

Stanford



Brian Cantwell

Edward C. Wells Professor in the School of Engineering and Professor of Mechanical Engineering, Emeritus
Aeronautics and Astronautics

CONTACT INFORMATION

- **Administrator**

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Bio

BIO

Professor Cantwell's research interests are in the area of turbulent flow. Recent work has centered in three areas: the direct numerical simulation of turbulent shear flows, theoretical studies of the fine-scale structure of turbulence, and experimental measurements of turbulent structure in flames. Experimental studies include the development of particle-tracking methods for measuring velocity fields in unsteady flames and variable density jets. Research in turbulence simulation includes the development of spectral methods for simulating vortex rings, the development of topological methods for interpreting complex fields of data, and simulations of high Reynolds number compressible and incompressible wakes. Theoretical studies include predictions of the asymptotic behavior of drifting vortex pairs and vortex rings and use of group theoretical methods to study the nonlinear dynamics of turbulent fine-scale motions. Current projects include studies of fast-burning fuels for hybrid propulsion and decomposition of nitrous oxide for space propulsion.

ACADEMIC APPOINTMENTS

- Emeritus Faculty, Acad Council, Aeronautics and Astronautics
- Affiliate, Precourt Institute for Energy
- