions | 447 |
| L. Drska, J. Limpouch and R. Liska (Comp. Phys. Group Czech Tech. Univ. in Prague, Prague, Czechoslovakia): Fokker-Planck simulations of ultrashort-pulse laser-plasma interactions | 461 |
| L.D. Mikheev (P.N. Lebedev Phys. Inst., Acad. of Sci., Moscow Russia): Possibility of amplification of a femtosecond pulse up to the energy 1 kJ | 473 |
| S. Kawata (Nagaoka Univ. of Tech., Nagaoka, Japan) and H. Nakashima (Kyusyu Univ., Kasuga, Japan): Tritium content of a DT pellet in inertial confinement fusion | 479 |
| C. Marchisio (CEL-V, Villeneuve Saint-Georges, France): Polystyrene shells from pellets containing a chemical blowing agent | 485 |
| S. Eliezer and E. Mínguez (Inst. of Nuclear Fusion, Madrid, Spain): Equations of state for ions in non-LTE plasmas | 495 |
| Y.S. Sayasov (Inst. of Physics, Univ. of Fribourg, Fribourg, Switzerland): Nonlinear theory of ion stopping in classical plasmas: Application to the Barkas effect | 505 |
| S. Humphries, Jr. (Univ. of New Mexico, Albuquerque, NM): Simulations of longitudinal instabilities in ion induction linear accelerators | 511 |
| O.L. Komarov, Y.M. Saveljev and V.I. Engelko (D.V. Efremov Inst. of Electrophys. Apparatus, Leningrad, Russia) and P. Vrba (Inst. of Plasma Phys., Czechoslovak Acad. of Sci., Prague, Czechoslovakia): Influence of collector ions on operation of magnetically insulated diode | 531 |
| T. Westermann and W. Bauer (Inst. für Neutronenphysik und Reaktortechnik, Karlsruhe, Germany): Treatment of edge beams in a focusing self-magnetically B_θ -insulated ion diode | 539 |
| Book Reviews by H. Kislev and C. Deutsch | 549 |
| Erratum | 553 |

NUMBER 4

| | |
|--|-----|
| H. Fiedorowicz: Preface | 555 |
| M. Andre, C. Bayer, D. Babonneau, M. Bernard, J.L. Bocher, J. Bruneau, A. Coudeville, J. Coutant, R. Dautray, A. Decoster, M. Decroisette, D. Desenne, B. Duborgel, J.M. Dufour, J.P. Jadaud, D. Juraszek, J.P. Garçonnet, P.A. Holstein, J. Lachkar, M. Louis-Jacquet, F. Mucchielli, B. Meyer, J.P. LeBreton, J. Ouvry, D. Schirmann, G. Schurtz, D. Véron, and J.P. Watteau (CEL-V, Villeneuve Saint-Georges, France): ICF-related experiments at CEL-V | 557 |

- M. Koenig, V. Malka, E. Fabre, P. Hammerling, A. Michard, J.M. Boudenne (LULI, Palaiseau, France), D. Batani (Univ. di Milano, Milano, Italy), J.P. Garçonnet (CEL-V, Villeneuve Saint-Georges, France) and P. Fews (Univ. of Bristol, Bristol, UK): Recent results on implosions directly driven at $\lambda = 0.26\text{-}\mu\text{m}$ laser wavelength 573
- D. Schirmann, C. Bayer, J.P. Garçonnet, D. Juraszek (CEL-V, Villeneuve Saint-Georges, France), A. Bertin and G. Grenier (Centre d'Etudes de Bruyères, Bruyères Le Châtel, France): Radiochemistry measurements on Phebus laser 585
- R.P. Drake (LLNL, Livermore, CA, USA): Three-wave parametric instabilities in long-scale-length, somewhat-planar, laser-produced plasmas 599
- I. Deha (Univ. Sci. de la Tech. Houari Boumedienne, Algiers), V. Biancalana, F. Bianconi, M. Borghesi, P. Chessa, A. Giulietti, L.A. Gizzi, L. Nocera (IFAM, Pisa, Italy), D. Giulietti (Dipart. Fisica, Univ. di Pisa, Italy) and E. Schifano (LULI, Paris, France): Forward second harmonic emission from laser plasma filaments 617
