

EDITORIAL

## A tribute to Marat Soskin

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## Editorial

# A tribute to Marat Soskin

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## Knight of science

Stanislav Soskin

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My father was a great enthusiast of science. He liked to metaphorically state during our philosophical discussions: 'My god is science.' Though I disagree with such a position, I appreciate his commitment to science (particularly to physics), its ideals and ethics. During my school time, his enthusiasm played a major role in the formation of my intention to become a researcher in physics.

Marat was born in Kiev in 1929 in the secular Jewish family. Both his parents graduated from the chemistry department of Kiev University, and then started working as teachers in a school. But Marat's mother Faina realized that her husband Samuel had a potential for an engineering work and convinced him to move to a shoe industry, where he then manifested himself as a talented engineer and manager: he organized the first chemical laboratory in the shoe industry of Ukraine, made a number of inventions in the industrial processing of leather and had grown to a position of a chief engineer of a large shoe factory by the end of the 30th. The latter provided his and his family evacuation from Kiev prior its occupation by the Nazi troops in September 1941, that saved them from the death in Babiy Yar.

After the return to Kiev, Marat graduated with honors (the golden medal) from a high school in 1946. His mother was urging him to enter the medical institute but Marat had preferred physics and entered the physics department of Kiev University, from which he graduated with honours in 1952. Because of a strong state antisemitism in the USSR that time, he could not get to the academia and had to work first as an engineer at a plant in Donbass and then as a school teacher in Kiev. Only in 1956, he was accepted to the Institute of Physics in Kiev as a PhD student of Academician Antonina Prihot'ko. This was a beginning of his remarkably long, rich and productive scientific life. His achievements were highly appreciated by many great scientists in the world: two of the founders of the laser physics Nobel Prize Winners Alexandr Prohorov and Nicolai Basov, Sir Michael Berry famous owing to his outstanding achievements in quantum physics, in the theory of waves and in many other fields, one of the most famous opticians Emil Wolf, Yuri Denisyuk being one of those who laid foundations of holography, and many others.

Main scientific results of my father and the creation by him of the school of scientists many of whom have become internationally renowned scholars is described by other contributors to the article as well as by Prof. Mikhail Vasnetsov in his paper in the present issue while I will concentrate on different sides of father's life which provided a background for his work on science.

In 1958, Marat married Elena Losinskaya, who bore me in 1960. When mum was not ill, she provided as good conditions for dad's work as she could. Perhaps it was my mum due to whom my deep respect towards a scientific work

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Samuel Kaplan. *Portrait of physicists. The USSR State Prize Winner M.S. Soskin with the son Slava.* Charcoal, pencil, sanguine. 1982.

originated yet in my early childhood: the dad often was writing his papers at home and, as soon as I was starting to produce noise at such time, my mum shouted at me: ‘Stop noise: it prevents the dad to concentrate on his scientific work!’ The mum was absolutely devoted to her husband, and it is symbolic that, when the tragic accident occurred in 1992, namely when a bus drove from the road to the pavement along which the parents were going, the bus first hit the mum so that she weakened the hit for the dad, that saved him the life while mum’s injuries turned out fatal.

The tragedy greatly depressed him but the work was gradually healing him. Furthermore he met Lyudmila Dibner in 1994, who later became his wife, that additionally inspired him. Altogether, he vigorously continued the journey into the exciting field of optics which he called ‘Singular Optics’—the field which became his favourite one in the last part of his life and brought him a lot of enjoyment, new scientific links, new friends and more fame.

It is worth saying that my father was a broadly educated person. He well knew and liked literature, music, cinema, theatre, photography, art, and so on. Up to the beginning of his sixth decade, he liked hiking, fishing, mushrooming, and many other kinds of a physical activity. In a sense, he was a man of the Renaissance, and it is symbolic that just he (together with his colleagues Alex Goncharov, Grigory Galich and Sergei Odoulov) inspired his friend Nicolai Storozhenko, often called by art critics as ‘Ukrainian Michelangelo’, to create in 1981 a monumental panel in the Institute of Physics reflecting the history of physics. Curiously, there was a ‘gratitude’ from one of the main characters of the panel, namely Galileo Galilei: the father was awarded in 2009 with the ‘Galileo Galilei’ medal by the International Commission on Optics.

My father’s characteristic would be incomplete if I did not mention his excellent sense of humour: he liked joking himself and enjoyed good jokes by others.

He was also a happy grandfather, loving his grandson Daniel and granddaughter Elina and being loved and respected by them. He was proud by their achievements and supported their studies.

There is a characteristic tendency in the evolution of male representatives of the Soskin genealogical tree. The father of the father of Marat was engaged in a physical labour, Marat’s father was an engineer, Marat was a physicist-experimentalist, his son is a physicist-theoretician, and Marat’s



Marat with his parents and 3-years old sister. Kiev. 1940.



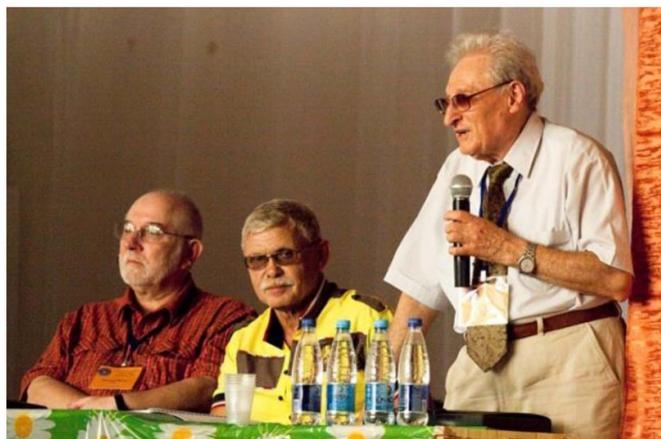
Marat demonstrates his unique interferometer for studies of crystals at low temperatures to the Nobel Prize Winner Pyotr Kapitsa and his son Sergei. Kiev. 1971.

grandson has started a research in pure math. Perhaps a physical work and an intellectual one were best of all balanced just in Marat's life.

My father was a happy person for most of his life, except possibly the few last years, when the disease deprived him of a possibility to do a scientific work. But



Mum, dad and me. Kiev. 1962.



Upper: the party in father's flat in Kiev in October 1997 on the eve of the 1st conference on Singular Optics (in Partenit). From left to right: Prof. Norman Heckenberg, Prof. Michael Berry, Prof. Grover Swartzlander, my wife Larisa, me, father's wife Lyudmila and the father.

Lower: at the 5<sup>th</sup> conference 'Singular Optics' (Sevastopol, September 2012). From left to right: Prof. Michael Berry, Prof. Alexander Volyar and the father.



Nicolai Storozhenko. *Illuminated by light*. Colored wax encaustic frescos under the cupola of the Institute of Physics. Kiev. 1981.



A print bought by my father in Paris, which hung on a wall in his office. It is one from the satirical series about a social life in Paris in the early XIXth century. The print shows the frivolous lesson on the game called 'Diabol'. The reason why he hung it in the office was perhaps an allusion to the optical diabol—one of the key concepts in Singular Optics which the father experimentally studied.



Marat with the grandchildren. I shot this photo in my flat on the 3rd of January 2005 (using his camera) and it was presented to us by him with the inscription '*The eaglet and the little dove*'.

even then he was very enthusiastic about any scientific news. I think that my father was a true Knight of Science.

### **Remembering Marat Soskin**

Michael Berry

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What follows is not a scientific biography of Marat Soskin. It is personal: an account of the mutual inspiration and influence between him and me, and, more generally, the optics research of the Bristol group, especially John Nye and later Mark Dennis.

In 1996, Marat wrote asking if he could visit us in Bristol and speak about his research. At that time I did not know him, and was only dimly aware of his work. We agreed to welcome him, and he stayed several days in my home. His talk was not easy to follow, mostly for linguistic reasons, but we understood that he had devised a way of creating phase singularities using fork holograms. In discussions after the lecture, we learned that he and his group in Kiev were energetically pursuing a substantial programme of research, creating and exploring optical phase singularities.

We reacted enthusiastically to what Marat told us. To understand why, I need to backtrack. In 1974, John Nye and I published our paper introducing phase singularities as a generic feature of waves of all kinds. At that time, we called them wavefront dislocations; now it is more common to refer to wave vortices; the terms are equivalent. This collaboration with Nye was important for me: in my unusual scientific trajectory, he was the only senior scientist with whom I enjoyed a serious collaboration.

We hoped our paper would provoke some interest. Instead, the scientific community's response for a number of years was: silence. In Bristol, we and our colleagues continued to study these geometrical features. Michael Walford invented a cardboard version of what was much later called a spiral phase plate, to generate screw dislocations in ultrasound; he did not think it worth publishing. Nye and I, separately and together, continued to study phase singularities, in quantum physics and in the optical interference patterns decorating geometrical caustics. Outside Bristol, it was only in the 1980s that Boris Zeldovich and colleagues in Moscow noticed our paper and wrote about wave dislocations in optical speckle; nevertheless, the subject did not catch fire. After Marat's work, it did: research on phase singularities became an active area of experimental optics.

Marat invited me to a meeting in Partenit, Crimea, in 1997, devoted to this new area of the physics of light, for which he introduced the term 'singular optics'. Arriving in Kiev, I was taken to Marat's apartment, where I enjoyed his and Lyudmila's generous hospitality, and had the pleasure of meeting Norman Heckenberg, also Slava Soskin. We travelled together to Simferopol and from there to Partenit.

Marat's meeting was memorable in several ways. The setting, on the Black sea, was magical. We stayed in what had been a holiday centre/sanatorium for Soviet military personnel. Something of the Soviet mentality lingered; in the restaurant, the waiters noted where we sat on the first day, and insisted we always sit at the same table thereafter (we did not). More importantly, I met other people studying phase singularities. By then, the subject was being investigated worldwide, by scientists from Australia, USA, Russia—and mostly Ukraine, where, in addition to Kiev, there was singular optics activity, inspired by Marat, in Simeferopol, Chernivtsi, and Odessa (where my paternal grandparents had lived almost a century earlier). I can speculate on the reason for this concentration in Ukraine. In those years following the collapse of the Soviet Union, funds for science were scarce, so the only areas of experimental research that could be successfully pursued were those satisfying two criteria: not needing expensive equipment, and requiring imaginative and ingenious people. Singular optics and Ukraine were a perfect fit.

At the conference, several confusions in this fast-developing subject were clarified. Phase singularities had been considered as points in observation planes (usually perpendicular to a paraxial beam propagation direction), with attention focused on the events where they were created and annihilated pairwise. It was not appreciated that in three dimensional space the singularities are lines, usually curved, and the 'events' simply occur where dislocation curves touch the observation plane: they are artefacts, determined by the choice of location and orientation of that plane. Orbital angular momentum (OAM) of light was a fundamental aspect of optics, then developing in parallel with singular optics, and there was (and occasionally still is) the opinion that phase singularities are inevitably associated with the OAM of optical beams. But such an association only applies to beams that are eigenstates of OAM; in general, the two concepts are distinct.

