American Chemical Society

National Awards Nomination Packet

Ahmed Zewail Award in Ultrafast Science and Technology:2018
for: Robert Alfano

Received: 11/03/2014 *Cycle Year: 3*

"For the discovery of supercontinuum and contributions to the study of chemical, physical, and biological processes which stimulated major advances in ultrafast science"

NOMINATOR:

Martin Pope
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- Have you discussed this award nomination with the nominee? *Yes*

NOMINEE:

Robert Alfano
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New York, NY 10031
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ACS Current Member: No
Present Position: Distinguished Professor of Science and Engineering
Industry: Academia

SAFETY PROTOCOLS:

- Does the nominee employ and require good safety protocols and practices in his/her laboratory? *Yes*

SUPPORTER 1

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Chair
Selection Committee for the Ahmed Zewail Award in Ultrafast Science and Technology
Re: Nomination of Robert R. Alfano

I wish to nominate Professor Robert R. Alfano for the 2016 Ahmed Zewail Award in Ultrafast Science and Technology. .

Prof. Alfano has made major contributions to the study of chemical, physical, and biological processes with the far reaching discovery, made in 1970 of the generation of the "white light continuum" now called "Supercontinuum" (SC) using ultrafast laser pulses. The SC source has spread worldwide. The SC has become the ultimate ultrashort white light source. Since its discovery over forty years ago, it has advanced ultrafast laser spectroscopy, high precision optical frequency and time metrology, high capacity wavelength division multiplexing (WDM) communication, optical coherence tomography, light pulse compression, ultrafast laser pulse generation, attosecond pulse and extremely accurate clock generation, high resolution microscopy and nanoscopy, and stimulated emission depletion (STED). The SC is a nonlinear optical effect that is indispensable for the advancement of laser science, biology, chemistry, condensed matter and fundamental physics.

. He extended ultrafast relaxation studies to semiconductors, to spin relaxation, biological systems, nonradiative relaxation of excitation energy of ions in crystals and the measurement of vibrational dephasing times and vibrational decay routes in liquids.

Another of Prof. Alfano's contributions in ultrafast nonlinear optics is the extension of the self phase modulation (SPM) concept to cross-phase modulation (XPM) that provides a modulation scheme for coding different frequencies on an ultrashort pulse for potential application in THz computation and communication.

A detailed description of these discoveries follows in the attached document.

Sincerely,

Martin Pope

Martin Pope
Chemistry Department
Prof. Emeritus

Biographical Sketch
for Ahmed Zewail Award in Ultrafast Science and Technology 2016

ROBERT R. ALFANO

Distinguished Professor of Science & Engineering
Physics Department and Electrical Engineering Department
The City College of the City University of New York
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Robert Alfano discovered the supercontinuum ultrafast laser source which has spread worldwide and has strongly influenced time-resolved spectroscopy, ultrashort light pulse generation, communications, compressed pulses, accurate clocks and metrology. His impacts on fundamental and applied laser science spans many areas of pioneering research such as elucidating ultrafast dynamical processes of electronic and vibrational relaxation in matter, developing several ultrafast Cr^{4+} and Cr^{3+} tunable lasers in NIR from 1100 nm to 1600 nm.

Born: May 7, 1941 in New York, New York

Degree	Institution	Year Conferred
B.S. - Physics	Fairleigh Dickinson University	1963
M.S. - Physics	Fairleigh Dickinson University	1964
Ph.D.- Physics	New York University	1972

Professional Position	Institution	Years Held
Member Technical Staff	GTE Research Labs	1964-1972
Assistant Professor	City College of New York	1972-1974
Associate Professor	City College of New York	1974-1977
Professor	City College of New York	1978-1987
Herbert Kayser Professor	City College of New York	1983-1987
Distinguished Professor	City College of New York	1987-Present

Professional Affiliations: Fellow Member of: APS (1976 -), OSA (1989 -), IEEE (2001 -), NY Academy of Science (1999 -).

Major Awards: A.P. Sloan Fellow (1975-80), Lifetime Achievement Award in Biophotonics (2002) sponsored by the International Society for Optical Engineering (SPIE) and Coherent, Inc., 2008 OSA Charles H Townes Award for supercontinuum and Cr^{3+} and Cr^{4+} doped lasers, 2012 SPIE Britton Chance Biomedical Optics Award, and 2013 APS Arthur L Schawlow Prize in Laser Science.

Publications and Citations: Alfano's prolific scientific contributions of over 700 published articles, 113 patents, 3 edited research monographs and 20 edited conference proceedings have generated over 14,300 citations and 56 h-index.

