# ARIE ZIGLER

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**Abstract**: Dr. Zigler has more than 30 years of experience in experimental physics in area of electro-optics, spectroscopy, high power lasers , plasma physics, interaction of high intensity, ultra short pulse laser with matter. He holds a Chair of Physics at Faculty of Science of Hebrew University in Jerusalem and is a Full Professor at Racah Institute of Physics at Hebrew University of Jerusalem. Dr. Zigler has published over 180 scientific publications , delivered numerous invited talks at scientific conferences and holds 10 patents. He is a fellow of American Physics Society.

**Academic Degrees**

1968 - 1971: B. Sc. - Hebrew University , Jerusalem , Israel.

1972 - 1974: M. Sc. - Hebrew University, Jerusalem , Israel.

1975 - 1978: Ph.D. - Hebrew University, Jerusalem , Israel.

**Academic Appointments:**

1978- 1981 Senior Researcher Soreq Research Center Israel, Group Leader of XUV and X-ray spectroscopy experiments

1981-1982 Senior Scientist INESCO Tokamak project San Diego Ca, USA Responsible for diagnostics package for compact Tokamak experiment.

1982 -1983 Visiting Scientist, Plasma Fusion Center, M.I.T, Cambridge MA, USA Developed K alpha diagnostic for Alcator C Tokamak

1983- 1985 Head of Experimental Plasma Branch, Soreq NRC Israel Dealt with theoretical and experimental study of spectroscopy of highly ionized heavy atoms

1985 Visiting Scientist, Lawrence Livermore National Laboratory, USA. Study of interaction of high power laser and developed point backlighting source for fusion studies

1986- 1987 Visiting Scientist, Dept. of Physics, University of California, Berkeley, USA. Introduce ultra fast switching X-ray radiation

1987-1991 Head of Plasma Physics Department, Soreq Research Center Israel. Leader of R&D activities of 20 Ph.D researchers in the fields of laser-plasma interactions, X-ray radiation, shockwave phenomena and nonlinear optics. The application of one of methods is widely used for interpretation of laser-produced plasma experiments as well as of radiative properties of stellar plasmas is highly cited (above 220).

1991- 1992 Senior Physicist, ARCO Power Technologies, Inc., Washington DC, USA. Was responsible for physics aspects of design and development of airborne laser-optical instruments for detection oil films and trace elements in water. The work has led to two patents.

1992- 1995 Associate Professor, The Racah Institute of Physics, Hebrew University of Jerusalem. Leader of research group, deals with interaction of ultra short laser radiation with solids, laser wake field acceleration in plasmas, and x-ray lasers.

1995- present Full Professor, The Racah Institute of Physics of Physics, Hebrew University Main activities are in the field of electron and proton acceleration. More than 30 publications related electron accelerations were published and widely cited (more than 200), intense laser propagation in the atmosphere. Our works on laser filamentation the atmosphere are also highly cited.

2000- 2001 Senior Researcher, Naval Research Laboratory /FMtech, Washington DC. Dealt with interaction of ultra short pulse laser with solid targets (sabbatical)

2006-2007 Senior Researcher, Naval Research Laboratory/Icarus, Washington DC Development of capillary discharges for intense laser guiding (sabbatical)

2007 Louis and Ida Shlansky Chair of Physics at Faculty of Science, Hebrew University

of Jerusalem

2012- Visiting Professor University of Maryland, College Park Maryland, USA

**Fellowships**

2000 - Fellow American Physics Society - In recognition of his fundamental experimental contributions to the field of ultra high intensity laser matter interactions

**Current International activities**

Member of SILMI (Super Intense Laser Matter Interaction)

Member of COST program

Member of Editorial board High Power Laser Science and Engineering, Chinese Laser Press/Cambridge Press

