# Self-regularized Method of Moments (SR-MoM): Zooming into Near Fields


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**Abstract:**
The conventional wisdom in computational electromagnetics suggests that zooming into near fields is tantamount to tempering singularities by taming infinities. The question of whether infinities of various kinds and cardinalities are real in nature is as profound as the quest for deciphering the internal structure, twist, spin, and chirality of elemental particles in quantum fields. Thereby, scrutinizing models of idealized forces, such as the point charge, and revisiting foundational concepts in mathematical physics, including generalized functions and various integrability and summability schemes, are not merely curious academic pursuits. This lecture is a guided tour for CEM enthusiasts who wish to learn about the intricate design of problem-specific multi-physics algorithms. It is shown that known linear equations of mathematical physics are invariably diagonalizable. The deep connection of this result with well-established symmetry and invariance principles in mathematical physics has been formulated as a conjecture. The well-structured diagonalized differential equations transform into algebraic eigenvalue equations in the spectral domain. The application of this principle to EM in conjunction with the theory of generalized functions (e.g., the Dirac delta function) leads to the construction of problem-tailored Dirac delta-like functions, and consequently, to self-regularized dyadic (triadic) Green's functions. Two algebraic and exponential regularization techniques are also introduced. Subsequently, and perhaps intriguingly, the calculation of mutual interaction elements in the Method of Moments (MoM) is shown to be reducible to the calculation of (often dreaded and sometimes feared) self-action elements. It is demonstrated that the calculation of the self-action elements amounts to merely sampling high-order smooth functions that can conveniently be precalculated, given specific material parameters. The method is appropriately referred to as the Self-regularized Method of Moments (SR-MoM). The presentation also includes the novel design of customized multiresolution basis functions, such as Green's function-induced wavelets, frames, and Wannier

functions. It introduces the recently discovered Discrete Taylor Transform and Inverse Transform (D-TTIT), along with a glimpse of the Non-standard Finite Difference Method. The style of the presentation is axiomatic, rigorous, and illustrative, based on simple examples. The inductive nature of the storytelling guarantees clarity of thought and accessibility. The presentation cherry picks topics from the upcoming commissioned books on the speaker's life's work. PhD candidates and professionals in CEM constitute the target audience.

**Bio:**

**Dr. Alireza Baghai-Wadji** is a Professor Emeritus of Computational Engineering at the University of Cape Town. He received an MSc, a PhD, and a DSc (Doctor of Science) from Vienna University of Technology, Austria, in 1984, 1987, and 1994, respectively. He was also awarded an honorary DSc from Aalto University, Finland, in 2004. He has occupied tenured academic, senior executive, distinguished visiting professor, and resident principal engineering consultancy positions on five continents. He has presented 39 short courses and tutorials at IEEE and IEEE-sponsored conferences. He is the author of three books: "Mathematical Quantum Physics for Engineers and Technologists (MQPET)," Volume 1: "Fundamentals," MQPET, Volume 2: "Governing Equations," both published at IET, SciTech Publishing, 2023; and the original text D-TTIT, on the discovery of the "Discrete Taylor Transform and Inverse Transform," published at IEEE-Express, Wiley, 2024.