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LIGHT INFORMATION FIELD

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***Abstract:** The alternation of light and darkness has accompanied and shaped human development. Light has excited people with its dynamics and impact. Artificial light has gone through various periods of development, with the advent of electric lamps bringing about a revolution in lighting. Initially, light was sought for the realization of a purely functional purpose through routinely applied, standard technical solutions. The development of high technologies created conditions for wide accessibility to artificial lighting - it is not a luxury, but a natural necessity for people. Today, artificial lighting is applied to solve complex visual tasks in production and in normal human activities and is realized through modern lighting design which implies the emergence of a few new concepts one of which is the so-called light information field.*

***Keywords:** Lighting aggression; Light pollution; Visual Glare; Lighting Hygiene; System Lighting Design; Automotive Lighting Metasculpture; Metamobile (Metamob); Light-Fidelity (Li-Fi); Engaged Light; Lighting Metacommunication (LmC); Synchronization and Harmonization; Light Security (LS); Light Informational Field (LIF); Smart cities.*

INTRODUCTION

Through the process of its development, Lighting Design solves not only functional, but also creative problems by means of a set of lighting products and local lighting solutions, to achieve an adequate lighting environment. System Lighting Design is a qualitatively new step in the implementation of contemporary lighting solutions. It reveals the interaction and interdependence of lighting components as a structure and hierarchy in the overall Lighting Organization. System Lighting Design sets a new level of understanding of the lighting environment, where light modeling and light modulation play an essential role.

The human drive for development is limitless. It often brings us back to living nature with its inspiring perfection and engenders a quest for biomimicry. At the same time, this development begins to go beyond normal and socially acceptable norms. A good example is the uncontrolled over-illumination of the environment (leading to the so-called Light Scattering) mainly generated by street and road lighting, which gives rise to a serious attitude of lighting specialists towards the so-called Light Pollution, defined as "Borders" of Lighting Design (Kyuchukov T., 2022). In this regard, the system lighting design allows to achieve high efficiency in the implementation of sustainable lighting solutions. It also has a certain methodological applicability because it provides holistic lighting culture and a rich creative set of tools, with the help of which the lighting designer manages to solve complex problems in lighting and lighting design.

EXPOSITION

1. Development of Automotive Lighting

Light is a herald of beauty and harmony. Contrary to this philosophy and the expectations of the majority, the modern picture turns the night into a day. Light "improvements" of night vision in urban conditions often disrupt the natural rhythm - the starry sky disappears, the 24-hour circadian rhythm is disturbed. The level of intellectual development in the way light is used dictates the course of human civilization.

Contemporary lighting systems are still experiencing their teenage period. Outdoor lighting produces a significant amount of light scattering, which in many cases exceeds the permissible limits. The free distribution of artificial light produced by road (and street) lighting in a combination with the automotive lighting creates the well-known lighting pattern that causes light pollution of the natural environment (Kyuchukov T. (2015 a, b), light pollution of urban areas, incl. systemic visual glare that society still perceives as normal and acceptable (Davis S. et al., 2001; Eva S. et al.; Davis S. et al., 2001; Fonken, LK et al. 2009; Kyuchukov R. 2012; Kyuchukov T., 2015 b, 2018 a). In this regard, the development of a new lighting culture that synchronizes and harmonizes the current conditions is highly necessary.

Exterior automotive lighting has undergone a dynamic development both in technical aspect and in aesthetics. Table 1 presents the evolutionary milestones of the automotive lighting systems (Boyce P., 2014, 2019; Wördenweber, Wallaschek, Boyce, Hoffman, 2007).

Table 1. A historical overview of the development of automotive lighting systems (milestones in lighting).

Year	Stages in the development of the automotive lighting systems
1889	At the end of the 80s of the 19 th century, gas lamps, which can withstand wind and rain, came into use.
1898	Introducing the first electric car headlights.
1908	Use of electric bulb in motor vehicle
1915	Introduction of red tail lamps and yellow brake lights
1919	Introduction of dipped beams against glare
1925	First double filament bulbs for high and dipped beam
1936	Launch of incandescent sealed beam lamp
1940	Flashing turn signal on front and rear with self cancelling
1945	Integration of headlamps into vehicle body
1960	Introduction of first halogen lamp in Europe
1979	Introduction of first halogen sealed beams in US
1983	Introduction of first composite replaceable bulb lamp in US.
1991	Introduction of high intensity discharge (xenon) in Europe
1993	Application of the first LED tail lamps.
1996	Mandatory headlamp levelling in Europe
2003	First steerable dipped beam headlamps
2004	Introduction of the first light-emitting diode (LED) daytime running lights.
2009	Expanding the application of LED lighting in the interior and exterior of cars.