Meeting Marat in Bristol, and visiting Partenit, influenced me in two ways. It kick-started a return to singular optics; I had not worked on this subject for a long time because I thought it was done and dusted, but after Partenit I realised that

much remained to be understood. And when Mark Dennis came to Bristol as a Ph.D student in 1998, it seemed a good idea to suggest we work together on singular optics. This rapidly turned into a productive collaboration, continuing while Mark left Bristol and then returned as a colleague for several years. Mark also made many important contributions of his own, and initiated collaborations with many other scientists worldwide. None of this would have happened without the stimulus from Marat.

The renewed singular optics theory stimulated Marat's experimental research to evolve in new directions. He soon understood that dislocations do not need to be created deliberately; they are inevitable features of optical fields that occur naturally ('in the wild'), and provide a skeleton of such fields. Therefore he switched his research to generate random fields, and test theoretical predictions by measuring the statistical properties of their phase singularities.

The Partenit meeting spawned a series of others in Ukraine. I attended several: in Alushta, in Sevastopol, in Kiev, and, after the Russian takeover made Crimea a difficult venue, in Chernivtsi—thanks to Oleg Angelsky, who generously expanded his 'correlation optics' meetings to include singular optics.

The Kiev conference, organised with Marat and Mark and supported by NATO, was memorable in several ways. It was the only meeting in the series that John Nye was able to attend; his eloquent presentation, questions, and reminiscences, were highlights. The location was the Bogolyubov Institute on the edge of the city, surrounded by forests. One night, expensive cars appeared, watched over by intimidating minders. It turned out that the owners—even more intimidating gentlemen whose business seemed unconnected with science—were frequent visitors to the Institute restaurant. They talked loudly throughout our conference dinner and the accompanying speeches; nobody had the courage to ask them to be quiet. The UK Institute of Physics, through the *Journal of Optics*, contributed to the meeting by supplying conference bags; these were delayed by Ukrainian customs, who demanded a 'certificate of ecological cleanliness'. Marat managed to overcome this obstacle; I did not ask how.

As originally conceived by Marat, his term 'singular optics' was too restricted in scope. Phase singularities referred to wave optics in the scalar approximation. Already in 1987 Nye and his student Jo Hajnal had discovered the corresponding singularities in vector light: C lines, on which the polarisation is purely circular, and L lines on which the polarisation is purely linear. Their seminal contribution was not appreciated at first, but when Marat learned about it he redirected his research towards the exploration of polarisation features in the wild, thereby extending 'singular optics' to include both scalar and vector waves and the connections between their singularities. This is the current usage, but it is still too narrow because it ignores the caustic singularities of the rays of geometrical optics; properly understood, 'singular optics' should refer to singularities at all three levels (also quantum optics, if natural singularities emerge there).

Over the quarter-century during our scientific and personal friendship, at the conferences and in extensive correspondence, I enjoyed Marat's unique personal style. He was respectful, sometimes to a degree bordering on exaggeration. His questions often appeared naive but his quiet insistence uncovered matters that needed to be understood, sometimes leading to new theoretical research directions.

No senior scientist could survive so many years of the Soviet Union without being able to manoeuvre through bureaucratic labyrinths, and Marat developed a canny political awareness. World War II loomed large in his consciousness; the anniversary of its end, hardly celebrated in the West, always brought this message from him and Lyudmila: 'Our hot congratulations on Victory Day!'

He had a idiosyncratic sense of humour. Ending one of his messages, he mentioned my wife: 'Best wishes to Monica (not Monica Lewinsky!!!)'. And his

political insight contrasted with a endearing innocence in other areas. Each conference bag for the Kiev meeting contained a frisbee, stamped with an invitation to publish in the *Journal of Optics*, prompting Marat to ask: ‘Please, what is function of plastic disks?’

John Nye died a year before Marat. The passing of these two unusual scientists, original in their different ways, is a double blow to our beautiful singular optics. But, thanks largely to them, the subject has passed its adolescence and is now fully alive and a flourishing area of research worldwide.

Until recently, I was not aware that Marat had a productive and distinguished career in optics for several decades before the 1990s. It is all the more impressive that his research on singular optics began in the autumn of his scientific life. He was an influential scientist and a unique personality. I miss him

### **Etienne Brasselet**

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Mentioning Marat Soskin brings my thoughts back to the 4th International Conference on Singular Optics held in Alushta, Ukraine, in 2008. It was the time of my very first steps into a research field—Singular Optics—that will remain as part of his scientific legacy. I remember him showing continued curiosity about shared results dealing with optical singularities of liquid crystals. It was him who prompted me to pay attention to C-points embedded in the elliptically polarized inhomogeneous fields emerging from liquid crystal topological defects, the kind of request you can hardly decline(!) As time went by, I had the opportunity to appreciate his love of experimental details, not only through discussions at conferences but also from his email requests having for object a simple but powerful word, *Science*, which is certainly something he was living for.

### **Isaac Freund**

Physics Department, Bar Ilan University, Ramat Gan, Israel

When I first became interested in polarization singularities I contacted Marat Soskin. The pioneering papers by John Nye, and Nye and Hajnal at Bristol, that introduced these singularities were too theoretical for me, and I found that I could not really understand them. Marat and his coworkers, on the other hand, had just published a highly accessible paper on experimental measurements of these singularities that I could understand—at least in part. Consultation soon evolved into friendship and collaboration, and over the years, Marat, his talented students and coworkers, and I, jointly published nine papers. The luster of Marat’s name was such that all but one appeared in *Optics Letters*—the single exception in *Physical Review Letters*.

