

**NATIONAL UNIVERSITY OF PUBLIC SERVICE**

**ANTAL CSUKA**

**EXAMINATION OF LASER LIGHT PROPAGATION IN  
CONTEXT OF APPLICATION OF MILITARY LASER LIGHT  
DEVICES**

Author's summary of the (PhD) Dissertation

**Scientific supervisor:**

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## **1. THE SCIENTIFIC PROBLEM**

Results of different disciplines in context to directed energy weapons can not be easy undertaken. I have restricted the area of my research onto laser light propagation investigation, using my previous results and experiences. It isn't known such optical media, that do not affect the light propagations. It can be assumed that propagation of light in thermally stabilized and reduced pressure chamber (vacuum) in a straight line, but otherwise not. Based on the foregoing it follows, that influence of atmosphere, onto the light propagation, can be observed even by free-space communication systems even by up to MW-power laser weapons. The extent to which it must be dealt with the effect of the atmosphere that affect the propagation of light, it is always a specific of application, or device, and it is determined by accuracy. Either free-space data, and information-transmission systems, whether destruction of ballistic missiles and artillery projectiles in air, both use the same monochromatic, coherent electromagnetic radiation that today is known as a laser.

Development of laser devices and laser light application are inconceivable without examination of interactions of atmosphere and laser light. Because of continuous changes in the composition of atmosphere the validity of empirical formula elaborate decades ago are today questionable. The compensation of deficiency requires clarification of relationships and continuous review of light propagation phenomena. Limitations and validity of relationships must be examined in context of monochromatic light, both laser light. The presentation and survey of phenomenon in depth, mentioned before are possible only by procurement of professional instruments, or by own designed non- series measurement devices.

## **2. RESEARCH OBJECTIVES**

1. To analyze the interaction of gas components of air, and to interpret the laser light propagation inside the micro-, and macroscopic system.
2. To examine how a laser source operate, to analyse its structure and performance.
3. To create a proper model of micro- structure and particle interaction of gaseous medium., based on micro-system interactions.

4. To elaborate the simplest measurement principle, for examination of laser light refraction in air, using simple, own designed devices based on semiconductor laser sources.
5. To build own designed, usable and programmable hardware for measurements.
6. To solve the transmission of pre- stored data's in a safe place.
7. To design data processing program.
8. To propose suitable methods for partial evaluation and processing of data's during the measurements.

### **3. RESEARCH HYPOTHESES**

- The Instabilities in the state of atmosphere are responsible for imprecision in optical measurements, using lasers.
- For precise description of refraction phenomena, new mathematical model it is needed.
- Using mathematical appliances and methods of differential-geometry can be deduced quite easy the differential function of laser light refraction in random media. This function describes the declination of elementary laser ray, when it passes the boundary layer of gas medium.
- Because of continuous grown of carbon-dioxide percentage in air the accuracy and reliability of today's empirical relationships are questionable.
- Semiconductor lasers, which produces concentrated laser beam, are suitable for middle range broadband, point- to point optical data transmission systems.
- With less additions and modifications, semiconductor lasers used in most of pointers are suitable for optical measurement apparatus.
- Using high-resolution and sensitive CCD's, management-free microcontroller based optical receiver and data logger, suitable for laser light refraction surveys it may be constructed.

## 4. RESEARCH METHODS

Analyse the results of relevant literature and studying the research methods relating to this subject.

Interpreting the deviation of laser ray during the propagation and selecting the proper mathematical appliances to derive new theorems of boundary layer of gas media.

Determine the selection criteria of semiconductor lasers.

Designing precise instruments for measurement based on microcontrollers.

Critical analysis of earlier research results, measurement methods and description of appliances published in literature.