1. ***Top 10 peer-reviewed publications in related fields (the last 10 years)***
2. Conversion of Electrostatic to Electromagnetic Waves by Super-luminous Ionization Fronts. D.Hashimshony, A.Zigler and D.Papadopoulos. Phys.Rev.Lett. 86, 2806, 2002
3. [Cohesive acceleration and focusing of relativistic electrons in overdense plasma](http://wos4.newisiknowledge.com/CIW.cgi?SID=P56Zlgrg-GkAAD8OcCo&Func=Abstract&doc=1/3) Yakimenko V, Pogorelsky IV, Pavlishin IV, H.Hirose and A.Zigler Phys.Rev.Lett 91. 014802 2003
4. [From quantum ladder climbing to classical autoresonance](http://wos4.isiknowledge.com/?SID=QX6CvArg-GkAABDydp8&Func=Abstract&doc=1/2). Marcus G, Friedland L, Zigler A Phys. Rev. A 69, 013407 2004
5. [Control of multiple filamentation in air](http://wos15.isiknowledge.com/?SID=ObB2h@4knNca47e1Cnc&Func=Abstract&doc=1/6)  Fibich G, Eisenmann S, Ilan and A.Zigler Opt. Lett. 29 1772-1774 2004
6. [Self-focusing distance of very high power laser pulses](http://wos02.isiknowledge.com/?SID=Z1biMeeahji@B@eafh@&Func=Abstract&doc=1/5)  Fibich G, Eisenmann S, Ilan B, and A.Zigler Optics Express. 13, 5897, 2005
7. [Fine structure of a laser-plasma filament in air](http://apps.isiknowledge.com/WoS/CIW.cgi?SID=P2PjJ3lCd2lHchiPl1k&Func=Abstract&doc=2/1)  Eisenmann S, Pukhov A, Zigler A Phys.Rev.Lett 98 155002 , 2007
8. [Generation of controlled radiation sources in the atmosphere using a dual femtosecond/nanosecond laser pulse](http://apps.isiknowledge.com/full_record.do?product=UA&search_mode=GeneralSearch&qid=1&SID=X2KjjCKpgH384L81E3F&page=1&doc=2&colname=WOS) Henis, Z; Milikh, G; Papadopoulos, K and A.Zigler J. APPLIED PHYSICS    103,    103111,  2008
9. [Effect of an energy reservoir on the atmospheric propagation of laser-plasma filaments](http://apps.isiknowledge.com/full_record.do?product=UA&search_mode=GeneralSearch&qid=1&SID=X2KjjCKpgH384L81E3F&page=1&doc=3&colname=WOS) Eisenmann, S; Penano, J; Sprangle, P, and A.Zigler Phys.Rev.Lett 100,    155003,   2008
10. [5.5-7.5 MeV Proton Generation by a Moderate-Intensity Ultrashort-Pulse Laser Interaction with H2O Nanowire Targets](http://apps.isiknowledge.com/full_record.do?product=UA&search_mode=GeneralSearch&qid=1&SID=R2g5nIJ4aOk@5MobaNf&page=1&doc=2&colname=WOS) Zigler, A; Palchan, T; Eisenmann,S, Button M, ShlieferE and D. Gordon Phys.Rev.Lett  106, 134801, 2011
11. [Enhanced proton acceleration by an ultrashort laser interaction with structured dynamic plasma targets.](http://apps.webofknowledge.com/full_record.do?product=UA&search_mode=GeneralSearch&qid=1&SID=Z13n3AHIIaHHj8BllHM&page=1&doc=1)  Zigler, A; Eisenman, S; Botton, M; et al. Phys. Rev. Lett.110 215004    2013

***Selected Invited Presentations at International Conferences***

1. 2007 International Symposium on Laser-Driven Relativistic Plasmas Applied for Science, Industry and Medicine, Kansai Photon Science Institute, Japan, Sept 2007
2. 2007 16th International Laser Physics Workshop León, Mexico
3. 2008 2nd International Symposium on Filamention Paris, France
4. 2008 The XIII International Conference "Laser Optics 2008". St.Petersburg, Russia
5. 2009 Extreme Light Infrastructure *:*Grand Challenges Meeting*,* Pars France
6. 2009 The Sixth International Conference on Inertial Fusion Sciences and Applications
7. 2010 Advanced Accelerator Concept Workshop Annapolis MD, USA
8. 2010 3rd International Symposium on Filamentation Crete, Greece,
9. 2010 Conference on “Superstrong Fields in Plasma” Varenna, Italy
10. 2011 The 31st International Workshop on Physics of High Energy Density in Matter Waldemar-Petersen-Haus, Hirschegg, Austria
11. 2011 ELI-Beamlines Scientific Challenges Prague 2011
12. 2011 Light at Extreme Intensities (LEI 2011), Szeged, Hungary
13. 2012 Advanced Accelerator Concept Workshop Austin Tx, USA
14. 2012 Conference on High Intensity Laser Interaction, Jerusalem, Israel

**Research expeditions**

Leader of several collaborative experiments including in the frame of European LASERLAB project.

1. Electron acceleration using capillary discharges – LULI Ecole Polytechnique 1999
2. X-ray laser using channelling – Max Born Institute 2001
3. Guiding Ultra \high laser Intensities - Max Born Institute 2003
4. Proton Acceleration using nano wire targets APRI*,* Gwangju Inst.
5. of Sci. & Technol., Gwangju, South Korea 2010
6. Proton acceleration from snow targets Max Born Institute Berlin 2011-2013
7. Proton acceleration, Texas PW Laser , Univ. Texas , Austin USA 2013

**Organisation of International workshops and conferences**

French Israeli Symposium on Non linear Optics 2000- 2013

( advisory committee, permanent)

Annual meeting of Israel Physical Society, Jerusalem, Israel – 2001 (meeting coordinator)

Conference on “Superstrong Fields in Plasma” Varenna, Italy - 2010 (program committee)

3rd International Symposium on Filamentation Crete, Greece, 2010 (program committee)

Conference on High Intensity Laser Research, Jerusalem, Israel -2011 (meeting coordinator and chair)