Marat was the quintessential experimentalist. He understood and appreciated theory, but whereas theory could suggest what might be, only experiment could say what actually is. In Marat’s own words, theory was ‘paper vortices’, experiment real ones.

Of course, not every collaboration yielded a paper. I had become enamored of the idea of experimentally generating and measuring a vortex fractal. Marat, with his unerring instincts was skeptical. Rightly so it turned out, because analysis showed that the fractal was so unstable that it would immediately explode into a large number of ordinary vortices. So, not a real vortex, but a tissue paper one (Marat actually used a somewhat ruder term).

Marat was always straightforward, and usually serious, but could be charming and wryly amusing when he wanted to. His many talents served him well as he shepherded his Institute through difficult political and economic times, and placed it front and center on science’s world stage.

Marat's magnificent scientific legacy ensures him a large measure of the immortality that, truth be told, scientists aspire to. A dear friend and colleague has passed away, but fond memories live on in the hearts and minds of his many admirers.

### **Boris A Malomed**

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Although I have never had a chance to personally meet Prof. Marat Soskin, I was very well aware of his works which played a pioneering role in theoretical and experimental work on the fundamentally important research area known as *singular optics*, that deals with optical vortices as robust objects that naturally produce phase singularities at pivots of the vortices. Prior to the advent of vortices, earlier generic classes of singularities in optics were identified still in the 19th century, such as caustics produced by intersections of light rays in the framework of geometric optics [1]. A milestone in establishing the concept of singular optics as a new branch of modern photonics, with emphasis on vortices, was publication of review article [2] coauthored by Prof. Soskin. The great impact of that review is attested to by the fact that it has been cited 878 times, according to Web of Science. Studies of optical vortices have also helped to put forward closely related concepts, such as angular momentum carried by optical beams [3], and *topological photonics*, dealing with optical fields characterized by topological charges [4] (integer numbers which, in particular, are identical to vorticity carried by the fields).

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### **Valery Aksenov**

IAO SB RAS, Tomsk, Russia

For the first time, the ups and downs of scientific life brought me in contact with Marat Soskin in spring of 1997. He and the team of his scientific companions prepared for organization of the International Conference on Singular Optics in the Crimean village of Partenit. At this time, I was finishing the work on my doctoral thesis and negotiating with the staff of the International Laser Center (ILC) at the Moscow State University, figuring out whether the ILC could take on the role of an opposing organization. Upon reviewing generally my doctorate, ILC representatives tentatively agreed to oppose. However, after finding out that a part of my thesis was devoted to the search for ways to reduce the distorting effect of wavefront dislocations on the propagation of laser beams in a turbulent atmosphere, they advised me to pre-test my findings with Professor Marat Soskin at the upcoming international conference. By this time, I only knew Marat Soskin as a distinguished, honored scientist and an author of publications on holography and lasers. I called Marat to Kiev, and his response was favorable: it turned out that, although the deadline for report submission has expired, I could bet that my report would be included in the conference program, but only as a poster presentation. I remember I was puzzled that a person with a long-standing scientific reputation, Corresponding Member of the Ukrainian Academy of

Sciences, courageously generates a vortex of scientific and organizational events, ideas, new problems, and discussions in the stable scientific space and involves both young scientists and experts in this vortex. There were only few such personalities among the scientists around me. Being one of the founders of the new research field—singular optics, Marat Soskin himself was an actual human singularity.

Then there were a lot of conferences at which we met with Marat Soskin: in the Crimea, Kiev, Chernivtsi, and St. Petersburg, where we discussed briefly scientific problems and issues of everyday life, which worried both of us. Marat was a participant and a witness of the fundamental events associated with the foundation of the Institute of Atmospheric Optics, now named after Academician V.E. Zuev, in Tomsk, in Siberia. He visited Tomsk on business. He was a storehouse of stories about unknown details of these seemingly well-known events and about the legendary personalities contemporary with him. It was a real pleasure to listen to him. It is impossible not to mention our joint research projects, one of which finally received grants from the Russian and Ukrainian Foundations of Basic Research and was successfully completed.

Both in scientific activity and in a series of ordinary affairs, my attention was always attracted by his enthusiasm and energy, his ability to be included in details of all that was happening. The last time I heard his voice by phone in late 2016, when I reported to him about the success of my advisee doctoral candidate.

It is sad. The human vortex Marat Soskin has ceased to exist. But his aftereffect will leave a trace in our memory for a long time and have an impact on the fate of people and a string of noticeable and ordinary events.

### **Carmelo Rosales-Guzmán**

Harbin University of Science and Technology

I became interested in optical vortices while I was an undergraduate student. At that time, I had no idea of who Prof. Marat S. Soskin was, but, to my fortune, I came across his paper ‘Topological charge and angular momentum of light beams carrying optical vortices’. It was in this article that I read the term singular optics for the first time, and I soon realized I was in front of a fascinating subject. Since then, I have read most of his articles on singular optics, and have been working now for over ten years in the field. I am certain his legacy will continue attracting the interest of future generations and inspiring the advancement of this alluring topic.

