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International Conference on

Physics

June 27-29, 2016   New Orleans, USA

Revival of the phase-amplitude description of a quantum-mechanical wave functon

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The Phase-Amplitude (Ph-A) description consists in writing the wave function $\psi(r)$ as $\psi(r) = y(r)\sin(\phi(r))$, where y is the amplitude and ϕ the phase. Both functions vary slowly with the distance r, and hence should be easier to calculate than the highly oscillatory function $\psi(r)$. In 1930, W. E. Milne established the second order differential equation for y(r), which unfortunately is non-linear, and hence cumbersome to solve with the conventional finite difference methods. In 1962, M. J. Seaton and G. Peach demonstrated an iterative solution of Milne's equation, and in 2015 and 2016 the present author improved the iterative method by making use of a modern spectral expansion procedure of y(r) in terms of Chebyshev polynomials. The method is very economical and fast, as will be shown. One drawback of the iterative method is that it does not converge in the vicinity of the turning points. It is possible that this difficulty can be overcome by considering an alternative third order linear differential equation which may propagate the solution across the turning points. Attempts to solve this equation numerically will be described. If successful, that may represent an important advance for the Ph-A description.

Biography

George Rawitscher has received his BS degree in Physics and Mathematics at the University of Sao Paulo, Brazil in 1949, and his PhD in Physics from Stanford University in 1956. After serving as the faculty at Yale University, he moved to the University of Connecticut where he taught for more than 40 years as Full Professor. He is now Research Professor at the University of Connecticut since 2009, continuing to do research, and is presently co-authoring a book on spectral computational methods.

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J Phys Chem Biophys

ISSN: 2161-0398 JPCB, an open access journal

Physics 2016

June 27-29, 2016

Volume 6, Issue 3(Suppl)

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