4th International Symposium on Filamentation Tucson, Arizona 2012 (program committee)

Conference on High Intensity Laser Interaction, Jerusalem, Israel -2012 (meeting coordinator and chair)

Conference on High Intensity Laser Interaction, Jerusalem, Israel -2013 (meeting coordinator and chair)

**Major contributions to early careers of excellent researchers**

During my academic career I have mentored and stimulated 20 M.Sc and 15 PhD young researchers. They have integrated into various academic as well as hi tech positions. In particular Dr. G. Marcus, Dr. Y. Erlich, Dr. M.Fraenkel, Dr. M.Inon, Dr.Y.Glick are holding faculty positions in universities and permanent research positions in research institutions in Israel. Dr. D.Kaganovich holds a permanent position as Senior Researcher at Naval Research Lab at Washington DC, USA. Dr.D.Hashimshony, is the founder and President of Dune Inc. Dune Medical Devices is a privately held company with offices in the US, Israel and Switzerland and employs tens of young researchers in Israel including my former students like Dr.I.Getner. Dr.S.Eisenman is a founder and CEO of HIL Medical Inc a start up company that employs several young researchers. My current group includes 4 PhD students and 3 M.Sc students. Annually, few undergraduate honor students perform independent research in my laboratory in conjunction with ongoing research projects.

Main Scientific Contributions

**Origin of K-alpha radiation in laser produced plasma**. During his Ph.D work he has found that the origin of K-alpha radiation in laser produced plasma is due to the presence of hot electrons deviated from the thermal distribution (ref 4). This method is widely used today by many laser produced plasma labs for measuring fast electrons.

**Spectroscopy of heavy highly ionized atoms.** In later years his research was focussed on the study of spectra emitted by highly ionized heavy ions. In particular a complex spectra emitted by the heavy, highly ionized atoms were collected and analyzed by calculating the bound-bound emission from a local thermodynamic equilibrium plasma. The total transition array of a specific single-electron transition, including all possible contributing configurations, was described by only a small number of super-transition-arrays (STA’s). The method allows interpolating smoothly between the relatively simple average-atom (AA) results and the detailed configuration accounting that underlies the unresolved transition array method. It was shown that under certain plasma conditions the contributions of low-probability transitions can accumulate into an important component of the emission. In these cases, detailed configuration accounting is impractical. On the other hand, the detailed structure of the spectrum under such conditions is not described by the AA method. The application of the STA method is widely used for interpretation of laser-produced plasma experiments as well as of radiative properties of stellar plasmas. (see ref 9,12,14,17,23,30,31,37,39,43,57) . Some of the publications were highly cited (above 220).

**Guiding of ultra high laser intensities by plasma channels – electron acceleration.**

The next major contribution was development of ablative capillary discharges. This approach was used as X-ray laser medium (ref 46, 52, 54,62, 75 and 148). In parallel in 1996 these slow capillary discharges were used for demonstration of optical guiding of a high intensity, up to 1019W/cm2 laser pulses in a long (up to 25cm) cylindrical plasma capillary channel. Optical guiding in a curved plasma (radius of curvature = 10 cm) was also demonstrated. Results show guiding of many tens of vacuum diffraction lengths in both straight and curved channels, in agreement with theory and simulation. In 2000 these channels were proposed as medium for achieving multi-GeV electron energies in the laser wakefield accelerator (LWFA) since it is necessary to propagate an intense laser pulse long distances in plasma without disruption. It was shown that electron energies of similar to GeV in a plasma-channel LWFA can be achieved by using short pulses where the forward Raman and modulation nonlinearities tend to cancel. Further energy gain can be achieved by tapering the plasma density to reduce electron dephasing. It was also demonstrated that energy depletion can be overcome using multistage capillary discharges. More than 30 publications in the related subjects were published and widely cited, for example ref 88 was cited more than 200. In the recent years a modified version of the capillary discharge was used by other group for the experimental demonstration of electron acceleration above GeV.

**Conversion of Electrostatic to Electromagnetic Waves by Super-luminous Ionization Fronts –Generation of THz radiation.**

