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Andrew M. Weiner (1958–2024)

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Andrew M. Weiner, a luminary in ultrafast optics and quantum photonics passed away on February 13, 2024, at the age of 65. He will be remembered for his profound contributions to the optics and photonics community, engineering, education, and for his devoted mentorship. He leaves behind a legacy of innovation and inspiration.

Born on 25th July, 1958, in Boston, Massachusetts, Andy spent his formative years in Winter Park, Florida, where he was a precocious child. At the age of 5, his "Portrait of a Monster" was accepted into the juried Winter Park Art Show. In first grade, he was often given stacks of books at school, directed to the corner, and instructed to "go at his own pace". After skipping the second grade, Andy essentially learned independently until graduating from high school at age 16. Early in his teens, Andy knew the Massachusetts Institute of Technology would be the only college for him and he enrolled at MIT just as he turned 17. At 21, supported by a John and Fannie Hertz Fellowship, he was able to begin graduate studies under Prof. Erich Ippen. He earned his ScD in 1984.

After graduation, he began his professional career at Bell Communications Research (Bellcore) as a member of the technical staff and was promoted to the role of Manager of Ultrafast Optics and Optical Signal Processing Research. Upon his arrival at Bellcore he was recruited to play first baseman on a recreational softball team, the "Belliups". As fate would have it, his coach Brenda became his wife five years later! Together they would live in eight different houses, two states, and two countries, but Andy would change jobs only once.

In 1992, Andy embarked on his distinguished tenure at Purdue University as a full Professor of Electrical and Computer Engineering, moving Brenda to West Lafayette. Here, they raised three children: Rob, Willow, and Gabriella. Andy's groundbreaking research in ultrafast optics revolutionized the processing of high-speed lightwave signals, particularly in the area of femtosecond pulse shaping. Remarkably comfortable entering new research fronts throughout his career, he made pioneering contributions in one high-level aspect of his work roughly every decade.

Andy's early work (circa 1984–1994) in ultrafast pulse generation and optical pulse shaping resulted in the generation of 16-femtosecond-long short pulses, the shortest waveforms to date at that time[1], as well as powerful techniques to tailor their temporal shapes[2]. His seminal work on Fourier synthesis methods enabled the precise control of optical pulses, facilitating their engineering into intricate phase- and amplitude-modulated waveforms. These advances later found applications in fibre-optic networks and laboratories worldwide[3]. While developing these tools, Andy also pursued novel applications such as the generation of user-defined THz radiation from semiconductor heterostructures[4] and soliton formation in passively mode-locked fibre lasers[5] – discoveries that would lay foundations for subsequent research in radio-frequency arbitrary waveform generation and Kerr combs in microring resonators, respectively.

In the following decade (circa 1994–2004), the idea of pulse shaping optical waveforms to generate tailored THz radiation[4] was further extended to the radio-frequency domain[6]. At the time, commercially available equipment to generate high-frequency wide-bandwidth (≳1 GHz) electrical waveforms was extremely limited. As one of few groups tackling this challenge, Andy's group replaced semiconductor heterostructures with high-speed photodiodes driven by tailored pulse trains[7] or wideband pulsed intensity waveforms, resulting in millimetre[7] and microwave[8] waveforms unachievable by purely electronic means. This work[9] generated worldwide interest in the generation of arbitrary electromagnetic waveforms using optical means, ushering in a new research area in microwave photonics. During this time, in collaboration with Martin Fejer at Stanford, Andy began leveraging periodically poled lithium niobate (PPLN) waveguides for highly efficient nonlinear optics[10]. Research in this period emphasized the processing and characterization of short classical pulses, but Andy's knowledge of PPLN would prove a decisive advantage in quantum optical endeavours in the years to come.