Accomplishments in Ultrafast Science and Technology:

Robert Alfano made important original contributions to the development of ultrafast laser science and spectroscopy and the understanding of dynamical processes in matter. His crowning achievement is the 1970-discovery, characterization and development of the supercontinuum (SC); the extreme spectral broadening of ultrashort light pulses when focused into a condensed medium, self-focusing, and applications to time-resolved laser spectroscopy published in 3 papers in the same Vol. 24 of the Physics review Letters in 1970. Self phase modulation (SPM) and four-photon mixing were identified as key mechanisms behind SC generation [1]. Alfano first used continuum in pump-probe the inverse Raman effect [2]. Alfano later demonstrated cross phase modulations, [6] the spectral broadening of a weak ultrashort pulse by a co-propagating strong pulse. Prof. Alfano is making major contributions in laser science in the expanding field of singular and structured light [13, 14].

Alfano's other Seminal Contributions include:

- First time-resolved measurement of the optical phonon lifetime, [3] and vibrational dephasing times and day routes in liquids [4]. Alfano extended such studies to carrier spin relaxation in semiconductors, [9] nonradiative relaxation of ions in crystals [11].
- First demonstration of Cr:Forsterite laser and identification of Cr4+ as lasing ion, [5] leading to the development of Cr-based lasers tunable between 1100-1600nm, and LIGO/LISO which span from 1150-1600nm [12].
- Pioneering development of fluorescence spectroscopy [7] and imaging methods [8, 10] that launched the field of non-invasive detection and diagnosis of cancer. Carried out fundamental work to develop detailed understanding of optical pulse propagation through highly scattering media in which he developed time-resolved, space-grating, polarization gate, and nonlinear optical spectroscopic techniques for imaging targets in turbid media [8].
- Introduced a higher order Poincare sphere representation for polarization. This will lead to novel developments utilizing light's orbital and spin angular momentum for classical and quantum information in conjunction with supercontinuum in optical fibers as well as enhancing the degree of freedom of light's orbital angular momentum to spectroscopy [13, 14].

References in Accomplishments:

1970 Observation of Self Phase Modulation and Small Scale Filaments in Crystals and Glasses, R.R. Alfano and S. L. Shapiro, Phys. Rev. Lett, 24, 592 [1]

1971 Picosecond Spectroscopy Using the Inverse Raman Effect, R. R. Alfano and S. L. Shapiro, Chem. Phys. Lett. 8, 631-633 [2].

1971 Optical Phonon Lifetime Measured Directly with Picosecond Pulses, R. R. Alfano and S. L. Shapiro, Phys. Rev. Lett. 26, 1247, [3]

1972 Establishment of a Molecular Vibration Decay Route in Liquid, R. R. Alfano and S. L. Shapiro, Phys. Rev. Lett. 29, 1655, [4]

1988 Laser Action in Chromium-Activated Forsterite for Near-Infrared Excitation: is Cr4+ the lasing ion?, V. Petricevic, S. K. Gayen, and R. R. Alfano, Appl. Phys. Lett. 53, 2590. [5]

1989 Cross-Phase Modulation and Induced Focusing Due to Optical Nonlinearities in Optical Fibers and Bulk Materials , R.R. Alfano, P. L. Baldeck, P. P. Ho and Govind P. Agrawal, J. Opt. Soc. Am. B 6, 824. [6]

1991 Light Sheds Light on Cancer – Distinguishing Malignant Tumors form Benign Tissue and Tumors, R. R. Alfano, B. Das, J. Cleary, R. Prudente, and E. Celmer, Bull. New York Academy Sci. Medicine 67, 143. [7]

1991 Ballistic 2-D Imaging Through Scattering Walls sing an Ultrafast Kerr Gate, L. Wang, P. Ho, C Liu, G. Zhang, R. R. Alfano, Science 253, 769-771. [8]

1992 L6 to X6 Intervalley Scattering Time and Deformation Potential for Al0.6Ga0.4As Determined by Femtosecond and Time-Resolved Infrared Absorption Spectroscopy, W. B. Wang, K. Shum, R. R. Alfano, D. Szmyd, A. J. Nozik, Phys. Rev. Lett. 68,662. [9]

1996 Time Resolved Optical Diffusion Tomography Image Reconstruction in Highly Scattering Turbid Media, W. Cai, B. B. Das, F. Liu, M. Zevallos, M. Lax, R. R. Alfano, Proc. Nat. Acad. Of Sci. 93, 13561. [10]

1997 Dynamics of Local Modes During Nonradiative Relaxation, D. M. Calistru, S. G. Demos, and R. R. Alfano, Phys. Rev. Lett. 78, 374. [11]

