Far from falling (ultra)short

With applications across scientific fields, Dr Stelios Tzortzakis details some of the unique properties that led his team to study ultrashort nonlinear laser propagation phenomena

Can you provide an overview of your research and principal goals?

Our research involves intense ultrashort laser pulses, whose intensity allows the study of highly nonlinear phenomena. More specifically, we work on two major axes, the study of nonlinear propagation phenomena (fi lamentation) and the development of novel secondary radiation sources across the electromagnetic spectrum with special emphasis on terahertz (THz) radiation. Our work involves both fundamental physics studies as well as applications which span interdisciplinary ground, involving photonics, materials, cultural heritage and biochemistry. Finally, tailoring the strong nonlinearities to control the propagation properties of the intense laser beams is of major importance and we are strongly involved in this problem.

Can you give an insight into your group’s studies involving fi lamentation? How are you seeking to advance studies within this area, and can you highlight how light fi lamentation is used in real-life applications?

Filamentation is a major research field for us. Our focus here is on the study of highly nonlinear phenomena and the development of novel secondary radiation sources across the electromagnetic spectrum with special emphasis on terahertz (THz) radiation. Our work involves both fundamental physics studies as well as applications which span interdisciplinary ground, involving photonics, materials, cultural heritage and biochemistry. Finally, tailoring the strong nonlinearities to control the propagation properties of the intense laser beams is of major importance and we are strongly involved in this problem.

What would the possibility of creating more sophisticated 3D plasma photonic lattices open up in terms of controlling the propagation of high-intensity ultrafast laser beams and laser filaments?

Following the previous question, one of the ways we have introduced in the control of filamentation is the use of photonic lattices, on the basis of which we have shown that by adjusting the parameters of the lattice, one can obtain efficient control of the filament properties. Practically, the lattices can be permanently written waveguide arrays in the bulk of glasses, with far bigger arrays, or temporary ones, such as plasma filaments which are formed by intense laser pulses interacting with a gas.

Could you outline the potential future research directions for your research group?

The future of this research field looks as bright as the intense sources we use and develop. Of particular interest to us is the field of metamaterials, which are artificial structures with negative refractive indices. We are investigating the applications of these materials in various fields, including telecommunications, sensors, and microelectronics.
Harmonising ultrashort lasers in the Terahertz range of the spectrum, the FP-6 funded MULTIRAD study has broad-ranging applications, from metamaterials to masterpieces.

**A LAYERED PERSPECTIVE**

As a research team, we study the interaction of light with matter at high light intensity and very short timescales. This involves understanding the fundamental physical processes that govern the behaviour of light when it interacts with material, such as the emission of light, the absorption of light, and the interaction of light with matter, including solid, liquid, and gas.

**MULTIRAD**

with applications across scientific and industrial fields. In this context, the development of metamaterials for fundamental research is important. The research is focused on studying the interaction of light with matter, particularly at high light intensity and short timescales. The goal is to understand the fundamental physical processes that govern the behaviour of light when it interacts with matter, including solid, liquid, and gas.

**APPLICATIONS IN BIOLOGY, MEDICINE, AND MATERIALS SCIENCE**

As a research team, we study the interaction of light with matter at high light intensity and very short timescales. This involves understanding the fundamental physical processes that govern the behaviour of light when it interacts with material, such as the emission of light, the absorption of light, and the interaction of light with matter, including solid, liquid, and gas.

**Waves of wonder**

Harmonising ultrashort lasers in the Terahertz range of the spectrum, the FP-6 funded MULTIRAD study has broad-ranging applications, from metamaterials to masterpieces.

**A LAYERED PERSPECTIVE**

As a research team, we study the interaction of light with matter at high light intensity and very short timescales. This involves understanding the fundamental physical processes that govern the behaviour of light when it interacts with material, such as the emission of light, the absorption of light, and the interaction of light with matter, including solid, liquid, and gas.

**MULTIRAD**

with applications across scientific and industrial fields. In this context, the development of metamaterials for fundamental research is important. The research is focused on studying the interaction of light with matter, particularly at high light intensity and short timescales. The goal is to understand the fundamental physical processes that govern the behaviour of light when it interacts with matter, including solid, liquid, and gas.

**APPLICATIONS IN BIOLOGY, MEDICINE, AND MATERIALS SCIENCE**

As a research team, we study the interaction of light with matter at high light intensity and very short timescales. This involves understanding the fundamental physical processes that govern the behaviour of light when it interacts with material, such as the emission of light, the absorption of light, and the interaction of light with matter, including solid, liquid, and gas.

**Waves of wonder**

Harmonising ultrashort lasers in the Terahertz range of the spectrum, the FP-6 funded MULTIRAD study has broad-ranging applications, from metamaterials to masterpieces.

**A LAYERED PERSPECTIVE**

As a research team, we study the interaction of light with matter at high light intensity and very short timescales. This involves understanding the fundamental physical processes that govern the behaviour of light when it interacts with material, such as the emission of light, the absorption of light, and the interaction of light with matter, including solid, liquid, and gas.

**MULTIRAD**

with applications across scientific and industrial fields. In this context, the development of metamaterials for fundamental research is important. The research is focused on studying the interaction of light with matter, particularly at high light intensity and short timescales. The goal is to understand the fundamental physical processes that govern the behaviour of light when it interacts with matter, including solid, liquid, and gas.

**APPLICATIONS IN BIOLOGY, MEDICINE, AND MATERIALS SCIENCE**

As a research team, we study the interaction of light with matter at high light intensity and very short timescales. This involves understanding the fundamental physical processes that govern the behaviour of light when it interacts with material, such as the emission of light, the absorption of light, and the interaction of light with matter, including solid, liquid, and gas.

**Waves of wonder**

Harmonising ultrashort lasers in the Terahertz range of the spectrum, the FP-6 funded MULTIRAD study has broad-ranging applications, from metamaterials to masterpieces.

**A LAYERED PERSPECTIVE**

As a research team, we study the interaction of light with matter at high light intensity and very short timescales. This involves understanding the fundamental physical processes that govern the behaviour of light when it interacts with material, such as the emission of light, the absorption of light, and the interaction of light with matter, including solid, liquid, and gas.

**MULTIRAD**

with applications across scientific and industrial fields. In this context, the development of metamaterials for fundamental research is important. The research is focused on studying the interaction of light with matter, particularly at high light intensity and short timescales. The goal is to understand the fundamental physical processes that govern the behaviour of light when it interacts with matter, including solid, liquid, and gas.

**APPLICATIONS IN BIOLOGY, MEDICINE, AND MATERIALS SCIENCE**

As a research team, we study the interaction of light with matter at high light intensity and very short timescales. This involves understanding the fundamental physical processes that govern the behaviour of light when it interacts with material, such as the emission of light, the absorption of light, and the interaction of light with matter, including solid, liquid, and gas.

**Waves of wonder**

Harmonising ultrashort lasers in the Terahertz range of the spectrum, the FP-6 funded MULTIRAD study has broad-ranging applications, from metamaterials to masterpieces.

**A LAYERED PERSPECTIVE**

As a research team, we study the interaction of light with matter at high light intensity and very short timescales. This involves understanding the fundamental physical processes that govern the behaviour of light when it interacts with material, such as the emission of light, the absorption of light, and the interaction of light with matter, including solid, liquid, and gas.

**MULTIRAD**

with applications across scientific and industrial fields. In this context, the development of metamaterials for fundamental research is important. The research is focused on studying the interaction of light with matter, particularly at high light intensity and short timescales. The goal is to understand the fundamental physical processes that govern the behaviour of light when it interacts with matter, including solid, liquid, and gas.