### **C N Alexeyev<sup>1</sup>, A N Alexeyev<sup>2</sup> and M A Yavorsky<sup>1</sup>**

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*‘...And the hunter home from the hill’*

The demise of Marat Samuilovich is an irreplaceable loss for all physical science. Speaking in John Donne’s terms, without him Europe is the less. As for its minor part, he was like a sun for us and we orbited in the embraces of his scientific gravity bathing in his very specific charisma and charm. Because of the known spring events, the Crimean branch of singular optics has somewhat been displaced to the periphery of his ‘solar system’. Yet, we remained its members and, maybe, this very remoteness enables us to perceive his true value. I do not think he was an easy man. At least, he was not supposed to, especially, with respect to us younger researchers. But he always was, using Pasternak’s words, a

‘genius of an unchildish discipline’, who has taught us with his notional ruler scientific rigorousness and honesty.

Now that his sun is down, what remains is the memory of its brilliance scattered over the shards of our reminiscences, the gospel of his life expanded over the books of our impressions. Let it be the complete system that will help us to preserve his personality as it was. As for our part, we shall remember his incredible intellectual stamina that carried him through the longest and obscurest conference talks ‘in full mind and memory’, long after the younger participants had switched off. We shall remember his ability to understand an author’s result better than the author himself. Soskin’s role in Ukrainian singular optics is best illustrated by an episode with M. Ya. When I (C. N. A.) while presenting him to Soskin made a high appraisal of Maxim’s accomplishments, Marat Samuilovich peered at him and—half-jokily—asked:—‘Maxim, maybe its high time to make acquaintance with you?’ This reminds me of the known quotation of Russia’s Emperor Paul the First: ‘In Russia, a nobleman is the one with whom I speak and until I speak with him’. And indeed, for us Soskin was such an emperor of singular optics.

We have titled our tribute note with an auto-epitaph by R. L. Stevenson. We want to believe that Marat Samuilovich has returned to his homeland, where the Reason presides, and where he will always be by His throne as His dutiful and devoted servant.

### **Liliya Tryfonyuk<sup>1</sup> and Alexander Ushenko<sup>2</sup>**

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*Polarization-singular approach in biomedical optics, inspired by Marat S. Soskin* Marat Soskin, when in the process of familiarizing himself with our research in the field of biomedical optics, put forward the idea of using a singular approach in the analysis of polarization-heterogeneous images for the diagnosis of pathological conditions of tissues of human organs. To implement this idea, a scientific group was formed under the leadership of Liliya Trifonyuk, which included opticians from the Chernivtsi National University and oncologists from Department of Urology at Rivne Regional Hospital. Two statistically significant groups of histological sections of benign and malignant prostate tumors were chosen as an object of polarization-singular research. Excellent accuracy was obtained (>90%) of the polarization-singular differential diagnosis of benign (adenoma) and malignant (carcinoma) prostate tumors. Such encouraging results were further developed in optical diagnostics of various pathological conditions of biological tissues and fluids of human organs using the polarization-singular approach. We remain grateful to Prof. M. Soskin for his enlightening advice which stimulated the development of an important instrument in biomedicine.

### **David L Andrews**

University of East Anglia, United Kingdom

It was a great privilege to become personally acquainted with Marat, relatively late in his expansive and distinguished career. Our first encounter was at one of the annual conferences on Complex Light and Optical Forces, at Photonics West in San Francisco. I well recall his own presentations, but more especially his incisive and assertive questions following many other talks. I was delighted when he accepted the invitation to join the conference Program Committee and he remained a regular, committed participant for many years, until health issues made travel more difficult. But we still remained in email contact, and I greatly

valued his always enthusiastic support. His keen intellect and insights into physics will seldom be matched, but above all I miss the kind warmth that was a special hallmark of all his personal communications.

### **Lluís Torner**

ICFO, Barcelona

Prof Marat Soskin visited us in Barcelona, together with Prof Misha Vasnetsov, around the year 2000. We had studied several of his seminal research papers about the experimental creation of optical vortices using phase masks and admired his contributions to singular optics in general, therefore his visit was a much-awaited event for our young group. During his stay, I specially recall the discussions we had about different aspects of classical wave optics, in particular about holography, interference phenomena and singular optics in general, topics in which he clearly showed a profound knowledge and experience. I recall Marat talking to us with a deliberately precise rhythm, explaining everything in great detail. I had an early heads-up about his care for accuracy during the preparation of his visit, as he insisted in planning everything in full detail well in advance. We all remember when, at arrival, he made a point about agreeing first on all the practicalities and also in not to waste funding in unnecessarily expensive meals. I also recall his profound interest in painting and the joy he experienced in describing to us his favourite pieces, several of which were on display in El Padro Museum in Madrid. My professional life switched gears a few years after his visit, thus we did not have much chance to meet again. My collaborators and I have fond memories of his visit to our laboratory and his legacy still influences our research about the foundations and applications of optical vortices and the orbital angular momentum of light.

### **First impressions: tribute to Marat Samuilovich Soskin**

Anton Desyatnikov

Nazarbayev University, Kazakhstan

Early July of 1998 turned out to be exciting and memorable, not the least because of Marat Samuilovich (MS). As a freshly admitted PhD student I attended the conference ICONO'98, my first international meeting. Most of the talks I could not follow, lacking both English and competence. One talk, however, by late Prof. Anatoly P. Sukhorukov, discussed 'soliton spiraling' in quadratic media, when two interacting skewed laser beams form a two-body system with orbital angular momentum (OAM). After the talk, a small senior Professor raised from the first row, half-turned to the audience, and with a loud and confident voice involved all of us there into conversation with a single 'I do not understand, please explain!'. As much as the word 'skew' was in question, I think the notion of OAM without vortices was new to MS at the time.