2007 Continuous Tunable Laser Operation in Both the 1.31 and 1.55μm Telecommunications Windows in LiIn(Si/Ge)O4 Olivines Doped with Trivalent Chromium, M. Sharanov, V. Petricevic, A. Bykov, and R. R. Alfano, Opt. Lett. 32, 3489-3491. [12]

2011 Higher-Order Poincaré Sphere, Stokes Parameters, and the Angular Momentum of Light, Giovanni Milione, H. I. Sztul, D. A. Nolan, R. R. Alfano, Phys. Rev. Lett., 107, 053601. [13]

2012 Higher-order Pancharatnam-Berry Phase and the Angular Momentum of Light, Giovanni Milione, S. Evans, D. A. Nolan, R. R. Alfano, Phys. Rev. Lett. 108, 190401. [14]

ROBERT R. ALFANO
Distinguished Professor of Science & Engineering

List of 20 (out of total 700) most significant publications that address the general area of Ahmed Zewail Award's in Ultrafast Science and Technology purpose

Patents:

1. Picosecond Spectrometer Using Picosecond Continuum - Robert R. Alfano and Stanley L. Shapiro, Patent 3,782,828 (Jan. 1, 1974).
2. Tetravalent Chromium (Cr^{4+}) as a Laser-Active Ion for Tunable Solid-State Lasers, R. R. Alfano, V. Petricevic, #4,987,575 (January 22, 1991).
3. Non-linear optical tomography of turbid media, Robert R. Alfano, Yici Guo, Feng Liu, Ping Pei Ho, #6,208,886 B1, March 27, 2001.

Articles:

1. R. R. Alfano and S. L. Shapiro, Observation of Self-Phase Modulation and Small Scale Filaments in Crystals and Glasses, Phys. Rev. Lett. **24**, 592-594 (1970).
2. R. R. Alfano and S. L. Shapiro, Emission in the Region from 4000 to 7000 **Å** via Four Photon Coupling in Glass, Phys. Rev. Lett. **24**, 584-587 (1970).
3. R. R. Alfano and S. L. Shapiro, Direct Distortion of Electronic Clouds of Rare Gas Atoms in Intense Electric Fields, Phys. Rev. Lett. **24**, 1217-1220 (1970).
4. R. R. Alfano and S. L. Shapiro, Picosecond Spectroscopy Using the Inverse Raman Effect, Chem. Phys. Lett. **8**, 631-633 (1971).
5. R. R. Alfano and S. L. Shapiro, Optical Phonon Lifetime Measured Directly with Picosecond Pulses, Phys. Rev. Lett. **26**, 1247-1251 (1971).
6. R. R. Alfano, and S. L. Shapiro, Establishment of a Molecular Vibration Decay Route in a Liquid, Phys. Rev. Lett. **29**, 1655-1658 (1972).
7. R. R. Alfano, S. L. Shapiro and M. Pope, Fission Rate of Singlet Excitons in Tetracene Crystal Measured with Picosecond Laser Pulses, Opt. Commun. **9**, 388-391 (1973).
8. M. Seibert and R. R. Alfano, Probing Photosynthesis on a Picosecond Time Scale - Evidence in Photosystem I and Photosystem II Fluorescence in Chloroplasts, Biophys. J. **14**, 269-283 (1974).
9. W. Yu, and R. R. Alfano, Multiple Photon Scattering in Diamond, Phys. Rev. A **11**, 188 (1975).
10. R. R. Alfano, P. P. Ho, P. A. Fleury, and H. J. Guggenheim, Nonlinear Optical Effects in Antiferromagnetic KNiF, Opt. Commun. **19**, 261 (1976).
11. P. P. Ho and R. R. Alfano, Temperature Dependence of the Rotational Relaxation Times of Anisotropic Molecules in Pure and Mixed Liquids, Chem. Phys. Lett. **50**, 74 (1977).
12. W. Yu, F. Pellegrino, M. Grant, R. R. Alfano, Subnanosecond Fluorescence Quenching of Dye Molecules in Solution, J. Chem. Phys. **67**, 1766 (1977).
13. R. Seymour and R. R.Alfano, Time Resolved Measurement of Electron Spin Relaxation Kinetics in GaAs, Appl. Phys. Lett. **37**, 231 (1980).
14. F. Pellegrino, A. Dagen, and R. R. Alfano, Fluorescence Polarization Anisotropy and Kinetics of Malachite Green Measured as a Function of Solvent Viscosity, Chem. Phys. **67**, 111 (1982).
15. Z. X. Yu, P. Y. Lu and R. R. Alfano, Temperature Dependence of J-Band Aggregate of the Dye 1,1'Diethyl-2,2'-Cyanine Bromide Studied by Steady State and Time Resolved Picosecond Fluorescence Spectroscopy, Chem. Phys. **79**, 289-296 (1983).
16. R. R. Alfano, Q. X. Li, T. Jimbo, J. T. Manassah, and P. P. Ho, Induced Spectral Broadening of a Weak Picosecond Pulse in Glass Produced by an Intense Picosecond Pulse, Opt. Lett. **11**, 626 (1986).
17. R. R. Alfano, P. L. Baldeck, F. Raccah, and P. P. Ho, Cross Phase Modulation Measured in Optical Fibers, Appl. Opt. **26**, 3491 (1987).