The lighting devices of the motor vehicles are legally established. They are regulated in national and international legal acts mainly related to traffic safety (Burkard, Vallaschek, Boyse, Hoffman, and others). In most cases, they are mandatory and only some of them are optional (recommended), but with legally formulated requirements for them. **Table 2** presents a hypothetical trajectory in the development of exterior automotive lighting, incl. the emergence of the *Automotive Lighting Sculpture* concept, (Traverso M., 2009).

Table 2. A hypothetical trajectory in the development of exterior automotive lighting. Emergence of the Automotive Lighting Sculpture concept.

Stage	Content
I	Application of utilitarian lighting solutions
II	Introduction of legally established and mandatorily installed lights on vehicles, mainly incandescent light sources.
III	Introduction of legally established, but recommended additional lights .
IV	Integration of the light sources into the overall architecture of the vehicle – the headlights follow the aerodynamic shape of the car .
V	The role of automotive exterior lighting is strengthened - firstly, automotive lights improve their functional parameters through the application of new types of light sources and special optics to optimize light output ; secondly, they acquire individuality with the application of various lighting effects following the corporate (company) identity and philosophy of the car manufacturer.
VI	Light decoration (temporary or permanent), in some cases it is implemented by the car owner; in other cases, the light decoration is the work of the car manufacturer.
VII	The appearance of the so-called automotive lighting tuning commissioned by the car owner and carried out by a specialized company for tuning services - serves for corporate, organizational and personal identification of the car.
VIII	Automotive Lighting Sculpture (ALS) – the birth of a new niche in automotive and lighting design. The ALS concept represents a complete lighting design; clear differentiation of the car's day and night vision by applying a systemic lighting design. Introduction of dimmed lighting in the body of autonomous cars.

2. A brief historical overview of the Automotive Lighting Sculpture concept

The *Automotive Lighting Sculpture*, (*ALS concept*) has a history that begins more than a decade ago in late 2005. “*Born beyond existing borders*”, the ALS idea explores a series of conceptual *sculptural and lighting metamorphoses*, and despite the vague picture, the idea manages to overcome psychological

barriers and to make its way on an experimental basis as a modern scientific research avant-guard, (Kyuchukov T., 2018).

In its evolution, the ALS idea develops the image of a *futuristic automotive metasculpture*, which aims to draw attention to the *lighting aggression* on the road. The concept represents the "*lighting metacommunication*" idea that serves as an hypothesis towards the interaction between road and automotive lighting. The concept introduces the image of the so-called *Metamobile (Metamob)*, (Kyuchukov T., 2018) as a hypothetical successor to contemporary vehicles, with the appearance of a new generation of intelligent lighting forming the so called "*Light Semantic Field*" (Kyuchukov T., 2022), hence the vision of the smart cities, **Table 3**.

Table 3. Evolution of the Automotive Lighting Sculpture concept, (Kyuchukov T., 2022)

