WSS/CI Western States Section/Combustion Institute

2022 SPRING TECHNICAL MEETING
WESTERN STATES SECTION OF THE COMBUSTION INSTITUTE
Stanford University – Stanford, CA

Monday, 21 March 2022

7:30 – 4:00 **Registration:** Basement of Building 380 (marked on map)
7:30 – 8:00 **Breakfast:** Outside Patio of Building 380 (marked on map)
8:00 – 8:15 **Welcome Address in 420-041**
Welcome Remarks: Dr. Ellen Kuhl, *Walter B. Reinhold Professor in the School of Engineering*
Robert Bosch Chair and Professor of Mechanical Engineering, Stanford University

8:15 – 9:15 **Plenary Lecture in 420-041: Dr. Nicole Labbe, University of Colorado at Boulder**
Title: *Next Generation Microreactors for Rapid Reaction Speciation Data*
Session Chair: G. Blanquart, *Caltech*

9:15 – 9:25	**Transition to Morning Sessions**		
	Turbulent and Laminar Flames **420-041** **Session Chair: C. Wei**	**Detonations, Explosions, and Supersonic Combustion I** **380X** **Session Chair: M. Hajilou**	**Internal Combustion Engines I** **380Y** **Session Chair: V. Rapp**
9:25 – 9:45	**1A01: Using tabulated chemistry to capture non-unity Lewis number effects in turbulent premixed flames** *M.X. Yao, P. Samimy, G. Blanquart* *California Institute of Technology*	**1B01: Toward fidelity-adaptive simulation of a cavity-stabilized scramjet combustor** *M. Bonanni, M. Ihme* *Stanford University*	**1C01: Comparative analysis of a spark-ignited CFR engine operation on compressed natural gas and liquefied petroleum gas at stoichiometric conditions** *T. Fosudo, T. Kar, B. Windom, D. Olsen* *Colorado State University*
9:45 – 10:05	**1A02: Turbulent flame propagation of multi-component gasoline surrogate fuel** *B.S. Soriano, T.M. Nguyen, J.H. Chen* *Sandia National Laboratories*	**1B02: Large eddy simulation of a rotating detonation rocket engine** *G. Vignat, D. Brouzet, M. Bonanni, M. Ihme* *Stanford University*	**1C02: Effect of fuel composition on spark-ignited engine combustion with LPG: Experimental and numerical investigations** *T. Kar, T. Fosudo, A. Marchese, B. Windom, D.B. Olsen* *Colorado State University*
10:05 – 10:25	**1A03: Vortex breakdown in swirling Burke-Schumann flames** *B.W. Keeton, K.K. Nomura, A.L. Sánchez, F.A. Williams* *University of California San Diego*	**1B03: Detonation propagation in curved channels: A geometric modeling case study** *X. Shi[1], R.J. Hencel[2], J. Crane[3], M.L. Fotia[2], H. Wang[1]* *[1]Stanford University* *[2]Innovative Scientific Solutions Inc.* *[3]Queen's University*	**1C03: Impact of oxygen and carbon dioxide levels on combustion under Argon Power Cycle conditions** *G. Beardsell[1], D. Bestel[1], D. Kozarac[1], M. Sierra Aznar[1,2], J.-Y. Chen[2], R.W. Dibble[1,2]* *[1]Noble Thermodynamic Systems, Inc.* *[2]UC Berkeley*