## 5. THE EXECUTED RESEARCH WORK IN CHAPTERS

**Chapter one:** I analyze the semiconductor laser structure and the laser light properties.

**Chapter two:** I studied the interaction of particle in micro-, and macroscopic structure.

**Chapter three:** I analyse the mathematical methods for studying of stochastical systems.

**Chapter four:** I derive the partial differential function of refraction of elementary light ray.

**Chapter five:** I describe the source side of optical measurement system.

**Chapter six:** I describe the receiver side of optical measurement system.

**Chapter seven:** I present the general structure of data processing program.

## **6. CONCLUSIONS**

In laser light propagation theory, there are a many unanswered questions. Excessive simplifications are found in description of light refraction. It can be conclude that the literature explain this phenomenon without any reference to the microscopic interactions between elementary particle of gas medium.

Using high – precision optical sensors, accurate free – space measurements may also made. The measurements and the collection of data’s may require long time depending onto the measuring principle.

Statistics and correlation analysis are the best methods to evaluate the results.

## **3. NEW SCIENTIFIC RESULTS**

The new scientific results of my dissertation are the followings:

**Tesis 1.** I have deduced the function, which describes the laser light refraction in inhomogeneous gas media.

**Tesis 2.** I compared some empirical function and I determined its applicability.

**Tesis 3.** I gave the definition of boundary layer of inhomogeneous gas media.

**Tesis 4.** I designed and constructed the experimental apparatus for measurements of laser light deviations.

## **4. RECOMMENDATIONS**

I recommend the elaborated model and the theoretical description of boundary layer for further studies and developments.

I recommend the theoretical studies to institutions of higher education for lecture notes as a reference document, and the practical skills for professional and hobbyist developers.

## 5. PUBLICATIONS

1. **CSUKA, A.:** Az irányított energiájú fegyverek perspektivikus alkalmazása az amerikai hadseregben; Repüléstudományi Közlemények különszám, 2007. április 20. ISSN 1417-0604  
[http://www.szrfk.hu/rtk/kulonszamok/2007\\_cikkek/csuka\\_antal.pdf](http://www.szrfk.hu/rtk/kulonszamok/2007_cikkek/csuka_antal.pdf)
2. **CSUKA, A.:** Impulzusbombák és repülőgép fedélzeti nagyenergiájú impulzuskeltők hatásfokának növelése szupravezetők alkalmazásával, Repüléstudományi Közlemények, Különszám 2008. április 11. ISSN 1789-770X  
[http://www.szrfk.hu/rtk/kulonszamok/2008\\_cikkek/Csuka\\_Antal.pdf](http://www.szrfk.hu/rtk/kulonszamok/2008_cikkek/Csuka_Antal.pdf)
3. **CSUKA, A., ELŐHÁZI, J.:** Irányított energiájú fegyverek és veszélyeik a számítógépes rendszerekre, Hadmérnök III. évf. 3. szám 2008. szeptember, ISSN 1788-1919  
[http://hadmernok.hu/archivum/2008/3/2008\\_3\\_csuka.pdf](http://hadmernok.hu/archivum/2008/3/2008_3_csuka.pdf)
4. **CSUKA, A.:** Nagyfeszültségű villamos ív alkalmazása és előállításának feltételei az akusztikus fegyverekben, Bolyai Szemle 2008. XVII. évf. 4. szám, ISSN 1416-1443  
[http://portal.zmne.hu/download/bjkmk/bsz/bszemle2008/4/09\\_Csuka\\_Antal.pdf](http://portal.zmne.hu/download/bjkmk/bsz/bszemle2008/4/09_Csuka_Antal.pdf)
5. **CSUKA, A.:** Információvédelem, merre tovább?, ZMNE Kommunikáció 2008, 2008 október 7., ISBN 978-963-7060-57-1
6. **CSUKA, A.:** Irányított energiájú fegyverek hullámjelenségeinek modellezése és számítógépes szimulációja, ZMNE Repüléstudományi Közlemények, CD kiadvány különszám 2009. április 24. ISSN 1789-770X  
[http://www.szrfk.hu/rtk/kulonszamok/2009\\_cikkek/Csuka\\_Antal.pdf](http://www.szrfk.hu/rtk/kulonszamok/2009_cikkek/Csuka_Antal.pdf)
7. **CSUKA, A., KACZUR, S.:** Modeling of microwave interaction with matter, DUF, Magyar Tudomány Napja Konferencia. Dunaújváros, 2009 nov. 13. ISSN 1586-8567

- <http://www.duf.hu/tudomanyhete2009/>
8. **CSUKA, A.:** A haditechnikai fejlesztés építőkövei –Irányított energiájú fegyverek, GDF 2009 Informatika, XI. évfolyam 2. szám. ISSN 1419-2527  
<http://www.gdf.hu/tudomanyos-elet/informatika-folyoirat/34szam-2009>
  9. **CSUKA, A.:** Modelling and Simulation Systems for 21 Century: Informatika, XIII. évf. 2. szám (38.), 2011. június. ISSN 1419-2527  
[http://www.gdf.hu/sites/default/files/informatika\\_38\\_5.pdf](http://www.gdf.hu/sites/default/files/informatika_38_5.pdf)
  10. **CSUKA, A.:** A Föld légkörének hatása a lézernyaláb terjedésére és a továbbított fénytjeljesítményre, Szolnoki Tudományos Közlemények XV., 2011. nov. 10. ISSN 2060-3002  
[http://www.szolnok.mtesz.hu/sztk/kulonszamok/2011/cikkek/Csuka\\_Antal.pdf](http://www.szolnok.mtesz.hu/sztk/kulonszamok/2011/cikkek/Csuka_Antal.pdf)
  11. **CSUKA, A.:** A fény szabadtéri terjedésének elméleti és gyakorlati vizsgálata, Hadmérnök, VII. évf. 4. szám- 2012. december. ISSN 1788-1919  
[http://hadmernok.hu/2012\\_4\\_csuka.pdf](http://hadmernok.hu/2012_4_csuka.pdf)
  12. **CSUKA, A.:** Inhomogén közegben terjedő fény refrakciójának vizsgálata differenciálgeometriai módszerekkel, Professzorok az Európai Magyarorszáért Egyesület IV. PhD konferencia,2012,  
[http://www.peme.hu/userfiles/file/Alkalmazott%20term\\_tud\\_,%20orvosi%20szekci%C3%B3%20.pdf](http://www.peme.hu/userfiles/file/Alkalmazott%20term_tud_,%20orvosi%20szekci%C3%B3%20.pdf)

## 6. PROFESSIONAL CV

<b>Personal information</b>	
First name(s) / Surname(s)	<b>Antal Csuka</b>
E-mail	csuka@gdf.hu
Occupation or position held	Assistant Professor
Name and address of employer	Gábor Denis College- Budapest
Dates	2004-2007
Occupation or position held	Technical teacher
Main activities and responsibilities	Teacher, form-master
Name and address of employer	Budai Middle School- György Szigeti Technical Secondary School- Budapest
Type of business or sector	Education
Dates	2000-2004
Occupation or position held	Service- designer engineer
Main activities and responsibilities	Machine and automation designing, servicing appliances
Name and address of employer	Home enterprise, Szolnok

Type of business or sector	Engineering
Dates	1997-2000
Occupation or position held	Computer –service engineer
Main activities and responsibilities	Installing and maintaining computer hardware and software systems
Name and address of employer	IBUSZ Travel Agency- IBUSZ Holding Co.- Budapest
Type of business or sector	Informatics, Servicing
Dates	1996-1997
Occupation or position held	Bank Security engineer
Main activities and responsibilities	Design of installing the closed circuit camera system
Name and address of employer	Bank Security Rt., Budapest
Type of business or sector	Bank Security
Dates	1995-1996
Occupation or position held	Electrical- designer engineer
Main activities and responsibilities	Designing and maintaining of geological probes
Name and address of employer	Geoport Ltd. ,Budapest
Type of business or sector	Engineer technology
Dates	1993-1995
Occupation or position held	IT Teacher (part time)
Main activities and responsibilities	Teaching medium level IT and technical skills
Name and address of employer	Czeiner- Bükki voluntary school, Székesfehérvár
Type of business or sector	Education
Dates	1992-1995
Occupation or position held	IT Teacher
Main activities and responsibilities	Teaching medium-high level IT skills
Name and address of employer	István Széchényi Technical Secondary School, Székesfehérvár
Type of business or sector	Education
Dates	1990-1992
Occupation or position held	Quality Controller
Main activities and responsibilities	Controlling the quality of refrigerator components
Name and address of employer	Lehel Refrigerator Factory, Jászberény
Type of business or sector	Industry
Dates	1988-1990
Occupation or position held	Coordinator
Main activities and responsibilities	Leading auto and airplane modeling circle
Name and address of employer	House of Learner, Kézdivásárhely
Type of business or sector	Education
Dates	1987-1990
Occupation or position held	Quality Controller
Main activities and responsibilities	Controlling the quality of the metal parts
Name and address of employer	Mechanical Company, Kézdivásárhely
Type of business or sector	Industry

Dates	1985-1987
Occupation or position held	<b>Mechanics and lathe operator</b>
Main activities and responsibilities	Machining of metal parts
Name and address of employer	Mechanical Company, Kézdivásárhely
Type of business or sector	Industry

Dates	1983-1988
Occupation or position held	<b>Technician</b>
Main activities and responsibilities	Servicing radio and TV apparatus
Name and address of employer	Radio TV Co-op, Kézdivásárhely
Type of business or sector	Provision, service

### **Education and training**

Dates	2009-2014
Title of qualification awarded	PhD
Principal subjects/occupational skills covered	Military electronic defense systems, ongoing study
Name and type of organisation providing education and training	National University of Public Service-Hungary
Level in national or international classification	PhD doctoral degree

Dates	2009-2011
Title of qualification awarded	Mechanical engineer
Principal subjects/occupational skills covered	Mechanical engineering master degree,
Name and type of organisation providing education and training	Szent István University- Gödöllő
Level in national or international classification	University- MSC

Dates	2006-2009
Title of qualification awarded	PhD
Principal subjects/occupational skills covered	Military electronic deffense systems,
Name and type of organisation providing education and training	Miklós Zrínyi National Defense University of Hungary
Level in national or international classification	PhD doctoral degree

Dates	1995- 1997
Title of qualification awarded	Technical teacher
Principal subjects/occupational skills covered	Natural and society Science- Education

Name and type of organisation providing education and training	Technical University of Budapest
Level in national or international classification	University complementary study- Master degree
Dates	1995- 1996
Title of qualification awarded	Personal and object security
Principal subjects/occupational skills covered	Security
Name and type of organisation providing education and training	Bank Security Co. –Budapest
Level in national or international classification	Certificat
Dates	1992- 1996
Title of qualification awarded	Electrical -computer engineer
Principal subjects/occupational skills covered	Informatics, hardware and computer systems
Name and type of organisation providing education and training	Kálmán Kandó Technical College of Computer Technology -Székesfehérvár
Level in national or international classification	BSC degree
Dates	1992- 1994
Title of qualification awarded	Electronic Designer
Principal subjects/occupational skills covered	Analog and digital electronics-microcomputer systems (MCS family of single chip computer s
Name and type of organisation providing education and training	Tel Aviv University of Meyerhoff Technical College- TAUTO- Israel
Level in national or international classification	Certificate
Dates	1991- 1994
Title of qualification awarded	Agricultural – mechanical engineer
Principal subjects/occupational skills covered	Mechanical and agricultural electronic systems
Name and type of organisation providing education and training	Agricultural University of Gödöllő
Level in national or international classification	BSC degree

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Antal Csuka

Budapest, 08. szeptember 2014.