- S. Abdelli, A. Khalfaoui, T. Kerdja, and D. Ghobrini (MDRTE/CDTA, Alger-gare, Algeria): Laser-plasma interaction properties through second harmonic generation 629
- C. Arnas, J. Briand, J.F. Moor, M. Armengaud, and A. Gomes (I.R.S.A.M.C., Univ. Paul Sabatier, Toulouse, France): X-ray pulsation caused by collapse processes in laser interaction with plasma 639
- J. Ramirez (ETSI, Madrid, Spain): Flux-limiting effects in a quasisteady plasma corona with nonclassic heat flux 645
- E. Mínguez and R. Falquina (Inst. Nucl. Fusion, Madrid, Spain): Analysis of atomic physics models for gold plasmas in local thermodynamic equilibrium 651
- A.A. Offenberger, R. Fedosejevs, M. Fujita, Y.-Y. Tsui, and J.N. Broughton (Univ. of Alberta, Canada): KrF laser-plasma interaction experiments with ns and ps pulses 661
- F. Mucchielli, P.A. Holstein, B. Meyer, N. Périgaud, and O. Vanderpotte (CEL-V, Villeneuve Saint-Georges, France): Self-backlighting study of a mix in a laser-accelerated planar target 677
- V.A. Bolotin, I.N. Burdonsky, V.V. Gavrilov, A. Yu. Gol'tsov, E.V. Zhuzhukalo, S.V. Zavyalets, V.N. Kondrashov, N.G. Kovalsky, and M.I. Pergament (Kurchatov Atomic Energy Inst., Moscow, Russia): X-ray shadowgraphy applications in ablatively accelerated planar foil studies 685
- W. Mróz, A. Nowak-Goroszczenko, J. Wołowski, and E. Woryna (Inst. of Plasma Phys. & Laser Microfusion, Warsaw, Poland): Investigations of laser interaction with high-Z targets 689
- R. Buccellato, P.F. Cunningham, M.M. Michaelis, and A. Prause (U. Natal, Durban, South Africa): Comparative electron density measurements for the refractive fringe diagnostic and Nomarski interferometry 697
- X.C. Zeng (Inst. of App. Phys. and Comp. Math., Beijing, China), D.P. Singh, V. Palleschi, A. Salvetti, M. De Rosa, and M. Vaselli (IFAM, Pisa, Italy): Simulation and experimental studies on the evolution of a laser spark in air 707
- J.S. Bakos, I.B. Földes, P.N. Ignácz, M.Á. Kedves, and J. Szigeti (KFKI Res. Inst. for Part. and Nucl. Phys., Budapest, Hungary): Radiation imprisonment in laser blow-off plasma 715
- U.S. Begimkulov, B.A. Bryunetkin, V.M. Dyakin, G.A. Koldashov, S.N. Priyatkin, A.Y. Repin, E.L. Stupitsky, and A.Y. Faenov (NPO NIIFTRI, Moscow, Russia): Laser-produced plasma expansion in uniform magnetic field 723
- G.E. Belyaev, A.A. Golubev, B.Y. Sharkov (ITEP, Moscow, Russian Federation), B.A. Bryunetkin, I.Y. Skobelev, A.Y. Faenov, (NPO VNIIFTRI, Mendeleevo, 141570 Russian Federation), K. Mahrt-Olt and D.H.H. Hoffmann (GSI, Darmstadt, Germany): Spectroscopic study of plasma produced with a heavy ion maxilac beam 737

| | |
|---|-----|
| M. Chvojka, B. Králíková, E. Krouský, L. Láska, K. Mašek, O. Renner, K. Rohlena, J. Skála, O. Štirand, and P. Třenda (Inst. Phys., Prague, Czechoslovakia): An effect of the target position relative to the laser focus on X-ray emission from the laser plasma | 743 |
| V.A. Bolotin, I.N. Burdonskii, V.V. Gavrilov, A.Yu. Gol'stov, S.V. Zavyalets, E.V. Zhuzhukalo, V.N. Kondrashov, M.I. Pergament (Kurchatov Atomic Energy Inst., Moscow, Russia), M.O. Koshevoi, A.A. Rupasov, and A.S. Shikanov (P.N. Lebedev Phys. Inst.): Experimental study of X-ray emission from laser-irradiated planar targets on "Mishen" facility | 753 |