	Turbulent and Laminar Flames 420-041 Session Chair: C. Wei	Detonations, Explosions, and Supersonic Combustion I 380X Session Chair: M. Hajilou	Internal Combustion Engines I 380Y Session Chair: V. Rapp
10:25 – 10:45	**1A04: Experimental evaluation of double Tsuji flame dimensions** *J.A. Barbosa[1], J.C. de Andrade[1], M.P. Severino[2], V.M. Sauer[3], F.F. Fachini[1]* *[1]Instituto Nacional de Pesquisas Espaciais* *[2]Universidade de São Paulo* *[3]California State University Northridge*	**1B04: Study of detonation structures by solving the spatially-filtered Euler equations** *A. Baumgart, G. Blanquart* *California Institute of Technology*	**1C04: Physical and chemical properties of extended-alkyl oxymethylene ethers for compression ignition fuel use** *S.P. Lucas[1], A. Gilbert[1], F.L. Chan[1], J. Luecke[2], J. Zhu[3], C. McEnally[3], B. Windom[1]* *[1]Colorado State University* *[2]National Renewable Energy Laboratory* *[3]Yale University*
10:45 – 11:00	**BREAK**		
	Turbulent Flames **420-041** **Session Chair: V. Sauer**	**Numerical Methods and Machine Learning Techniques Applied to Combustion I** **380X** **Session Chair: A. Ferris**	**Internal Combustion Engines II** **380Y** **Session Chair: D. Olsen**
11:00 – 11:20	**1A05: Numerical simulation of Ammonia/Air non-premixed turbulent combustion in porous media** *G. Ponce, K.R. Anderson* *California State Polytechnic University*	**1B05: Training on lossy compressed data in combustion machine learning** *W.T. Chung, M. Ihme* *Stanford University*	**1C05: Simulations of combustion chamber outflow configurations for a hybrid rocket motor** *A.T. Carroll[1], C. Dhandapani[1], G. Blanquart[1], J. Rabinovitch[2]* *[1]California Institute of Technology* *[2]Stevens Institute of Technology*
11:20 – 11:40	**1A06: Flame-flame interactions in premixed hydrocarbon flame with varying Reynolds number** *S. Trivedi[1], A. Attili[2], R.S. Cant[1]* *[1]University of Cambridge* *[2]University of Edinburgh*	**1B06: Optimal state estimation by Ensemble Kalman Filter for shock tube simulation in n-heptane/iso-octane surrogate mixture** *S. You[1], D. Barajas-Solano[2], D. Tartakovsky[3], D. Brouzet[1], M. Ihme[1]* *[1]Stanford University* *[2]Pacific Northwest National Laboratory* *[3]Stanford University*	**1C06: High fidelity simulations of supercritical CO_2 based oxy-combustion with non-ideal equation of state** *O.A. Doronina, B.A. Perry, S. Yellapantula* *National Renewable Energy Laboratory*
11:40 – 12:00	**1A07 (Virtual): Fractal characteristics of premixed ammonia/hydrogen/nitrogen flames in intense sheared turbulence at different pressures** *M. Rieth[1], A. Gruber[2], J.H. Chen[1]* *[1]Sandia National Laboratories* *[2]SINTEF Energy Research*	**1B07: Predicting physiochemical properties using molecular descriptors and machine learning models** *A.E. Comesana[1], T.T. Huntington[1,2,] C.D. Scown[1,2,4], K.E. Niemeyer[3], V.H. Rapp[1]* *[1]Lawrence Berkeley National Laboratory* *[2]Joint BioEnergy Institute* *[3]Oregon State University* *[4]University of California Berkeley*	**1C07 (Virtual): Initial measurements with a miniature, portable solid fuel ramjet slab burner** *J. Kalman, A. Guerra* *California State University Long Beach*

	Turbulent Flames 420-041 Session Chair: V. Sauer	Numerical Methods and Machine Learning Techniques Applied to Combustion I 380X Session Chair: A. Ferris	Internal Combustion Engines II 380Y Session Chair: D. Olsen
12:00 – 12:20	**1A08 (Virtual): Effect of momentum ratio on methane jet diffusion flames in crossflow** *S. Simons-Wellin, C.B. Lapointe, S. Coburn, S. Sheppard, A. Makowiecki, J.F. Glusman, J.W. Daily, J.A. Farnsworth, G.B. Rieker, P.E. Hamlington* *University of Colorado*	**1B08 (Virtual): Monitoring catalysts synthesis using real-time emission spectroscopy and advanced machine learning models** *C. Wang, B. Ko, M.O Najimu, E. Sasmaz* *University of California Irvine*	**1C08: Characterization of a commercial 200kW recuperated gas turbine operated on mixtures of hydrogen and natural gas** *W. Villatoro, V. McDonell* *University of California Irvine*
12:20 – 13:45	**LUNCH** **Women in Combustion Luncheon sponsored by Ansys: 420-041** **Featuring Invited Guest Speaker Jeanette Borzo** "Unleash your Inner Genius: How to Get More of the Professional Success We Crave"		
	Fire and Fire Safety I **420-041** **Session Chair: S. Adusumilli**	**Diagnostics** **380X** **Session Chair: F. Di Sabatino**	**Novel Combustion Systems** **380Y** **Session Chair: K. Anderson**
13:45 – 14:05	**1A09: Comparing the combined effects of ambient pressure and external heat flux on flame spread rate behavior in vertical PMMA cylinders** *C. Liveretou[1], C. Scudiere[1], M. Thomsen[2], C. Fernandez-Pello[1], M. Gollner[1], S. Olson[3], P. Ferkul[3]* *[1]University of California - Berkeley* *[2]Universidad Adolfo Ibáñez* *[3]NASA Glenn Research Center*	**1B09: Schlieren and CH*-emission imaging of autoignition through the side walls of a round shock tube** *A.J. Susa, R.K. Hanson* *Stanford University*	**1C09: Performance of tankless and storage water heaters operated on mixtures of hydrogen and natural gas** *Y. Zhao, V. McDonell* *University of California Irvine*
14:05 - 14:25	**1A10: The effect of enclosure dimensions on fire whirl formation and emissions** *J.L. Dowling, M. Hajilou, M.J. Gollner* *University of California Berkeley*	**1B10: Quantitative volumetric laser absorption imaging of flame thermochemistry exploiting line-mixing effects of methane** *C. Wei[1], K.K. Schwarm[1], D.I. Pineda[2], R.M. Spearrin[1]* *[1]University of California Los Angeles* *[2]The University of Texas at San Antonio*	**1C10: Hydrocarbon ignition on high surface area pt-electroplated wires** *Y. Shi[1], J.J. Whalen[1], P.D. Ronney[2]* *[1]University of Southern California* *[2]Pasadena Bioscience Collaborative*
14:25 - 14:45	**1A11 (Virtual): Parametric study of anisotropic thermal conductivity of decomposing carbon fiber epoxy composites** *G.B. Anleu[1], J.C. Hewson[1], M.W. Kury[1], J.P. Hidalgo[2], R.M. Hadden[3], S.N. Scott[1]* *[1]Sandia National Laboratories* *[2]The University of Queensland* *[3]The University of Edinburgh*	**1B11: Turbulence-driven bias in time-averaged laser absorption tomography of correlated thermochemical fluctuations** *C. Wei[1], N. Perakis[2,3], D.I. Pineda[4], M. Ihme[2], R.M. Spearrin[1]* *[1]University of California Los Angeles* *[2]Stanford University* *[3]Technical University of Munich* *[4]The University of Texas at San Antonio*	**1C11: Numerical modeling of heat-recirculating combustors: Geometrical and chemical effects** *P. Bhuripanyo, P. Ronney* *University of Southern California*

	Fire and Fire Safety I 420-041 Session Chair: S. Adusumilli	Diagnostics 380X Session Chair: F. Di Sabatino	Novel Combustion Systems 380Y Session Chair: K. Anderson
14:45 - 15:05	**1A12 (Virtual): Numerical study on the influence of chimney effect on fire behavior of rainscreen façades** *A. Sharma[1,2], K.B. Mishra[2]* *[1]Case Western Reserve University* *[2]Indian Institute of Technology Roorkee*	**1B12: A mid-infrared laser absorption diagnostic for CO and temperature measurements in first-stage ignition** *S. Clees, R. Choudhary, V. Boddapati, R.K. Hanson* *Stanford University*	**1C12 (Virtual): Performance of bi-metallic Cu-Mn oxygen carrier for chemical looping combustion with oxygen uncoupling in presence of SO_2** *T. Barua, M.H. Talebi, B. Padak* *University of California Irvine*
15:05 - 15:25	**1A13 (Virtual): Initial investigation of carbon dioxide hydrate fire extinguishment** *E. Jeon, G.S. Tahim, N. Saeidi, Y.C Chein* *University of California Irvine*	**1B13 (Virtual): Time-resolved mass loss measurements of composite materials subjected to radiant heating** *C. Winters, D. Roybal, T. Fitch, J. Engerer* *Sandia National Laboratories*	**1C13 (Virtual): Simulations of low Mach number reactive flows coupled with electric fields** *L. Esclapez[1], M. Day[1], J. Bell[2]* *[1]National Renewable Energy Laboratory* *[2]Lawrence Berkeley National Laboratory*
15:25 - 15:40	**BREAK**		
	Fire and Fire Safety II 420-041 Session Chair: E. Belmont	**Chemical Kinetics 380X Session Chair: X. Shi**	**Heterogeneous Combustion 380Y Session Chair: D. Brouzet**
15:40 - 16:00	**1A14: A physics-based ignition model with detailed chemical kinetics with application to live fuel burning studies** *D. Behnoudfar, K.E. Niemeyer* *Oregon State University*	**1B14: Ignition delay time measurements and model improvements of syngas with H_2S in supercritical CO_2 systems** *P. Biswas, J. Shao, R. Choudhary, D.F. Davidson, R.K. Hanson* *Stanford University*	**1C14: Analysis of the hot surface ignition limits of a wall-stagnating fuel spray** *D. Mohaddes, M. Ihme* *Stanford University*
16:00 - 16:20	**1A15: RADLIB radiative property library for combustion simulations** *D.O. Lignell, V.B. Stephens, I. Wheeler, S. Jensen* *Brigham Young University*	**1B15: A theory based low temperature ignition mechanism for 2-butanol** *K.S. Lockwood[1], S.F. Ahmed[2], T.D. Foust[2], N.J. Labbe[1]* *[1]University of Colorado Boulder* *[2]National Renewable Energy Laboratory*	**1C15: Evaluation of the Nusselt number for a fluid sphere in Stokes flow** *B.D. Shaw, C.L. Vang* *University of California, Davis*
16:20 - 16:40	**1A16: Uncertainty analysis for chemical kinetic parameters and thermophysical properties in smoldering combustion of wildland fuels** *W.J. Jayasuriya, K.E. Niemeyer* *Oregon State University*	**1B16: Towards HyChem modeling of kinetics of distillate fuels in the NTC regime** *R. Choudhary[1], V. Boddapati[1], S. Clees[1], P. Biswas[1], J. Shao[1,2], D.F. Davidson[1], R.K. Hanson[1]* *[1]Stanford University* *[2]Beijing Institute of Technology*	**1C16: An analysis of the required scalar dissipation rate and minimum particle size for MILD coal combustion** *H. Zhou, J.C. Sutherland* *University of Utah*

	Fire and Fire Safety II 420-041 Session Chair: E. Belmont	Chemical Kinetics 380X Session Chair: X. Shi	Heterogeneous Combustion 380Y Session Chair: D. Brouzet
16:40 - 17:00	**1A17 (Virtual): Simulations of large-scale wildfire scenarios using Tensorflow compute architectures** *Q. Wang[1], M. Ihme[1,2], Y.-F. Chen[1], J. Anderson[1]* *[1]Google* *[2]Stanford University*	**1B17: Development of error-controlled compact mechanisms using reduction and optimization** *G. Litrico, K. Puduppakkam, C. Naik, E. Meeks* *ANSYS Inc.*	**1C17: HOMO-LUMO gaps of large polycyclic aromatic hydrocarbons and their implication on the quantum confinement behavior of flame-formed carbon nanoparticles** *N. Kateris, A.S. Jayaraman, H. Wang* *Stanford University*
17:00 - 17:20	**1A18 (Virtual): Wind effects on smoldering behavior of simulated wildland fuels** *J. Cobian-Iñiguez[1,2], H. Xiong[2,3], C. Liveretou[2], L. Carmignani[2], F. Richter[2], C. Fernandez-Pello[2], M. Gollner[2], S. Stephens[2], M. Finney[4]* *[1]University of California, Merced* *[2]University of California, Berkeley* *[3]University of Science and Technology, China* *[4]US Forest Service*		**1C18 (Virtual): Analysis of noisy radiometer data from ISS reduced gravity droplet combustion experiments** *S. Das, B.D. Shaw* *University of California, Davis*
16:45 - 17:45	**Special Session:** **Exponent, Inc.: Engineering and Scientific Consulting - Information Session** Location: 380F		
18:00 – 20:00	**Reception sponsored by NSF –** Paul Brest Hall		
20:00	**Young Researcher Mixer sponsored by Exponent –** Treehouse		

WSS/CI Western States Section/Combustion Institute

Tuesday, 22 March 2022

7:30 – 12:00 Registration: Basement of Building 380 (marked on map)
7:30 – 8:00 Breakfast: Outside Patio of Building 380 (marked on map)
8:00 – 8:05 Opening Announcements in 420-041
8:05 – 9:05 Plenary Lecture in 420-041: Dr. Michael Gollner, *U.C. Berkeley*
Title: *The Role of Combustion in Wildland Fire Science*
Session Chair: D. Blunck, *Oregon State University*