Work in arbitrary waveform generation continued in the following decade (circa 2004–2014), with a focus on applications and optical frequency combs generated via electro-optic modulation[11]. Thanks to the high (GHz-scale) repetition rates, optical pulse shapers could access each comb line independently, heralding an era of "line-by-line" pulse shaping with fully arbitrary 100% duty-cycle optical and electronic waveforms[12]. This led to enormous growth in the use of optical combs for microwave filtering, signal processing, and waveform generation[13]. Also, during this period, interest in integrated photonics grew in the Weiner group, with particular emphasis on optical pulse generators and processors based on microring resonators[14,15].

Thanks to an auspicious 2012 funding opportunity, Andy leapt into the field of quantum pulse shaping virtually overnight, which captured a strong fraction of his interests in his final decade (circa 2014–2024). Focusing initially on shaping ultrafast correlation functions via complex spectral filtering techniques and PPLN-based ultrafast correlators[16,17], Andy continued to expand his reach to biphoton frequency combs: sources that produce pairs of photons entangled in discrete frequency bins that are compatible with both integrated photonics and fibre-optic communications[18,19].

In the process of exploring stand-alone quantum gates for frequency-bin-encoded quantum states[20,21], Andy developed signal processing techniques that have come to

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underpin the field of frequency-bin photonic quantum information[22]. Indeed, Andy's citation for the 2023 Charles Hard Townes Medal from Optica included "ground-breaking work bringing optical frequency combs to the quantum world", proving that, even deep into his career, Andy maintained the humility to teach himself a new field and had the vision to identify opportunities for impact.

His expertise garnered numerous accolades, including election to the U.S. National Academy of Engineering and the National Academy of Inventors. Andy's contributions were also recognized with the Adolph Lomb Medal from Optica in 1990, the R.W. Wood Prize from Optica jointly with J.P. Heritage in 2008, and the Herbert Newby McCoy Award from Purdue University in 2013.

Being the visionary Captain of Purdue's Elmore Family School of Electrical and Computer Engineering (ECE), Andy's initiatives went far beyond his own research. He defined strategic directions and led major hiring processes in areas that would define the future development of photonics in the School. Andy started what would become one of Purdue ECE's signatures — nanophotonics — by hiring and then nurturing and promoting several key team members. Well ahead of the national explosion of investment in quantum information science, Andy, together with Chris Greene and Vlad Shalaev, co-founded the Purdue Quantum Center, which grew from an intramural effort between the College of Engineering and College of Science into a national force under the United States National Quantum Initiative Centers. Andy's no-compromise high standards and his impeccable integrity helped shape the School of ECE to what it is today: one of best in the country.

Away from the lab and classroom, Andy was passionate about Aikido — a Japanese martial art focused on channelling an opponent's aggression to resolve an attack with minimal harm to all involved. Andy's study of Aikido began in high school with his dad. At the time of his death Andy was a Godan, a fifth-degree black belt. A level beyond the technical ranks, Godan is an honorary degree signifying a deep understanding of the concepts of harmony, balance, intuition, strength, and character. Those closest to Andy understand these qualities to be apt descriptors of a dear friend and colleague. He served as faculty advisor for the Purdue University Aikido Club.

Andy was incredibly funny. He loved to memorize and recite poetry. Edgar Allan Poe, Lewis Carroll, and Allen Ginsberg were some of his favourite authors. He loved to read John le Carré, Isaac Bashevis Singer, and the Harry Potter series by J. K. Rowling. He listened repeatedly to Bob Dylan, Marty Robbins' ballads, and operas like *The Threepenny Opera* and *Phantom of the Opera*. He loved a good chess game and two-person Scrabble.

Andy possessed incisive discernment of the difference between style and substance. Although never afraid to call out behaviour void of good sense or claims lacking sufficient justification, Andy did so always with the utmost concern to bring out the best from those around him. He chose to surround himself with people who could acquire new knowledge, process it in the context of what they already knew, and then apply it to solving difficult problems. Andy generously shared his knowledge, pushing his students, colleagues, and collaborators to levels of achievement they never could have reached without his uncompromising commitment to excellence. He will be remembered and forever missed.

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Competing interests

The authors declare no competing interests.