Concept	Year	Information
Emergence of the ALS concept	2005	A series of conceptual projects on the theme "Automotive Lighting Sculpture" (ALS) has been launched.
A'KIMONO Concept	2006	Building a conceptual model with the integration of non-traditional lighting systems.
	2007	The concept was included in the final selection of the Desire Design Contest 2007 organized by Domus Academy and Style Bertone, Italy.
A'KIMONO LS 2.0 Concept	2008	The new evolutionary concept A'KIMONO 2.0 (inspired by Walter de Silva and dedicated to the German car manufacturer Audi AG) is under development.
	2009	In the first months of 2009, the Automotive Lighting Sculpture concept was published in the leading Italian online website CarBodyDesign (www.carbodydesign.com). A series of publications followed in a number of websites, newspapers and magazines. The A'KIMONO 2.0 concept was included in the TOP TEN STORIES 2009 article of the Italian online journal CarBodyDesign (www.carbodydesign.com), being positioned in third place.
AUDIBLEYES ALS Concept	2009	In the first months of 2009, another evolutionary concept "Audibleyes" was completed, dedicated to the German car manufacturer Audi AG; with the introduction of dimmed lighting.
		The concept received the special award at the second edition of the Desire Design Contest 2009, organized by Domus Academy and Audi. It is published in CarBodyDesign (www.carbodydesign.com).
ATOLLA ABLS Concept	2010	The fourth conceptual model of the Automotive Bioluminescent Sculpture Atolla (Atolla ABLS Concept), inspired by Ettore Bugatti and dedicated to the French car manufacturer Bugatti Automobiles S.A.S., has been completed. The model explores a series of light metamorphoses incl. dimmed lighting
	2011	The Atolla ABLS concept receives the People's Choice Award at RTT Excite, Munich, Germany.
AUTOMOTIVE LIGHTING SCULPTURE	2013	The concept of Automotive Lighting Sculpture is presented in the doctoral dissertation "Systemological and Semantic Foundations of Lighting Design" defended in 2013 at the "Angel Kanchev" University of Ruse.
ΦEEARA Mm concept (Automotive Lighting Metasculpture, Metamobile)	2014 -	The concept pays attention to the lighting aggression on the road (the presence of light pollution and visual glare), The concept presents the idea of light metacommunication (synchronization and harmonization) between road and automotive lighting; introducing the term "engaged" light;
	2018	
VIVALS PERIPHERY	2018	In 2018, the book VivalsPeriphery was published (Vivals Periphery. Manifesto of the sculptural fractal).
	2020	In 2020, the e-book VivalsPeriphery was also published.
	2024	In 2024 VivalsPeriphery. Manifesto of the sculptural fractal, Third Edition was published.
LIGHT INFORMATION FIELD	2018 - 2022	The Light Information Field concept has been published in scientific report called "Evolution of the Automotive Lighting Sculpture concept.",(Kyuchukov T., 2022).

3. The emergence of the Light Information Field concept

Light culture is a priority issue in automotive design. Modern lighting systems follow a general framework: *light – lighting – lighting environment – smart cities*. The culture in lighting design is based on an achieved balance between functionality and aesthetics, defining the purpose of each lighting system. Functional lighting is based on lighting technical standards, according to which the quantitative and qualitative indicators of lighting systems must correspond to the type of visual tasks, therefore, light is applied "*where necessary, as much as necessary*" (Vassilev N., I. Vassileva, 2007; Vassilev N., 2010). This

implies minimal investment, minimal operating (including energy) costs, guaranteed quantity, quality, and safety of functional lighting.

Decorative lighting systems, on the other hand, are dedicated to aesthetics, revealing the beauty of the lighting environment (Vassilev N., I. Vassileva, 2007). The creative freedom of decorative lighting follows its own rules related to the level of information expressiveness and light comfort, which in many cases puts the observer to the test. History, especially the recent, shows that all human activity is in a state of progress, but at a certain point it begins to deviate from socially acceptable norms (Kolev D. 2009; Astronomy calendar 2019; Kyuchukov R., S. Basri, 2008). Modern lighting technologies often lead to a significant violation of reasonable limits (CIE, 2003, 2017) As a result, *light pollution* and *visual glare* are two major problems that still dominate the road (Kyuchukov T., 2012 a, b). Modern lighting culture implies the presence of *synchronization* between road (including street) lighting and automotive lighting, leading to a state of joint work and subsequent *harmonization*, which leads to the emergence of a *synergistic interaction* between the individual lighting components (Kyuchukov T., 2028, 2022), (Fig. 1).