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October 31, 2014

Members of the Award Committee
The Ahmed Zewail Award in Ultrafast Science and Technology
American Chemical Society
1155 16th Street, NW Washington, DC 20036-4801

Dear Selection Committee:

It is my understanding that Professor Alfano has been nominated for the Ahmed Zewail Award in Ultrafast Science and Technology. In my opinion, this nomination deserves the most serious consideration. I have known Dr. Alfano since the early 1970's when he was a graduate student at NYU and started his experiments on supercontinuum generation, self phase modulation, four wave mixing, cross phase modulation, self focusing, and first measurements of optical phonon lifetimes in crystals as well as decay route of vibrations in organic liquids at GTE Labs (now Verizon). First direct measurement of spin relaxation lifetime of electrons in GaAs was also done by him at that time. Later he made major inroads to biology in photosynthesis and vision and now in biomedical optics.

Now, he is my colleague at the City College of the City University of New York. I have followed his development of the field of ultrafast spectroscopy during the past four decades. He is clearly one of the most innovative scientists who made major accomplishments and still contributes to the areas of ultrafast science and technology. He is one of the leaders in applying ultrafast techniques to solid state, chemical, biological, and medical research problems. I believe that Prof. Alfano's contributions to the understanding and ultrafast applications of lasers is worthy to be distinguished by the Ahmed Zewail Award.

Bob has graduated 55 PhD students, among them Distinguished Professors Anthony Johnson and Peter Delfyett

Last but not the least Bob deserves great credit for his long-time support and training students of underrepresented minority groups in state of the art science using light. Eight of his PhD students are from minority --under represented groups.

Robert Alfano's name will do honor to the list of recipients of the Zewail award.

Sincerely yours,

Joseph L Birman
Distinguished Professor of Physics
Department of Physics
CCNY

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October 23, 2014

Member of the Award Committee
The Ahmed Zewail Award in Ultrafast Science and Technology
American Chemical Society
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Dear Selection Committee:

I am pleased to write this letter in support of the nomination of Professor Robert R. Alfano of City University of New York for the Ahmed Zewail Award in Ultrafast Science and Technology.

My primary knowledge is of Professor Alfano's early pioneering work. He has made important contributions to laser technology with applications to nonlinear optics. With Stanley Shapiro, he demonstrated that the self spectral broadening of short intense optical pulses, now known as supercontinuum was only bounded by the physical properties of the broadening medium.

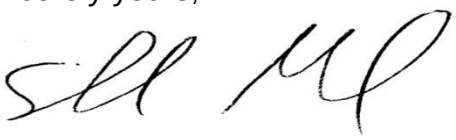
Currently there are at least 5 companies commercializing the supercontinuum lasers of various types for science and technology applications. Many labs had used supercontinuum as enabling technology which is widely applied to studies of ultrafast chemistry, biology, and condensed matter. Bob was the first to discover cross phase modulation (XPM) in glass and fibers for new optical modulation schemes. Self-broadening of pulses has played an important role in ultrafast science and in the development of optical frequency standards.

Bob was the first to use the continuum in pump-probe experiments involving the inverse Raman effect for molecular vibrations (Chem. Phys, Lett. 8, 631, 1971). He had also performed novel applications of short laser pulses to study molecular relaxation in chemical and biological systems. Bob's work has also had significant impact on a

number of areas of ultrafast laser technology including the invention of the femtosecond tunable Cr:forsterite and Cr:cunyite lasers.

Bob has published over 700 papers in optical science with citation index over 14,000 and h-index 56. Based on my knowledge of his early research and his continuing contributions to laser technology, he will be a well-deserving candidate for the Ahmed Zewail Award in Ultrafast Science and Technology.

Sincerely yours,



Shaul Mukamel
Distinguished Professor of Chemistry