The Magical World of Tight Focusing –
From Ultra-Precise Particle Localization to Polarization Möbius Strips

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It is well known that intensity, phase and polarization of light beams can be sculpted spatially. The resulting bespoke patterns find a plethora of applications in optical comm, sensing, and imaging. But the real elegancy of sculpted light is only apparent when looking at spatially highly confined electromagnetic fields. They inherently exhibit complex three-dimensional distributions. With their complexity and strong position-dependent field structure, they are the perfect platform for the selective excitation and study of nanosystems at the single entity level, extending the range of possible applications even further. In this context, tailored electromagnetic fields with nanoscale features pave the way for advanced single-particle spectroscopy, nanoscale traffic control, nano-metrology and more. In this talk, we plan to highlight two selected concepts – an intriguing and mind-boggling fundamental property of confined fields and a versatile and very promising application.

On the fundamental side of the story, tightly focused light beams might host intriguing and rather counter-intuitive topological structures hidden in the spatial polarization degree of freedom or the field itself. Here, we will discuss the appearance of tiny polarization Möbius strips in structured light. In addition, and seen from a more applied perspective, we highlight an application of bespoke nanostructured light fields in ultra-precise nano-metrology.