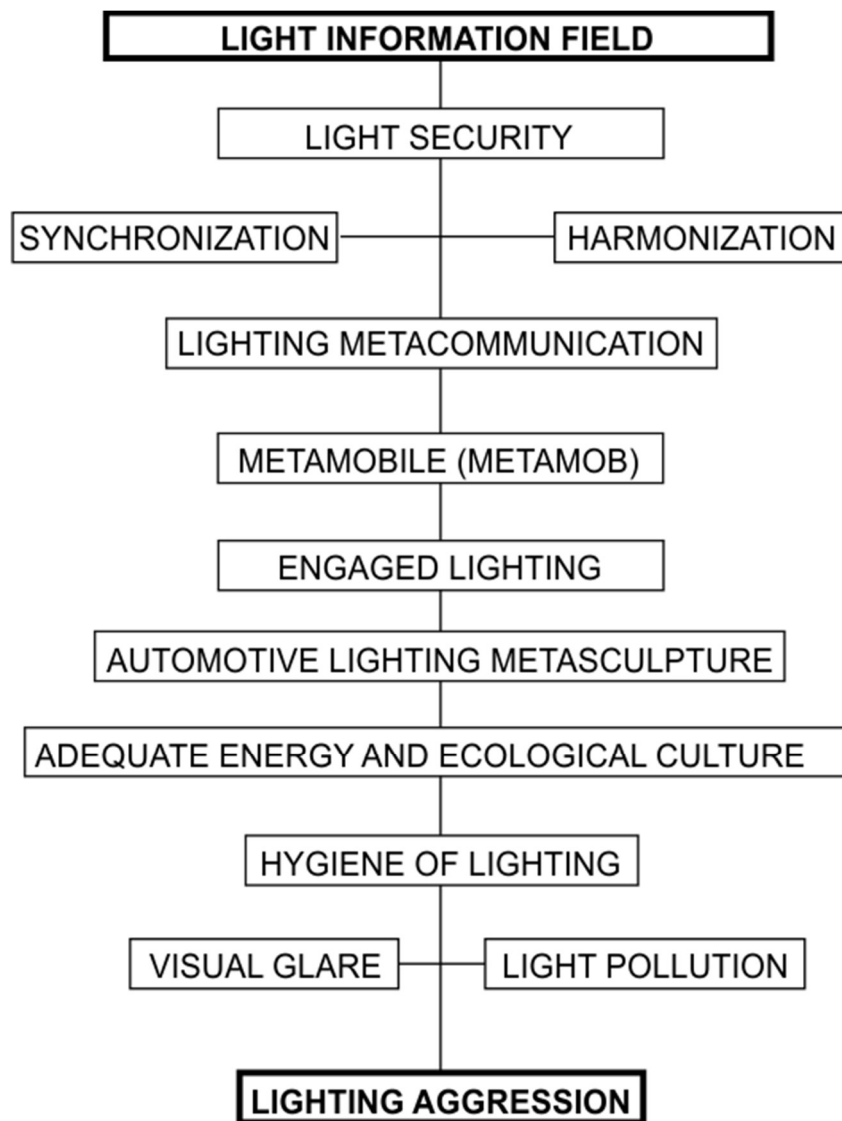


Fig. 1. Evolution of the Light Information Field concept

Synchronization and harmonization are two complementary processes that aim to draw attention to the Measure of the artificial lighting's impact - defining the so-called "*Borders*" of lighting design, as well as the conceptual "overspace" recognized as "*Beyond Boundaries*", where designers often find irrational solutions to existing unsolved problems. The *Light Information Field* concept, (Fig. 2, Table 4, Table 5) is a representative of the approach "*Beyond Borders*" (Kyuchukov T., 2022).

Table 4. Levels of lighting systems' behavior. Borders of Lighting Design. Beyond Borders

BORDERS OF LIGHTING DESIGN	ALPHA LEVEL	LIGHT COMFORT The alpha level represents a rationally organized lighting environment realized through conventional lighting equipment.
	BETA LEVEL	"POVERTY" BORDER A lighting environment characterized by its low illuminance and luminance; cases in which it is difficult to identify objects in space, hence the appearance of the so-called lighting "poverty". "BURNOUT" BORDER A lighting environment which includes the presence of "bright spot", lighting "burnout", leading to the occurrence of visual glare.
	GAMMA LEVEL	EMISSION BORDER: LIGHT POLLUTION The gamma level represents a lighting environment in which the lighting does not follow the principles of harmony, unity, and subordination among the lighting components; light pollution occurs.
BEYOND BORDERS	DELTA LEVEL	LIGHT INFORMATION FIELD The delta level represents the emergence of the so-called "engaged light" leading to the formation of a light information field; light is carrier of arrays of information, which forms the light metacommunication - synchronization and harmonization among individual lighting components; smart cities.

