

**NUMERICAL RECONSTRUCTION AND APPLICATIONS OF
ACOUSTIC AND ELECTROMAGNETIC ULTRA-WIDEBAND
LOCALIZED PULSES GENERATED BY DYNAMIC
APERTURE ANTENNAS**

by

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(ABSTRACT)

A study is undertaken of the numerical reconstruction of acoustic and electromagnetic (EM) localized waves (LWs). The latter are carrier-free ultra-wideband pulses characterized by large focusing depths and extended ranges of localization. Special emphasis is placed on finite energy LWs that can be generated by dynamic aperture antennas with independently addressable elements. The reconstruction techniques are based on Huygens and Rayleigh-Sommerfeld integral I and II representations, both in the time and frequency domains. In contradistinction to the Weyl representation, they lend themselves to the physical realization of space-time aperture sources capable of generating localized wave solutions propagating away from the aperture plane. A detailed comparison of the three reconstruction techniques has been carried out in connection with LW solutions to the scalar wave equation, especially with respect to their handling of acausal components incorporated in the aperture excitation fields. In addition, a study is presented of the characteristic properties of LWs propagating through dispersive media modeled by

the Klein-Gordon equation. It is demonstrated that contrary to expectation, the depletion of the spectral components of the LW Klein-Gordon field may be slower than that associated with the free space scalar field. Previous work by Power *et al.* [73] is extended by studying the acoustic bistatic scattering of a modified power spectrum (MPS) pulse from rigid and compressible spheres. The analysis allows the extraction of the radius of a sphere from the backscattered data. Finally, a special class of electromagnetic (EM) LWs, referred to as azimuthally polarized X waves (APXWs), is derived and their reconstruction is addressed, both in the time and frequency domains.

Dedicated
to the memory of my father who encouraged
me and provided me the valuable guidance
to pursue my life and career

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TABLE OF CONTENTS

	Page
TITLE	i
ABSTRACT	ii
DEDICATION	iv
ACKNOWLEDGMENTS	v
TABLE OF CONTENTS	vi
LIST OF FIGURES	ix
1.0 INTRODUCTION	
1.1 Historical Survey	1
1.2 Description of the Thesis	9
2.0 NUMERICAL RECONSTRUCTION OF SCALAR-VALUED LOCALIZED WAVE PULSES GENERATED FROM DYNAMIC APERTURE ANTENNAS	
2.1 Introductory Remarks on Localized Waves	11
2.2 Radiated Wavefield	12
2.3 Generation of Infinite Energy Localized Waves	15
2.4 Generation of Finite Energy Localized Waves	17
2.4.1 Superposition of Source-Free Focus Wave Modes	18
2.4.2 Time-Limited Excitation Wavefields	20
2.5 Numerical Implementation of the Huygens and Rayleigh-Sommerfeld Integral I, II Representations	22
2.6 Numerical Results	24
2.7 Reconstruction of LW pulses in the Frequency Domain	28
2.8 Concluding Remarks	29
Appendix 2-A The Equivalence of the Huygens and Weyl Representation of the Solution to the 3-D Scalar Wave Equation	31
Appendix 2-B The Equivalence of the Rayleigh-Sommerfeld Integral I and Weyl Representations of the Solution to the 3-D Scalar Wave Equation	36

Appendix 2-C The Equivalence of the Rayleigh-Sommerfeld Integral II and Weyl Representations of the Solution to the 3-D Scalar Wave Equation	40
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3.0 PROPAGATION OF LOCALIZED WAVES IN COLLISIONLESS PLASMA MEDIA

3.1 Introduction	55
3.2 Formulation of the Radiated Field	55
3.3 Depletion of the Spectral Components	59
3.4 Practical Considerations	61
3.5 Concluding Remarks	63
Appendix 3-A	65

4.0 SCATTERING OF LOCALIZED WAVES FROM RIGID AND COMPRESSIBLE SPHERES

4.1 Introduction	81
4.2 Source Free-Focus Wave Mode Solution	82
4.3 The Incident Pulse on the Sphere	83
4.4 Bistatic Scattered Fields Arising from a Plane Wave Incident on a Compressible Sphere	84
4.5 Bistatic Scattering of a Source-Free FWM from a Soft Sphere	87
4.6 Scattering of a MPS Pulse from a Compressible Sphere	88
4.7 Scattering of a MPS Pulse from a Rigid Sphere	89
4.8 Numerical Results	90
4.9 Extraction of the Radius from the Backscattered Spectrum	92
4.10 Conclusion	92

5.0 RECONSTRUCTION OF AXISYMMETRIC AZIMUTHALLY POLARIZED ELECTROMAGNETIC LOCALIZED PULSED WAVEFIELDS

5.1 Introductory Remarks	118
5.2 Azimuthally Polarized Electromagnetic Fields	118
5.3 Azimuthally Polarized X Wave	120

5.4	Reconstruction of Azimuthally Polarized X Waves in the Time Domain	123
5.5	Reconstruction of Azimuthally Polarized X Waves in the Frequency Domain	124
5.6	Time-Limited Azimuthally Polarized X Waves	126
5.7	Numerical Results	128
5.8	Concluding Remarks	129
6.0 CONCLUDING REMARKS AND FUTURE WORK		137
REFERENCES		141
VITA		154

LIST OF FIGURES

- Figure 2.1 Geometrical configuration of the source plane and the discrete annular sections for launching a localized wavefield. (43)
- Figure 2.2 Decay of the centroid field value obtained by discrete arrays: (a) FWM pulse; (b) MPS pulse. (44)
- Figure 2.3 Decay of the centroid field value of a FWM in the case of discrete arrays using Huygens' principle and a TLFWM using the Weyl representation. (45)
- Figure 2.4 Comparison between the decay of the exact MPS and the causal one obtained from the Weyl representation. (46)
- Figure 2.5 The decay of the centroid field value of the zeroth-order X wave for different radii. (47)
- Figure 2.6 The variation of the normalized field value of a zeroth-order X wave with distance z in the upper graph and with the radius of the discrete arrays (R) in the lower one. (48)
- Figure 2.7 Comparison between the exact MPS and one reconstructed using the Rayleigh-Sommerfeld integral I representation: (a) $z = 1$ km; (b) $z = 10$ km. (49)
- Figure 2.8 The decay of the centroid of the MPS pulse. The maximum radius of the source equals 5 m. (50)
- Figure 2.9 The dependence of the field amplitude for the MPS pulse on contributions from various radial elements. (51)
- Figure 2.10 A comparison between the time history of the second-derivative X wave pulse and the exact one. (52)
- Figure 2.11 The decay of the absolute value of the centroid of the second-derivative X wave derived for sources of different radii. (53)
- Figure 2.12 Comparison between the reconstructed second derivative X wave and the exact one at $z = 20$ cm and $\rho = 0$. The reconstruction has been carried out in the frequency domain using the Rayleigh-Sommerfeld integral II (RSII) representation: (a) time domain; (b) frequency domain. (54)

Figure 3.1 The infinite aperture FWM pulse propagating in a dispersive medium characterized by the plasma frequency $f_p = 10$ GHz at $z = 236.25$ m. Plots are provided for (a) $k_s = k_p$ and (b) $k_s = 1.02k_p$. (70-71)

Figure 3.2 The time history of an infinite aperture FWM pulse propagating in a dispersive medium: $f_p = 10$ GHz, $k_s = 1.02k_p$, $1.05k_p$ and $z = 236.25$ m. (72)

Figure 3.3 The decay of the amplitude of the centroid of the finite time FWM pulse for different plasma frequencies. (73)

Figure 3.4a The depletion of the spatial spectrum at different positions. The free space case is compared to a plasma medium having $f_p = 10$ GHz. (74)

Figure 3.4b The depletion of the spatial spectrum at different positions. The free space case is compared to a plasma medium having $f_p = 20$ GHz. (75)

Figure 3.4c The depletion of the spatial spectrum at different positions. The free space case is compared to a plasma medium having $f_p = 30$ GHz. (76)

Figure 3.4d The depletion of the spatial spectrum at different positions. The free space case is compared to a plasma medium having $f_p = 40$ GHz. (77)

Figure 3.5 A comparison of the time history of the finite-time FWM pulse propagating in free space as well as a dispersive medium: $f_p = 10$ GHz at (a) $z = 236.25$ m; (b) $z = 708.74$ m. (78-79)

Figure 3.6 The contour used to evaluate the integration in Eq. (3-A.11). (80)

Figure 4.1 The equivalence between the weighted plane waves incident on the sphere from different directions and the MPS pulse. (96)

Figure 4.2 A comparison of the time histories of the exact and the reconstructed MPS pulses at $r = 15$ cm. (97)

Figure 4.3 Fast Fourier transform of the time history related to the exact incident and reconstructed pulses given in Fig. 4.2. (98)

Figure 4.4 Predicted backscattered spectrum of the MPS pulse from a sphere, with $\rho_e = 7.8 \times 10^3 \text{ kg/m}^3$, $a = 30\text{mm}$ and different speeds c_e . The observation distance r equals 15 cm. (99)

Figure 4.5 Predicted backscattered spectrum of the MPS pulse from a sphere with $c_e = 3000\text{m/s}$, $\rho_e = 7.8 \times 10^3 \text{ kg/m}^3$ and different radii. The distance from the sphere is 15 cm. (100)

Figure 4.6 The backscattered spectra at $r = 50\text{m}$ from a hard sphere with radius $a = 5$ and 8 cm. (101)

Figure 4.7 The backscattered spectra at $r = 20\text{m}$ from a hard sphere with radius $a = 10, 15$ and 20 cm. (102)

Figure 4.8 Predicted backscattered spectrum from a sphere with $a = 30\text{mm}$, $c_e = 3000 \text{ m/s}$ and different material densities ρ_e . The distance from the sphere is 15 cm. (103)

Figure 4.9 The variation of the sphere radius and the spectral spacing between two adjacent peaks of the backscattered spectrum of a rigid and a non-rigid sphere at $r = 15 \text{ cm}$. The sphere is immersed in water for both cases. (104)

Figure 4.10 Time history of the backscattered MPS pulse at $r = 50\text{m}$ from a hard sphere with radius $a = 5$ and 8 cm. We notice that the delay between the two peaks for the sphere with radius $a = 8 \text{ cm}$ is larger than that with radius $a = 5 \text{ cm}$. (105)

Figure 4.11 Bistatic scattered spectra at $r = 150\text{m}$, $\theta_0 = \pi/2, 2\pi/3, 5\pi/6$ and π of the MPS pulse from a rigid sphere with radius $a = 3 \text{ cm}$ immersed in water. (106)

Figure 4.12 Bistatic scattered spectra at $r = 150\text{m}$, $\theta_0 = 0, \pi/6$ and $\pi/3$ of the MPS pulse from a rigid sphere with radius $a = 3 \text{ cm}$ immersed in water. (107)

Figure 4.13 Time history of the scattered MPS pulse at $r = 150\text{m}$, $\theta_0 = 0, \pi/6$ and $\pi/3$ from a rigid sphere with radius $a = 3 \text{ cm}$ immersed in water. (108)

Figure 4.14 Time history of the scattered MPS pulse at $r = 150\text{m}$, $\theta_0 = \pi/2, 2\pi/3, 5\pi/6$ and π from a rigid sphere with radius $a = 3\text{ cm}$ immersed in water. (109)

Figure 4.15 Bistatic scattered spectra at $r = 150\text{m}$, $\theta_0 = \pi/2, 2\pi/3, 5\pi/6$ and π of the MPS pulse from a rigid sphere with radius $a = 4\text{ cm}$ immersed in water. (110)

Figure 4.16 Bistatic scattered spectra at $r = 150\text{m}$, $\theta_0 = 0, \pi/6$ and $\pi/3$ of the MPS pulse from a rigid sphere with radius $a = 4\text{ cm}$ immersed in water. (111)

Figure 4.17 Time history of the scattered MPS pulse at $r = 150\text{m}$, $\theta_0 = 0, \pi/6$ and $\pi/3$ from a rigid sphere with radius $a = 4\text{ cm}$ immersed in water. (112)

Figure 4.18 Time history of the scattered MPS pulse at $r = 150\text{m}$, $\theta_0 = \pi/2, 2\pi/3, 5\pi/6$ and π from a rigid sphere with radius $a = 4\text{ cm}$ immersed in water. (113)

Figure 4.19 Bistatic scattered spectra at $r = 150\text{m}$, $\theta_0 = \pi/2, 2\pi/3, 5\pi/6$ and π of the MPS pulse from a rigid sphere with radius $a = 5\text{ cm}$ immersed in water. (114)

Figure 4.20 Bistatic scattered spectra at $r = 150\text{m}$, $\theta_0 = 0, \pi/6$ and $\pi/3$ of the MPS pulse from a rigid sphere with radius $a = 5\text{ cm}$ immersed in water. (115)

Figure 4.21 Time history of the scattered MPS pulse at $r = 150\text{m}$, $\theta_0 = 0, \pi/6$ and $\pi/3$ from a rigid sphere with radius $a = 5\text{ cm}$ immersed in water. (116)

Figure 4.22 Time history of the scattered MPS pulse at $r = 150\text{m}$, $\theta_0 = \pi/2, 2\pi/3, 5\pi/6$ and π from a rigid sphere with radius $a = 5\text{ cm}$ immersed in water. (117)

Figure 5.1 Variation of the current density $(\hat{n} \times \mathbf{H}_p)$ with the transverse distance p at different instants. (130)

Figure 5.2 The time history of the electric field E_ϕ on the source plane at different radii of the annular sections: $p = 0.177, 0.354, 0.531, 0.708, 0.885\text{m}$. The parameters of the pulse are as follows: $a_1 = 0.25, \beta = 6$. (131)

Figure 5.3 The decay of the centroid field value of finite time azimuthally polarized magnetic field H_z with the distance z in front of the source plane. It is clear that the decay is inversely proportional to the excitation time T . (132)

Figure 5.4 Comparison between the time history of the electric field component E_ϕ generated from a finite aperture of radius $R_{\max} = 4.8\text{m}$ and the exact one at observing point $z = 50\text{m}$, $\rho = 0.106\text{m}$. We have applied the vector Kirchhoff integral and then IFFT. (133)

Figure 5.5 Comparison between the time history of the electric field component E_ϕ generated from a time-limited aperture $4T$, $T = 0.04\text{ns}$ using the Weyl representation and the exact one at $z = 50\text{m}$, $\rho = 0.106\text{ m}$. (134)

Figure 5.6 The comparison between the time history of the magnetic field component H_z generated from a finite time aperture with radius $R_{\max} = 4.8$, $T = 0.04\text{ns}$ and the exact one at $z = 250\text{m}$, $\rho = 0$. (135)

Figure 5.7 The comparison between the time history of the reconstructed E_ϕ at $z = 250\text{ m}$, $\rho = 0.106\text{m}$ due to a localized current source distributed on the source plane and the exact one. The radius of the aperture is $R_{\max} = 4.8\text{m}$. (136)