9:05 – 9:15	**Transition to Morning Sessions**		
	Fire and Fire Safety III **420-041** **Session Chair: D. Lignell**	**Numerical Methods and Machine Learning Techniques Applied to Combustion II** **380X** **Session Chair: A. Comesana**	**Internal Combustion Engines III** **380Y** **Session Chair: B. Windom**
9:15 – 9:35	**2A01: Flammability limits of cellulose powder under varying oxygen, heating and wind conditions** *P. Garg, I. Shan, M. Hajilou, C. Fernandez-Pello, M.J. Gollner* *University of California - Berkeley*	**2B01: A cost function for optimizing manifold topology in reduced-order modeling** *E. Armstrong[1], K. Zdybał[2], A. Parente[2], J.C. Sutherland[1]* *[1]University of Utah* *[2]Université Libre de Bruxelles*	**2C01: Ultra high efficiency combustion in a spark ignited heavy duty natural gas engine** *J. Felipe Rodriguez[1], D. Bestel[1], H. Xu[2], G. Hampson[3], B. Windom[1], A. Marchese[1], D.B. Olsen[1]* *[1]Colorado State University* *[2]Cummins Inc.* *[3]Woodward Inc.*
9:35 – 9:55	**2A02: Energy deposition by firebrands generated from tree-scale burns** *S. Adusumilli, D. Blunck* *Oregon State University*	**2B02: Flammability limit prediction of hydrogen-air flames using DSMC** *S. Trivedi, J.K. Harvey, R.S. Cant* *University of Cambridge*	**2C02: Experimental investigation on the effects of passive pre-chamber geometry and ignition system on the engine heat release rate profiles** *F. Di Sabatino[1], P.J. Martinez-Hernandiz[2], R. Novella Rosa[2], I. Ekoto[1]* *[1]Sandia National Laboratories Livermore* *[2]Universitat Politècnica de València*
9:55 – 10:15	**2A03: Experimental study on smoldering and flaming ignition of natural fuel by hot stainless steel, and brass particles** *S. Saha, N. Maldonado, A.V. Juarez, Y. Guo, J. Cobian-Iñiguez* *University of California, Merced*	**2B03 (Virtual): Performance of dynamically bi-orthonormal decomposition based reduced-order modeling in capturing strongly transient combustion phenomena** *S. Desai[1], Y. Shimizu[1], M. Donello[2], H. Babaee[2], J.H. Chen[1]* *[1]Sandia National Laboratories* *[2]University of Pittsburgh*	**2C03: Simulation of a high-efficiency engine fueled by dilute anode tail-gas** *M.A. Valles Castro, D. Olsen, T. Bandhauer, Z. Swartwout, B.C. Windom* *Colorado State University*