Table 5. Priorities of the Lighting Information Field concept

Components		
1. Light aggression on the road	7. Light security	13. Synchronization, Synergy and Harmonization
2. Visual Glare	8. Light culture	14. Engaged Light
3. Light pollution	9. Light proportioning	15. Lighting Metacommunication
4. Moderation of artificial lighting management	10. Gestalicht. Laws of lighting organization	16. Automotive Lighting Metasculpture (ALmS)
5. Hygiene of artificial lighting	11. System Lighting Design (SATI System)	17. Metamobile (Metamob)
6. Adequate energy and ecological culture	12. "Borders" of light design. Beyond borders	18. Light information (semantic) field

CONCLUSION

The question that still arises is when the average citizen and lighting industry representatives will define the existence of light pollution and visual glare as a harm rather than a benefit. Visual culture is cultivated by creating an adequate lighting environment (Kyuchukov T. 2018 b, c; 2020 a, b). Several international campaigns dedicated to the use of artificial light are essential because they awaken and direct public attention and awareness to the problem of light pollution and its effects. The benefit of these campaigns is not in their demonstrativeness, but in the lack of an adequate energy and environmental culture to match modern high-technology progress. A rethinking of the use of the artificial light is needed, the understanding of *lighting hygiene*, especially when lighting is overdosed and unsatisfactorily managed.

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REFERENCES

- Boyce P. Human Factors in Lighting. Third Edition, CRC Press, ISBN: 978-1-4398-7488-2, 2014.
- Wördenweber B., J. Wallaschek, P. Boyce, D. Hoffman. Automotive Lighting and Human Vision, ISBN 978-3-540-36696-6 Springer Berlin Heidelberg New York, 2007.
- Boyce P. Lighting for Driving. Roads, Vehicles, Signs, and Signals, CRC Press, ISBN - 13: 978-0-8493-8529-2, 2009.
- Traverso M. CarBodyDesign. Top Ten Stories of 2009. <https://www.carbodydesign.com/archive/2009/12/top-ten-stories-of-2009/>.
- Vassilev N., I. Vassileva. Decorative and architectural lighting. Sofia, ABC Tehnika, 2007. Василев Н., И. Василева. Художествено и архитектурно осветление. София, ABC Техника, 2007.

Vassilev N. Problems and perspectives of the capital street lighting, *Energetika*, 2010, № 3. Василев Н. Проблеми и перспективи на столичното улично осветление. *Енергетика*, 2010, № 3.

Vassilev Hr. Quality assessment of the light pollution. Light pollution – essence, symptoms, and reduction strategies. “Light pollution” A national seminar, University of Ruse, Ruse, 2009, (www.cie-bg.org). Василев Хр. Количествена оценка на светлинното замърсяване. Светлинното замърсяване – същност, симптоми и стратегии за ограничаването. Национален семинар “Светлинното замърсяване”, Русенски университет, Русе, 2009.

Vassilev Hr. The light pollution. *Energetika*, 2009, № 8. Василев Хр. Светлинното замърсяване. *Енергетика*, 2009, № 8.

Astronomy calendar. Bulgarian academy of science. Institute of astronomy with National astronomy observatory, (<http://nao-rozhen.org/astrocalendar/2019/index.html>). Астрономически календар. Българска академия на науките. Институт по астрономия с Национална астрономическа обсерватория. (<http://nao-rozhen.org/astrocalendar/2019/index.html>).

Kolev D. The light pollution and the future of astronomy (Institute of Astronomy, BAS) “Light pollution” A national seminar, University of Ruse, Ruse, 2009, (www.cie-bg.org). Колев Д. Светлинното замърсяване и бъдещето на астрономията (Институт по астрономия при БАН), [6]. Национален семинар “Светлинното замърсяване”, Русенски университет, Русе, 2009 (www.cie-bg.org).

Kyuchukov R., S. Basri. Energy-economic indicators investigating the energy efficiency of outdoor lighting systems. University of Ruse, Proceedings, Ruse, 2008. Кючуков Р., С. Басри. Енергийно-икономически показатели при обследване за енергийна ефективност на външни осветителни уредби. Научни трудове на Русенския университет, Русе, 2008.

Kyuchukov T. (2012 a). Basics of light pollution. *Energetika*, 2012, № 2 (ISSN 0324-1521 (www.nek.bg/cgi) (p. 25-37)), Кючуков Т. Основи на светлинното замърсяване. *Енергетика*, 2012, № 2 (ISSN 0324-1521 (www.nek.bg/cgi) (стр. 25-37)).