| G.E. van Dorssen, E. Louis, and F. Bijkerk (FOM Inst. Plas. Phys. Rijnhuizen, Nieuwegein, The Netherlands): Optimization of X-ray emission from a laser-produced plasma in a narrow wavelength band | 759 |
| T. Pisarczyk, A. Faryński, H. Fiedorowicz, P. Gogolewski, M. Kuśnierz, J. Makowski, R. Miklaszewski, M. Mroczkowski, P. Parys, and M. Szczurek (Inst. Plas. Phys. & Laser Microfusion, Warsaw, Poland): Formation of an elongated plasma column by a magnetic confinement of a laser-produced plasma | 767 |
| X. Wang, Z. Xu, S. Chen, A. Qian, Y. Li, P. Fan, and L. Lin (Shanghai Inst. of Optics, China): Linear laser plasma toward large-sized uniform soft X-ray source | 777 |
| A. Sureau (Lab. de Spectroscopie Atom. et Ionique, Orsay, France): A possible effect of ASE high intensities on gain values in plasmas | 787 |
| C.A. Back, P. Renaudin, C. Chenais-Popovics, and J.C. Gauthier (Lab. Phys. de Milieux Ionisés, Palaiseau, France): Optimization study of a photoionization experiment of a laser-produced He-like plasma by an X-ray source | 793 |
| A. Faryński, P. Gogolewski, L. Karpiński, M. Kuśnierz, J. Makowski, M. Mroczkowski, M. Szczurek (Inst. Plas. Phys. & Laser Microfusion, Warsaw, Poland), B.A. Bryunetkin, A.J. Faenov, and I.J. Skobelev (Nat. Sci. and Res. Inst., Moscow, Russia): Inverse population of the H-like F ion levels in a recombining laser-produced plasma confined in a strong magnetic field | 801 |
| P. Glas and M. Schnürer (Zentralinstitut für Optik und Spektroskopie, Berlin, Germany): Population inversion in H- and He-like Al using laser-produced counterstreaming plasmas | 811 |
| R. Kodama (Rutherford Appleton Lab., Oxon, UK): Study of X-ray laser interaction plasmas | 821 |
| D. Schirmann, J.L. Bocher, J.P. Le Breton, A. Mens, and R. Sauneuf (CEL-V, Villeneuve Saint-Georges, France): Progress in UV soft X-ray imaging | 827 |
| O. Renner and M. Kopecký (Inst. Phys., Prague, Czechoslovakia): Theoretical analysis of double-crystal spectrograph for high-resolution spectroscopy of laser-generated X-rays | 841 |
| B.A. Bryunetkin, S.A. Pikuz, I.Y. Skobelev, and A.Y. Faenov (NPO VNIIFTRI, Moscow, Russia): Imaging spectroscopy of high-temperature plasma sources | 849 |
| R. Suchańska (Inst. Plas. Phys. & Laser Microfusion, Warsaw, Poland): Targets for investigation of X-ray laser-plasma emission | 861 |
| P. Kukiello and G. Rabczuk (Inst. Fluid Flow Machinery, Gdansk, Poland): High-power cw CO ₂ transverse flow laser with a stable multipass cavity: Comparative study | 865 |
| J. Beránek, M. Chvojka, V. Hermoch, B. Králíková, J. Krása, L. Láska, K. Mašek, J. Musil, K. Rohlena, B. Rus, J. Schmiedberger, J. Skála, O. Štirand, P. Třenda (Inst. Phys., Prague, Czechoslovakia), N.G. Basov, I.M. Divilkovskiy, V.C. Zuev, A.V. Kanaev, V.A. Katulin, K.S. Korolkov, L.D. Mikheev, E.P. Orlov, A.L. Petrov, and V.I. Yalovoy (Lebedev Phys. Inst., Moscow, Russia): A pulsed iodine photodissociation laser with slow pumping | 871 |
| Index | 891 |