Remembering Marat Soskin

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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 didn’t 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 didn’t 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 didn’t). 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 Simferopol, 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 an 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.