I was thrilled. My supervisor Andrei I. Maimistov and I expected the proofs of my first ever paper to be delivered by mail soon (hard-copy only, last century). We considered an approximate analytical model of spiraling in Kerr media. However, the term 'spiraling' was not familiar to us, our access to journals was limited. Nevertheless, I could understand what prominent professors discussed with such enthusiasm! The most exciting was to realize that my exotic little problem was something of real scientific interest, maybe even of some importance.

It happened that the journal office was within 10 minutes' walk from the conference venue, but it was already closed. Next morning, with large scissors, we cut the proofs from a huge roll of freshly printed journal issue. I ran into MS in an elevator and started to talk to him about his question yesterday, trying to provide my version of an answer. Confusing as it was, MS graciously listened to my mumblings and thanked me for the explanations and the manuscript. This

short exchange with MS was my first ever independent scientific communication.

Ten years later, at one of the Singular Optics conferences, I witnessed how contagious was his passion to Singular Optics. I was not the only victim; a whole international and very diverse community was captured by it. Genericity of phase singularities, their topological stability, and, of course: ‘The high-charge vortices do not exist!’—with great force and enthusiasm MS was able to turn an after-talk discussion into an intense dispute.

The energy and personality of MS greatly influenced, if not defined, the development of Singular Optics. He certainly made unforgettable my personal first impressions of scientific life.

### **Yoko Miyamoto**

Department of Engineering Science/Institute for Advanced Science, The University of Electro-Communications, Japan

I first became familiar with Professor Soskin’s work as I started studying vortices in the 1990’s. He was one of the first to report on vortex generation with a forked hologram [V. Yu. Bazhenov, M. V. Vasnetsov, and M. S. Soskin: JETP Lett. **52** (1990) 429], used by many experimentalists to this day. However it was when I started attending the Correlation Optics conferences in Chernivtsi that I made his acquaintance. I remember that my first talk in 2011 was met with criticism and that Professor Soskin took issue with my terminology, but he graciously reached out to me afterwards and a friendship was formed. Since then I have looked forward to our personal exchanges at the conference, and was worried when he did not attend last year. It has saddened me greatly to hear of his passing. He will be sorely missed.

### **Oleg Angelsky**

Chernivtsi National University, Ukraine

Professor Marat S. Soskin was one of the ideologists for the development of holography, correlation and singular optics in Chernivtsi, Ukraine.

He was also one of the initiators of creating and supporting of international scientific conference of Correlation Optics in Chernivtsi, which was held 14 times during last 28 years on the base of Chernivtsi National University. This laid the foundation for international cooperation as the ground for the development of correlation and singular optics in Chernivtsi University and whole in the world.

I remember his words that were addressed to me many times, stimulating development: the attainable level must be raised higher and higher, otherwise stagnation will occur. And the team is behind you.

Marat Soskin possessed the exceptional qualities of a persistent and deep researcher. A case in point can serve as evidence of this. It happened at our conference Correlation Optics, when for the first time we demonstrated the possibility of visual observation of an interference fork in a speckle field. It was at the dawn of conducting research in the field of singular optics. The materials presented by the speaker did not call Prof. Soskin confidence reaction. He demanded to prove this effect in the laboratory. During the night, the interference pattern was restored and the effect was seen ‘live’. The result of this discussion and observed phenomena was published by Angelsky *et al* (1991) [1].

I think this example was one of the stimuli for the study of singular optics.

And I appeal to the entire scientific community: Let us support the continuation of the traditions of the Correlation Optics conference, the topic of singular optics in the future in Chernivtsi. It will be a worthy tribute to the memory of Marat Soskin.

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### **Peter Banzer**

Max Planck Institute for the Science of Light, Germany

The sadness triggered by Professor Soskin's death can hardly be put into words. I had the great pleasure and honour to attend several of Professor Soskin's presentations on conferences and workshops. His ideas and broad research interests, inspiring generations of researchers world-wide working in various areas, have sparked the birth and rise of new research fields and the formation of corresponding scientific communities. If I am searching for the name 'Soskin' on my computer's hard disk, hundreds of results, references and articles are found, emphasizing how influential Professor Soskin's work has been and still is on our research. The exciting field of Singular Optics and many other research areas will always be intimately connected with Marat Soskin and his countless invaluable contributions. Singular Optics as a research area is one of his legacies. Rest in peace Marat.

### **Nikolay Rosanov**

Ioffe Institute, Saint-Petersburg, Russia

I am extremely sorry to know the sad news that Marat S. Soskin passed away. We have lost a deep scientist, a wise man whose advice was impossible to overestimate. Marat S. closely communicated with the Vavilov State Optical Institute (SOI, Leningrad—St. Petersburg), beginning with the dawn of laser science, into which he entered with his dispersive resonator lasers. Then his joint achievements with the SOI in the field of dynamic holography were awarded a state prize. He stood at the origins of the conference 'Laser Optics' and was its active participant. Similarly, he was one of the organizers of the Rozhdestvensky Optical Society, and since 2014 its honorary member. The scientific trajectory of Marat S. can be called an ascent to increasingly general, global issues of optics of a topological nature. The most widely known and recognized was his last field of activity, to which he himself gave the name 'singular optics.' Not all of Marat S.'s ideas have been implemented so far, and they still have to be developed. He was also very attentive to the history of science. I do not remember how Marat S. learned about the work of W. Ignatowsky, published in 1920 in the Proceedings of SOI, apparently the first work with the prediction of optical vortices; at his request I found this article in the library of SOI and sent a reprint to Marat S. I was lucky to communicate with him many times, most recently on Skype, and I, like many others, will really miss communication with this bright person and a great scientist.