Another area of investigation was a new approach for generation of THz radiation.It was achieved by the conversion of static electric fields to electromagnetic radiation by the incidence of a superluminous ionization front on plasma. For extremely superluminous fronts, the radiation is close to the plasma frequency and is converted with efficiency of order unity. A proof-of-principle experiment was conducted using semiconductor plasma containing an alternately charged capacitor array. The process has important implications in astrophysical plasmas, such as supernova emission, and to laboratory development of compact, coherent, tunable radiation sources in the THz range. Tunable radiation in the range from 0.1 to a few THz by the interaction of a superluminous photoconducting front with an electrostatic 'frozen wave' configuration in a semiconductor is reported. The interaction converts the energy contained in the 'frozen wave' into THz radiation, whose frequency depends on the energy in the laser pulse creating the superluminous front and the wavelength of the static wave. Power scaling as a function of the electrostatic 'frozen wave' energy was obtained. The capability of the concept to act as a narrow or wideband, tunable and powerful THz source was demonstrated. Using THz source we have measured the dielectric properties and thickness of thin semiconductor epitaxy layers by the reflection of THz radiation from the surface of a two-layered semiconductor wafer. The reflection from two interfaces the electromagnetic pulse has a destructive interference at a specific wavelength dependent on the thickness of the outer layer and its dielectric function. Near that frequency the reflection coefficient has a significant drop. By extending the incident pulse spectrum to include this interference frequency, a measurement of the thickness was obtained together with a direct measurement of the carrier number density. By this technique epitaxy layers of thickness down to a few microns were characterized (ref 103,110,111,114,121,122,126).

**Propagation of high laser intensities in atmosphere.**

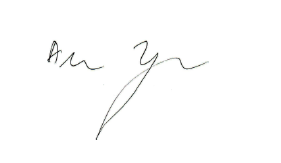
Propagation of high power femto-second laser pulses in the atmosphere has been observed to self-channel in air and to propagate as narrow light filaments over distances from several tens to several hundreds of meters. This propagation is the result of a dynamical equilibrium among many effects, including Kerr self-focusing, diffraction and plasma defocusing. For laser intensities of 5x1013 W/cm2 a plasma column with electron density of 1016 - 1017 cm-3 is created in the wake of the self-guided pulse. We have proposed a simple method that allows obtaining a single and highly stable filament, out of a high-power pulse which would otherwise generate a random multiple filamentation patterns. We also have demonstrated that the location of the initial air breakdown can be controlled by forming stable filamentary structures in air due to the replenishment phenomena. The developed control techniques produced very stable single or multiple filaments with an angular stabilityof 10-5rad. The ultra-short (femtosec) lasers can generate plasmas at desired locations and distances of several km in the atmosphere, the lifetime of the plasma plume is too short to be of interest because of limits in the pulse energy. The ultra-short (femtosec) lasers are not sufficiently powerful to initiate air breakdown at distances of several kilometers in the atmosphere. A new approach based on the use of a combination of ultra-short pulse laser and a long pulse laser was developed. The ultra-short pulse is deployed first to create ionized channel at desired location by multi-photon ionization. It is then followed by a long pulse that maintains the plasma channel at a controlled temperature level. This technique can generate plasma channels remotely at realistic timescales for the development of leader stroke with controlled characteristics of ionized filaments generated launched into the atmosphere with many applications, among which the two most spectacular are lightning control and laser-assisted water condensation. Ref. 142,153,162,167,168, 177. The works on laser filamentation are highly cited.

**Proton acceleration**

Laser powered acceleration of protons is considered to be a key technology in the development of compact source for hadron therapy of cancer. An advanced concept for proton acceleration based on the field enhancement by micro-structures was proposed ref 165,166 . The target exhibits an enhanced absorption of laser energy by snow deposited on Sapphire targets. Using modest level ultra short laser facility (<1018W/cm2) and snow deposited targets, my group has demonstrated production of 10MeV protons ref 173 and recently using more powerful system 25MeV ref 182. This points to an order of magnitude increase of the maximal proton energy (namely to 100MeV level) with high intensity lasers of 5∙1019 W/cm2). We also have shown that the scaling laws of the protons energy is similar to the TNSA-scheme, but shifted to lower laser energies. This pioneering work proved that protons can be accelerated by modest energy lasers, with all the important implications to possible future realizations.