Kyuchukov T. (2012 b). Contemporary street lighting, TD Installations, Sofia, Bulgaria, 2012, № 3 (ISSN1314-3492) (p. 24-27). Кючуков Т., Съвременно улично осветление, ТД Инсталации, София, България, 2012, № 3 (ISSN1314-3492) (стр. 24-27).

Kyuchukov T. (2015). Lighting Design (monography). Mediateh – Pleven 2015, ISBN:978-619-207-001-4, (стр. 221-222). Кючуков Т., Светлинен дизайн (монография). Медиатех-Плевен, 2015, ISBN:978-619-207-001-4.

Kyuchukov T. (2022) “Borders” of Lighting Design. Beyond Borders. Mediateh-Pleven ISBN: 978-619-207-252-0 („Граници“ на светлинния дизайн. Отвъд границите. ISBN: 978-619-207-252-0, Медиатех-Плевен) 2022.

Kyuchukov T., (2018). VivalsPeriphery. Manifest of the Sculptural Fractal. Mediateh-Pleven, ISBN 978-619-207-130-1, 2018.

CIE 150 2017, Technical Report. Guide on limitation of the effects of obtrusive light from outdoor lighting installations. CIE, (ISBN:978-3-902842-48-0), (<http://www.cie.co.at/publications/guide-limitation-effects-obtrusive-light-outdoor-lighting-installations-2nd-edition>).

CIE (2003), Guidelines on the limitation of the effects of obtrusive light from outdoor lighting installations. Publication No.150, Vienna, CIE, 2003.

Davis Scott, Dana K. Mirick, Richard G. Stevens (2001). Night Shift Work, Light at Night, and Risk of Breast Cancer". *Journal of the National Cancer Institute* , 2001, № 93 (20) (p.p. 1557–1562).

Eva S. Schernhammer Eva S., Francine Laden, Frank E. Speizer, Walter C. Willett, David J. Hunter, Ichiro Kawachi, Graham A. Colditz. Rotating Night Shifts and Risk of Breast Cancer in Women Participating in the Nurses' Health Study. *Journal of the National Cancer Institute* , № 93 (20) (p.p. 1563–1568).

Fonken, LK; Finy, MS; Walton, James C.; Weil, Zachary M.; Workman, Joanna L.; Ross, Jessica; Nelson, Randy J. (28 December). "Influence of light at night on murine anxiety- and depressive-like responses". *Behavioral Brain Research*, 2009, № 205 (2) (p.p. 349–354).

Kyuchukov T. (2015 a) A methodology for assessing and managing light pollution in lighting design. *Ecologica*, Beograd, 2015, № 78, Godina XXII (p.p. 315-320), (ISSN 0354-3285).

Kyuchukov T. (2015 b) Light pollution and lighting design, *Ecologica*, Beograd, 2015, № 79, Godina XXII, p. 356-350, ISSN:0354-3285.

Kyuchukov R., T. Kyuchukov, The Light Environment in Bulgaria (Invited paper). *BalkanLight 2012*, Proceedings, Publisher: Academic mind, Belgrade, 2012, p. 165-171, ISBN 978-86-7466-438-4.

Kyuchukov T. (2018 a) Light pollution and its price. The Seventh Balkan Conference on Lighting, *Balkan Light 2018.*, 20-22 september 2018, Varna, Bulgaria, Proceedings, ISSN 2603-414-X, p.p. 33-41.

Kyuchukov T. (2018 b). Culture of Quality of The Education in Lighting Design. Personalization and Individualization. FRI-K1-1-QHE-17. PROCEEDINGS OF UNIVERSITY OF RUSE-2018, volume 57, book 9, Ruse, Bulgaria.

Kyuchukov T. (2018 c). Culture of Quality of The Education. Borders of Lighting Design. Beyond Borders. FRI-K1-1-QHE-16. PROCEEDINGS OF UNIVERSITY OF RUSE-2018, volume 57, book 9, Ruse, Bulgaria.

Kyuchukov T. (2020 a). Esiah Concept. On the Road to European Academic Doctrine (FRI-ONLINE-1-QHE-15), Proceedings of University of Ruse - 2020, volume 59, book 9.1. ISSN: 1311-3321.

Kyuchukov T. (2020 b). Academic Doctrine of Light. Esiah Concept (FRI-ONLINE-1-ID-04) Proceedings of University of Ruse - 2020, volume 59, book 1.1. ISSN: 1311-3321.