### **Filippus Stefanus Roux**

National Metrology Institute of South Africa, South Africa

My first encounter with Marat Soskin was a hand-written letter that I received from him in 1995, starting with 'Dear still unknown prof F.S. Roux, ..'. In the letter, he expressed his interest in some work that I have published. He then went on to introduce his group and mentioned some of the work that they have done, including the generation of optical vortex beams with computer generated holograms, 2 years earlier than similar work by N. Heckenberg and co-workers.

Whether I have ever reached the stage with him of not being 'still unknown' remains a question. I remember Marat Soskin quite well from encounters at Singular Optics conferences. He was an avid experimentalist, and quite proud of

it. I will never forget how he often started a question after a talk with ‘I am experimentalist.’ Perhaps he did not know my name, but he knew where I was from, because once when I put up my hand to ask him a question, he said ‘Yes, let us hear what South Africa has to say.’

Through the Singular Optics conferences, Marat Soskin helped to create an international Singular Optics community. He also made the Ukraine a countries with a prominent activity in singular optics

### **Vladimir Venediktov**

St Petersburg Electrotechnical University, Russia

The holographic community in Russia, in the countries of the former Soviet Union and around the world was very sad to get known that our friend and teacher, Prof. Marat Samuilovich Soskin, has passed away in February, 2020 at the age of 90. During his long and very active life in science, Prof. Soskin had contributed to various fields of optics and physics. In the English literature his name is pronounced first of all with regard to the so-called singular optics—the term, introduced by him. But in the optical community of the former Soviet part of the world he is also remembered for his not less fundamental impact to holography. In late 60s—early 80s he was among the team of pioneers, who had established the fundamentals of dynamic holography. Numerous papers of M.S.Soskin and coauthors on dynamic holography and four-wave mixing in semiconductors and on lasing in devices with volume holograms were highly cited at that time. In 1982 he and the team of scientists, including, in particular, the father of 3D-holography Yuriy N.Denisyuk, were awarded the State Prize of USSR—one of the highest awards in the Soviet Union—for the cycle of papers on ‘Physical basics of dynamic holography and new methods of transformation of spatial structure of optical beams (1969–1980)’. We are also to remember his important works on tunable lasers, on optics and physics of liquid crystals etc.

In 1977 the team of enthusiasts, including Prof.Soskin, has established a series of Conferences ‘Laser Optics’. It was a major laser forum in Soviet Union, and since 1993 it is a major international event. Prof.Soskin has participated in all conferences in series from 1977 till 2016. I am proud that for many years we were co-chairing with him the ‘Laser Beam Control’ section of these conferences. In the next in series, 18th Laser Optics conference (now shifted from June 2020 to November 2020), we shall hold the memorial session, devoted to our prominent colleague, friend and teacher—Prof. Marat Samuilovich Soskin.

### **Rostyslav Vlokh**

Vlokh Institute of Physical Optics of the Ministry of Science and Education of Ukraine, Ukraine

In the February of this year, in the age of 91, there passed away Professor M. Soskin. He was a Corresponding Member of the National Academy of Science of Ukraine, a famous scientist, a teacher for many of us and an outstanding organizer of optical science. His contribution to the worldwide optical science is truly brilliant. One can remind a great role of Professor Soskin in the studies of lasers with tunable frequency of radiation and his contribution to dynamic holography. Probably, his pioneering works on singular optics were the most significant. In fact, he can be named a father of this branch of optics, which is now applied in such novel optical technologies as quantum information technologies, microparticles manipulation, acute light focusing, etc. Not the least in his versatile activities, Professor M. Soskin contributed much to organize the International conferences on Singular Optics and on Correlation Optics in Ukraine. These conferences became the place where many famous researchers from around the world had met. Professor M. Soskin was a mentor of many

young talented scientists who are now internationally recognized. The memory on Professor M. S. Soskin will stay with us.

**Alexander Volyar, Yurii Egorov and Alexander Rubass**

V.I. Vernadsky Crimean Federal University, Russia

A renowned Ukrainian physicist, devoted teacher and mentor, professor Marat Samuilovich Soskin, who greatly contributed to key developments of physical and nonlinear optics, passed away at the end of February 2020. A path-blazing researcher and discerning person, Marat Soskin was able to peer into optical processes and see those hidden properties that later took their honorable places in dynamic holography and topology of optical vortices. His wonderful ideas, as well as those of his followers and pupils, penetrated many parts of Europe, America, Asia and Australia. In the early 90th of the last century, Marat Soskin invited me (A. V.) to study the dynamics of optical vortices in optical fibers and anisotropic media at Taurida National University (Simferopol). Our collaboration has sprouted a new direction in modern optics. My pupils considered it an honor to go through the Soskin seminar at the Institute of Physics of the Ukrainian Academy of Sciences. In the mid-90th, Soskin proposed holding International Conferences ‘Singular Optics’ in the Crimea on the basis of Taurida National University, so that from 1997 to 2012, conference participants gathered regularly together on the Black Sea coast. Following Marat Soskin’s example a section of modern optics came to be called Singular Optics. Now an optical journal’s issue is seldom published without paper on this remarkable discipline.