**List of Publications**

1. Spatial Resolution of X-ray Line Emission in Laser-Produced Plasma by the Shadow Technique. A. Zigler, H. Zmora and Y. Komet, Phys. Lett. **60A**, 319 (1977).
2. Expansion of Laser Produced Al Plasma and Heat Penetration Depth in Multi-Layered Targets. A. Zigler, H. Zmora, Y. Paiss and J. L. Schwob, J. of Physics **D10**, L 159 (1977).
3. Experimental and Theoretical Studies of Laser Produced Plasmas at the Soreq Nuclear Research Center, D. Salzmann, Y. Gazit, Y. Komet, M. Loebenstein, H.Szichman, A. Zigler, H. Zmora, Laser Interaction and Related Plasma Phenomena, Vol. 4A, P. 407-415. Edited by H. J. Schwarz and H. Hora, Plenum Publishing Corp., 1977.
4. The Origin of K­ Radiation in Laser Produced Al Plasma, A. Zigler, H. Zmora, H. M. Loebenstein and J. L. Schwob, Phys. Lett. **63A**, 275 (1977).
5. Investigation of the Transient Ionizing Regime for Laser Produced Plasma, A. Zigler, H. Zmora, H. M. Loebenstein and J. L. Schwob, J. Appl. Phys. **50**, 165 (1978).
6. Burn-Through of Thin Aluminum Foils by laser Driven Ablation, A. Zigler, H. Zmora, B. Arad, S. Eliezer, Y. Gazit, H. M. Loebenstein, andS. Zweigenbaum. J. Appl. Phys. **50** (11), 6817 (1979).
7. Spectra of Highly Ionized Cr, Fe, Co and Ni Emitted from Laser Produced Plasmas,   
   N. Spector, A. Zigler and H. Zmora, J.Opt. Soc. Am. **67,** 1289, (1978).
8. Cr, Co and Ni Transitions Isoelectronic to the Fe XXIV-Fe XVII Lines Around 11 A in Laser Produced Plasma, N. Spector, A. Zigler and H. Zmora, J. Opt. Soc. America, **70**, 857, (1980).
9. Identification of the Spectra of Hf XLV , Ta XLVI, W XLVII and Re XLVIII Isoelectronic to Ni in Laser Produced Plasmas, A. Zigler, H. Zmora, N. Spector, M. Klapisch, J. L. Schwob and A. Bar-Shalom, J. Opt. Soc. Am. **70**, (1) 129 (1980).
10. A Q-Switched Oscillator for Stable Time-Tunable Operation in the Nanosecond Regime, S. Jackel, H. M. Loebenstein, A. Zigler, H. Zmora and S. Zweigenbaum, J. Phys. E **13**, 995 (1980).
11. Z Dependent Absorption and Stimulated Backscatter Processes in Laser Produced Plasma, S. Jackel **.** H. M. Loebenstein, A. Zigler H. Zmora and S. Zweigenbaum, Appl. Phys. Lett. **36** (1), 34 (1980).
12. Nickel-Like X-Ray Spectra of Laser Produced Platinum Plasma, A. Zigler, H. Zmora, N. Spector, M. Klapisch, J. L. Schowb and A. Bar-Shalom, Phys. Lett. A **75**, 343 (1980).
13. Effect of Pulse Duration and Polarization on Momentum and Energy Transfer to Laser Irradiated Targets, B. Arad, S. Eliezer, S. Jackel,A. Zigler, H. Zmora and S. Zweigenbaum, Phys. Rev. Lett. **44** (5), 326 (1980).
14. Nickel-Like Spectrum of Tm XLII and Yb XLIII from Laser produced Plasma, A. Zigler,M. Klapish et al.,Phys. Lett. A**79**. 67 (1980).
15. Laser-Light Absorption in long-Pulse High-Irradiance Experiments, B. Arad, S. Eliezer, Y. Gazit, S. Jackel, Y. Karmi and A. Zigler. Appl. Phys. Lett. **37** (9), 7 **(**1980).
16. Effect of Ponderomotive Forces on Wave Dispersion and Second-Harmonic Light Emissions in Laser Produced Plasmas, S. Jackel, S. Eliezer and A. Zigler, Phys. Rev. A **24** (3), 1601, (1981).
17. Identification of 3d-4p Transitions in Co-Like W XLVIII and Tm XLIII and in Cu-Like W XLVI and Tm XLI From Laser Produced Plasmas, Klapisch, P. Mandelbaum , A. Bar-Shalom, J. L. Schwob , A. Zigler and S. Jackel, J. Opt. Soc. Am. **71**, (10), 1267, 1981.
18. Pulse-length Polarization and Z. Dependent Properties of Laser Produced Plasmas at High Irradiances, S. Jackell B. Arad, S. Eliezer, Y. Paiss, N. Spector, A. Zigler, H. Zmora and S. Zweigenbaltm, Laser Interaction and Related Plasma Phenomena, Vol. 5, 524-532, 1981 Edited by H. J. Schwartz, H. Hora, M. Lubin and B. Yaakobi , Plenum Publishing Corp. 1981.
19. Temporal Pulse-Shaping for Laser Fusion Experiments Using a Cavity Dumped Q-Switched Oscillator, S, Jackel, R. Lalluz, Y. Paiss, S. Eliezerand A. Zigler, J. Phys. E: Sci. Instrum. **15**, 255, (1982).
20. Multistep Laser Pulse Generation Using Passive Electrical Networks in the Driver of A Cavity-Dumped Q-Switched Oscillator. S, Jackel, R. Lalluz, Y. Paiss, S. Eliezerand A. Zigler, J. Phys. E: Sci. Instrum. **15,** 670, (1982).
21. High Irradiance Studies of Laser-Produced Plasma, S. Jackel, R. Lalluz, Y. Paiss, S. Eliezerand A. Zigler, Proceedings of Fusion Energy, **5.** p. 141-152, IAEA-SMR-82.
22. Recent Experiments on Laser-Plasma Interaction Carried Out at Soreq S. Jackell B. Arad, S. Eliezer, Y. Paiss, N. Spector, A. Zigler, H. Zmora and S. Zweigenbaltm. Les Houches Session XXXIV, p. 51-62, Ed. R. Balian and J. C. Adam, North Holland Publishing Co., 1982.
23. Interpretation of Unresolved Transition Arrays in the Soft X- Ray Spectra of Highly IonizedMolybdenum and Palladium, M. Klapish, E. Meroz, P. Mandelbaum and A. Zigler, Phys. Rev. A **25**, 2391 (1982).