	Fire and Fire Safety III 420-041 Session Chair: D. Lignell	Numerical Methods and Machine Learning Techniques Applied to Combustion II 380X Session Chair: A. Comesana	Internal Combustion Engines III 380Y Session Chair: B. Windom
10:15 – 10:35	**2A04: Minimally invasive instrumentation for mock fire scenarios** *B.C. Houchens[1], E. M.C. Jones[2], E.T. Zepper[2], A.W. Murphy[2], E.C. Quintana[2]* *[1]Sandia National Laboratories, Livermore* *[2]Sandia National Laboratories, Albuquerque*	**2B04 (Virtual): Implementation of manifold-based combustion models in a highly scalable low Mach number reacting flow solver** *B.A. Perry, M.T.H. de Frahan, S. Yellapantula, M.S. Day* *National Renewable Energy Laboratory*	**2C04: Optimizing efficiency of an SI engine fueled by simulated exhaust anode tail-gas** *Z. Swartwout, T. Bandhauer, B. Windom, S. Garland, R. Braun, D.B. Olsen* *Colorado State University*
10:35 – 10:55	**2A05: Impacts of chemical composition and seasonal variability on ignition and burning of live fuels** *H. Fazeli[1], E. Conrad[2], W.M. Jolly[2], D.L. Blunck[1]* *[1]Oregon State University* *[2]USDA Forest Service*		**2C05: Use of direct and alternating current ion sensor for pre-ignition detection** *E. Singh, R.W. Dibble* *King Abdullah University of Science and Technology*
10:55 – 11:10	**BREAK** ***The 2022 Spring Hybrid Meeting of the Western States Section of The Combustion Institute*** is brought to you by: Ansys Exponent FM Global National Science Foundation		
	Biomass Combustion and Gasification **420-041** **Session Chair: N. Labbe**	**Detonations, Explosions, and Supersonic Combustion II** **380X** **Session Chair: B. Houchens**	**Internal Combustion Engines IV** **380Y** **Session Chair: D. Bestel**
11:10 – 11:30	**2A06 (Virtual): An investigation into the depletion of oxygen in fuel bed fires** *A.N. Howell[1], E.L. Belmont[1], S.S. McAllister[2], M.A. Finney[2]* *[1]The University of Wyoming* *[2]US Forest Service*	**2B06: Isolating gasdynamic and chemical effects on detonation cellular structure and regularity** *X. Shi[1], P.A. Meagher[2], J.P. Santos[1], N.K. Muraleedharan[1], J. Crane[3], A.Y. Poludnenko[2], X. Zhao[2], H. Wang[1]* *[1]Stanford University* *[2]University of Connecticut* *[3]Queen's University*	**2C06: Autoignition and flame speed of premixed liquefied petroleum gas in a rapid compression machine: Experimental results and reduced chemical kinetic mechanism** *C. Slunecka[1], A. Zdanowicz[1], S. Bhoite[1], I. Kessler[1], S. Vaughan[1], B. Windom[1], D. Olsen[1], A.J. Marchese[2]* *[1]Colorado State University* *[2]University of Rhode Island*
11:30 – 11:50	**2A07 (Virtual): TLUD production of Bonechar for the removal of fluoride from drinking water** *M.E. Baumgardner, N.R. Frojelin, R.B. Bahr, A. Graves, N. Stanton, K. Nolan, K. Shimabuku* *Gonzaga University*	**2B07 (Virtual): Ignition delay study of cracked JP10** *Saifullah, N. Agrawal, A. Bansal* *Indian Institute of Technology Roorkee*	**2C07: Autoignition and spark ignition study of premixed liquefied petroleum gas in a rapid compression machine** *S. Bhoite[1], C. Slunecka[1], B. Windom[1], D. Olsen[1], A.J. Marchese[2]* *[1]Colorado State University* *[2]University of Rhode Island*

	Biomass Combustion and Gasification 420-041 Session Chair: N. Labbe	Detonations, Explosions, and Supersonic Combustion II 380X Session Chair: B. Houchens	Internal Combustion Engines IV 380Y Session Chair: D. Bestel
11:50 – 12:10	**2A08 (Virtual): Effect of additives in non-isothermal biomass pyrolysis** *Y. Wongmat, D.R. Wagner* *San José State University*	**2B08 (Virtual): Effect of ozone addition and LTC on DME detonation** *M.C. Brown, E.L. Belmont* *The University of Wyoming*	**2C08 (Virtual): Engine speed and fuel effects on knock for high compression ratio spark ignition engines** *A.S. Bahar, B. Akih-Kumgeh* *Syracuse University*
12:10 – 12:30	**2A09 (Virtual): Devolatilization behavior of brewer's grain for energy production** *S. Fogelquist, D.R. Wagner* *San José State University*		**2C09 (Virtual): Engine CFD analysis of soot emissions from gasoline-alcohol blends under low-load gasoline compression ignition conditions** *K.C. Kalvakala[1], P. Pal[1], G. Kukkadapu[2], M. McNenly[2], S. Wagnon[2], R. Whitesides[2], S.K. Aggarwal[3]* *[1]Argonne National Laboratory* *[2]Lawrence Livermore National Laboratory* *[3]University of Illinois at Chicago*
12:30 – 12:50	**2A10 (Virtual): Analysis of biochar combustion and combustion systems on powering a Stirling engine** *K. Vickery, S. Qiu* *West Virginia University*		
12:50 **13:00**	**Adjourn** **SLAC National Accelerator Laboratory Virtual Tour** ***The 2022 Spring Hybrid Meeting of the Western States Section of The Combustion Institute*** was brought to you by: Ansys Exponent FM Global National Science Foundation		