**Greg Gbur**

Department of Physics and Optical Science and Center for Optoelectronics and Optical Communications, UNC Charlotte, United States of America

I will always remember Marat Soskin for his friendliness and his enthusiasm for his research. I first met him at the 2003 Advanced Research Workshop in Singular Optics in Kiev, which he co-organized, and though I was relatively new to the field and newly graduated, Marat made me feel as welcome as the very distinguished participants at the meeting. When I think back on seeing him at various events, I picture him moving among the attendees, eagerly talking about the most recent developments in singular optics. He was happy to challenge you on the details of your work, but always in a way that was good natured and left both of you more knowledgeable than before. In the field of singular optics, Marat Soskin made fundamental contributions that guided and led the direction of the field for many years. He will be greatly missed, as will his scientific insights.

**Miguel A Alonso**

Aix Marseille University, CNRS, Centrale Marseille, Institut Fresnel, UMR 7249, 13397 Marseille Cedex 20, France  
University of Rochester, United States of America

I first had contact with Prof. Marat Soskin in 2004. I had just started as a faculty member at the University of Rochester when I was asked by a colleague, Prof. Carlos Stroud, to organize a Symposium on the topic of Singular Optics for the XX Laser Science Conference, collocated with the Frontiers in Optics meeting in Rochester that year. Back then, my research was not so closely related to this area, although I had just started interacting with some of the people that would become central figures in this field in years to follow. For the Symposium, it was suggested to me to ask Prof. Soskin to be the session’s invited speaker. This led to many email contacts with him in preparation for the conference, and then to significant interaction while he was in Rochester, starting with his arrival at the airport. As a starting assistant professor, I felt responsible for helping him with

practical things, so I showed him how to get from his hotel to the conference venue and to the closest supermarket (an organic co-operative). We got along very well, and before leaving Rochester, he gave me a bottle of Ukrainian Vodka.

Two years later, Marat contacted me again to let me know that he had been invited to the 2006 Rochester Conference on Coherence and Quantum Optics. This provided me an opportunity meet him for a second time, not to mention to receive a second bottle of vodka. After that occasion, I only got to meet Marat a couple more times, at conferences in San Francisco and Rochester. Although I did not know it at the time, those encounters with Marat and other people in the area that he himself named ‘Singular Optics’ turned out to have a lasting effect on my research.

### **Ebrahim Karimi**

University of Ottawa, Canada

It was disheartening to learn that our colleague and friend Professor Marat Soskin passed away in February.

Marat was a phenomenal scientist, unique thinker, and an inspiring tutor. He spent more than half a century training and enlightening several generations in Eastern Europe as well as around the globe. His contributions in Optics, in particular to Singular Optics, remains profound and resulted in several primary experimental and theoretical studies, including the first holographic generation of optical beams possessing phase dislocations [1], followed of the seminal work of John Nye and Sir Michael Berry [2]. I had the privilege to attend the international meeting series on Singular Optics in Crimea—of which Marat was the principal founder of this conference series—where I learned many new concepts and met renowned and pioneer scientists.

Many thanks, Marat, for what you have done for our community. You will be missed but never forgotten—RIP.

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### **Mark Dennis**

University of Birmingham

It was with great sorrow and regret that I learned of Professor Marat Soskin’s passing earlier this year. He and his work had a profound influence on the way I approach science and life.

I first met Marat in 1999 at the conference ‘Correlation Optics CorrOpt99’ in Chernivtsy, Ukraine. It was my very first science meeting since starting my PhD in Bristol with Michael Berry. As an undergraduate in St Andrews University, I had heard of the experiments of Miles Padgett, Johannes Courtial and Kishan Dholakia on the angular momentum of light, but had not yet appreciated its connection with the Bristol work of Michael, John Nye and others since the 1970s on phase and polarization singularities. Marat’s group had used phase holograms to create phase singularities (optical vortices as we say now) on the axes of laser beams in the early 1990s, part of the growing interest, as in St Andrews, Ukraine and elsewhere around the world, in structuring light to carry topological singularities and optical momentum. Marat was described to me as one of the key figures in this dynamical new experimental field, who, as many here have pointed out, coined the term ‘Singular Optics’.

At the 1999 meeting, I was especially in awe of Marat Soskin, who enthusiastically switched between English and Russian when asking speakers awkward questions, especially his signature question: ‘What is the experimental significance?’ I was particularly worried about this question as I did not have an answer, as my presentation was concerned with the rather abstract idea of the speed distribution of time-dependent phase singularities in (scalar) black body radiation! In conversations, then as for many years thereafter, Marat was very enthusiastic in face-to-face and email correspondence about any ‘nice and unexpected’ ideas related to his ‘beloved singularities’, as well as many other issues.

Our closest collaboration was, appropriately enough, in assisting Marat and Michael in organising the international meeting ‘Singular Optics 2003’ in Kiev, with support from NATO. Marat was especially concerned that the invited participants balanced between many different countries around the world. In a preliminary visit to Kiev a few months before the meeting, Marat, his group and his son Slava took the time to show me around many aspects of that beautiful city. I also saw the high expectations he placed on his research group. Little did I realise these would extend to me until I found, on arriving in Kiev for the conference, that I had been put down as the Kiev tour guide for international participants!

Looking back, I see how Marat’s influence has shaped my own approach as a scientist. His insistence on experimental significance has shaped my own theoretical physics research, and his inspiration in using culture and shared experience to bring people with different backgrounds together. Whilst I was never surprised to receive an enthusiastic email from him in the middle of the night about a new result he had found or heard of (‘... your comments, please?’), he emphasised the importance of a balance life. Our thoughts are especially with his family at this time, Slava and Marat’s wife Lyudmila. We can all take Marat’s example in his style: ‘Life, Science, Family!’