24. Rationalization of Diagnostics Selection. B. G. Buss and A. Zigler, INESCO Internal Report No.80-12/06, 1982.
25. Periodically Pulsed Thompson Scattering, A. Zigler, INESCO Internal Report No. 81-11/51, 1982.
26. Ion Temperature Measurements, A. Zigler, INESCO Internal Report No. 82-04/18, 1982.
27. Ion Temperature Measurements II (High Temperature Region), A. Zigler, INESCO Internal Report No. 82-04/62, 1982.
28. Visible Spectroscopy of Tokomak Diagnostics. A. Zigler, INESCO Internal Report No. 82-04/19, 1982.
29. X- Ray Spectrometer for Bremsstrahlung Measurements, A. Zigler, INESCO Internal Report No. 82-06/26, 1982.
30. Classification of X-Ray Spectra from Laser Produced of Atoms from Tmto Pt in the Range 6-9A, A. Zigler, H. Zmora, P. Mandelbaum, M. Klapisch, J. L. Schowb and A. Bar-Shalom Physica Scripta **27**, 3953 (1983).
31. Classification of Cu-I like 3p-4s and 3p-4d Transitions in X-Ray Spectra, A. Zigler, H. Zmora, P. Mandelbaum, M. Klapisch, J. L. Schowb and A. Bar-Shalom, Phys. Lett. A **92**, 84 (1983).
32. X-Ray Transmission Spectrometer for Ion Temperature Measurement. A. Zigler, E. Marmar, J. Rice and J. Terry, MIT Internal Report , 1983.
33. Survey Spectrometer f or X -Ray Emission from Tokomak**,** A. Zigler, E. Marmar, J. Rice and J. Terry, MIT Internal Report, 1983.
34. Review of Recent Experimental and Theoretical Laser-Plasma Reseach Carried Out at Soreq., S, Jackel, R. Lalluz, Y. Paiss, S. Eliezerand A. Zigler, Laser Interaction and Related Plasma Phenomena, Vo. 6. p 351-364 ed. by H. Hora and G. M. Miley, Plenum Publishing Corp. 1984.
35. Deposition of energy outside of the focal spot as observed on the rear surface of laser irradiated targets. A. Zigler, M. Givon, A. Lyudmirski, S. Eliezer and M. Kishenevsky. Phys. Lett., A **112** (5), 223, (1985).
36. Acquisition and processing of optical two-dimensional Transients, M. Kishenevsky, A. Zigler and A. Arad, J. Phys. E: Sci. Instrum. 19, 864 (1986).
37. The unresolved 3d-4f transitions in the x-ray spectra of highly ionized Tm to Re from laser produced plasma. M. Klapisch, P. Mandelbaum, and A. Zigler, Phys. Scrip. **34**, 51-57 (1986).
38. Laser generated shock wave velocity measurements using visible backlighting techniques. A. Zigler, A. Ludmirsky, A.Borowitz, E.Moshe, S.Eliezer,Y.Pais, D.Saltzman and H.Zmora, J. Phys. E **19**, 309-311 (1986).
39. Multiple open shell x-ray spectra in laser irradiated W and Au plasmas. A. Zigler, M. Klapish, and P. Mandelbaum. Phys. Lett. 111, **31** (1986).
40. Identification of lines of ions belonging to the F I isoelectronic sequence for rubidium, strontium, and yitrium. A. Zigler, U. Feldman, and G.A. Doschek, J. Opt. Soc. Am. B **3**, 1222 (1986).
41. Double layers in laser produced plasmas. S.Eliezer, H.Hora,A.Ludmirsky,B.Arad ,A. Borovitz,A.Loeb, S.Jackel I.Gazit and A.Zigler . Laser interaction and related plasma phenomena, H. Hora and G. Miley, editors. Vol.7, p. 329 - 346 (1986).
42. The evolution of strong shock waves produced by a trapezoidal laser pulse. S.Eliezer, H.Hora,A.Ludmirsky,B.Arad ,A. Borovitz,A.Loeb, S.Jackel , I.Gazit and A.Zigler**.** Laser interaction and related plasma phenomena, , H. Hora and G.H. Miley, editors Vol.7 p. 276 - 288 , (1986) .
43. Use of unresolved transition arrays for plasma diagnostics. A. Zigler, M. Givon, E. Yarkoni, M. Kishinevsky, B. Arad, and M. Klapisch, Phys. Rev. A **34**, 280 (1987).
44. Use of multilayered targets to inject trace elements into laser produced plasma. A. Zigler, R. W. Lee, and J. D. Kilkenny, Appl. Phys. Lett. **50**, 1133, (1987).
45. Point radiation source characterization. A. Zigler, R. W. Lee, and J. D. Kilkenny. J. Appl. Phys. **62**, 107 (1987).
46. High power laser heating of an elongated dense plasma produced by a capillary discharge. A. Zigler, M. Kishenevsky, M. Givon, and B. Arad, Phys. Rev. A **35**, 4446 (1987).
47. Multiple-Pass amplifiers for High-Power Laser Systems.S.Jackel, A.Ludmirsky, A.Borovitz, B.Arad and A.Zigler. Laser and Particle Beams **5** , 115-124 (1987).
48. Rapid lattice expansion by laser heating. A. Zigler, J. H. Underwood, J. Zhu and R. W. Falcone, Appl. Phys. Lett. **51**, 157 (1987).
49. Electron density dependence of line intensities of Cu-I-like Sm+33 to Yb+41 emitted from tokamak and laser produced plasmas.N.Spector, M. Finkental, E. Moshe B. Arad . S.Jackel and A.Zigler. Phys. Rev. A **38**, 288 (1988).
50. Space and Time-Resolved Diagnostics of Soft X-ray Emission From Laser Plasmas. C.M. Brown, J.House, B.Yakkoby, U. Feldman, J.F. Seely, J.H. Underwood and A. Zigler, Proc. SPIE **913**, 110 (1988).
51. Imaging of laser-produced plasmas at 44 A using a multilayer mirror. C.M. Brown, U. Feldman, J.F. Seely, J.H. Underwood, and A. Zigler, Optics Communications, **68**, 190 (1988).
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**Education**

1989-1991 – B.Sc.: Physics & Mathematics, Hebrew University.  
1991-1993 – M.Sc.: Physics, under the supervision of Professor Arie Zigler, Hebrew University. M.Sc. thesis: Electrical capillary discharge as a source of large, high density, homogeneous plasma.  
1993-1998 – Ph.D.: Physics, under the supervision of Professor Arie Zigler, Hebrew University. Ph.D. thesis: Propagation of short intense laser pulses in plasmas.

Areas of Expertise: Strongly coupled plasma, frequency conversion, atmospheric optics, remote sensing, high energy density plasmas, laser - plasma interaction, X-ray diagnostics.

**Professional Experience**

1998-2005: Researcher at Nonlinear Optics group / Atmospheric Optics group, Soreq NRC, Israel.  
Wavelength conversion, mainly OPO wavelength conversion towards the near, medium and far IR. OPO wavelength tuning control and spatial beam quality improvement.  
Holographic photography at a micron scale resolution. Development and establishment of a research laboratory for optical remote sensing, using wavelength tunable laser devices.  
Joint research with the Hebrew University and Tel Aviv University on optical self-guiding of ultra-short laser pulses in air.

2005-2010: Researcher at atmospheric optics group and plasma group, Soreq NRC, Israel.  
Wavelength conversion. OPO at high rep-rate, pulse energy and beam quality. Innovative use of seeding of a confocal OPO for beam quality improvement. Remote sensing of gases and aerosols at different scenarios. High intensity laser-matter interaction. High power lasers frequency conversion, and beam diagnostics. Soft x-ray spectroscopy and imaging.  
Advanced research on optical self-guiding of powerful laser pulses in air,

In collaboration with the Hebrew University and Tel Aviv University.

2010-2011: Sabbatical year at the Hebrew University, Israel.

Soft X-ray spectroscopy. Control of the filamentation process of femtosecond laser pulses in air. Microwave diagnostics of femtosecond laser-generated plasma filaments. Controlling and characterizing of polarization in self-guided laser pulses.

2011-2016: Researcher at plasma group, Soreq NRC, Israel.

Development of a variety of soft x-ray diagnostics, transmission gratings spectroscopy, x-ray imaging, x-ray component calibration. Advanced laser- plasma experiments.

**Awards**

Rector's Award for academic excellence, Hebrew university,1989.  
Rector's Award for M.Sc. students, Hebrew university, 1992.  
Shimon Offer Award, Hebrew university, 1992.  
Excellence Scholarship, Hebrew university, 1992.

Excellence Scholarship, Hebrew university, 1993.  
Summer Excellence Scholarship , Hebrew university, 1995.  
Israel Physical Society Award for outstanding Ph.D. student's research 1997.  
Katsir Scholarship, Soreq NRC 1998-2004.  
Efficiency award, Soreq NRC, 1999.  
Efficiency award, Soreq NRC, 2000.  
Efficiency award, Soreq NRC, 2001.  
Outstanding employee of Electro-Optics Division Soreq NRC, 2008.

Outstanding research, Research Day, Soreq NRC, 2011.

Outstanding research, Research Day, Soreq NRC, 2012.

Publication list

**Refereed journal papers:**

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2. A. Zigler, Y. Ehrlich, and C. Cohen, J. Krall and P. Sprangle, *Optical guiding of high-intensity laser pulses in a long plasma channel formed by a slow capilla discharge.* J. Opt. Soc. Am. B **13** 68 (1996).
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4. D. Kaganovich, P.V. Sasorov, Y. Ehrlich, C. Cohen, and A.Zigler, *Investigation of Double Capillary  Discharge Scheme for Production of Wave Guide in Plasma,*  Appl. Phys. Lett. **71** 2925  (1997).
5. Y. Ehrlich, D. Kaganovich, C. Cohen, and A.Zigler, R.F. Hubbard, P. Sprangle, and E. Esarey, *Long Channel Optical Guiding of High Intensity Laser Pulses*, JOSA B **15**, 2416 (1998).
6. D. Kaganovich, a. Ting, C.I. Moore, A. Zigler, H.R. Burris, Y. Ehrlich, R. Hubbard and P. Sprangle, *High Efficiency Guiding of Terawatt Subpicosecond Laser Pulses in a Capillary Discharge Plasma Channel*, Phys. Rev. E **59**, R4769, (1999).
7. I. Paiss, E. Lebiush, Y. Tzuk, Y. Ehrlich and R. Lavi, *Continuous wave intra-cavity periodically-poled lithium niobate optical parametric oscillator*, TOPS Volume 34, Advanced Solid State Lasers, 293 (2000).
8. S. Pearl, S. Fastig, Y. Ehrlich and R. Lavi, *Limited efficiency of a silver selenogallate optical parametric oscillator caused by two-photon absorption*, Appl. Optics **40**, 2490(2001).
9. Marcus,-G.; Zigler,-A.; Englander,-A.; Katz,-M.; Ehrlich,-Y.  *Generation of ultrawide-band chirped sources in the infrared through parametric interactions in periodically poled crystal.* Appl. Phys. Lett. **82**, 164-166 (2003).
10. S. Pearl, Y. Ehrlich, S. Fastig, S. Rosenwaks, *Nearly diffraction-limited signal generated by a lower beam- quality pump in an optical parametric oscillator*, Appl. Opt. **42**, 1048-1051, (2003).
11. Y. Ehrlich, S. Pearl, S. Fastig, *High brightness tunable tandem optical parametric oscillator at 8-12m*, ASSP, G. Quarles ed., Trends in Optics and Photonics v.94, OSA WA-DC, (2004).
12. Gadi Fibich, Shmuel Eisenmann, b. Ilan, Yosi Ehrlich, Moshe Fraenkel, Z. Henis, A.L. Gaeta, Arie Zigler, *Self-focusing distance of very high power laser pulses,* Optics Express, **13**, 5897-5903 (2005).
13. E. Louzon, Z. Henis, S. Pecker, Y. Ehrlich, D. Fisher, M. Fraenkel, A. Zigler, *Reduction of damage threshold in dielectric materials induced by negatively chirped laser pulses.* Appl. Phys. Lett. **87**, 241903 (2005).
14. G. Marcus, A. Zigler, D. Eger, A. Bruner, A. Englander, M. Katz, and Y. Ehrlich, " Generation of a High-Energy Ultra-Wideband Chirped Source in Periodically Poled Crystals," in *Advanced Solid-State Photonics*, Technical Digest, paper MB21. (2006)
15. Gadi Fibich, Yonatan Sivan, Yosi Ehrlich, Einat Louzon, Moshe Fraenkel, Shmuel Eisenmann, Yiftach Katzir, Arie Zigler, *Control of the collapse distance in atmospheric propagation,* Optics Express, **14**, 4946-4957 (2006).
16. S. Eisenmann, Y. Katzir, A. Zuigler, G. Fibich, E. Louzon, Y. Ehrlich, Z. Henis, S. Pecker, D. Fisher and M. Fraenkel, *Intercation of intense short laser pulses with air and dielectric materials*, International Journal of Modern Physics B **21**,615-625 (2007).
17. E. Louzon, Z. Henis, I. Levi, G. Hurvitz, Y. Ehrlich, M. Fraenkel, S. Maman and P. Mandelbaum, *X-ray spectrum in the range of 6-12 Å emmited by laser-produced plasma of samarium,* JOSA B **26**, 959 (2009).
18. E. Louzon, Z. Henis, I. Levy, G. Hurvitz, Y. Erlich, M. Fraenkel, S. Maman, E. Raicher, A. Malka, P. Mandelbaum, Z. Zigler, *Density diagnostic of highly ionized samarium laser produced plasma using Ni-like spatially resolved spectra*, Laser and Part. Beams **29**, 61-67, (2011).
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25. Y. Frank, E. Raicher, Y. Ehrlich, G. Hurvitz, Z. Shpilman, M. Fraenkel, A. Zigler, Z. Henis*,* [*Influence of atomic modeling on integrated simulations of laser-produced Au plasmas*](http://journals.aps.org/pre/abstract/10.1103/PhysRevE.92.053111), Physical Review E **92**, 053111 (2015).‏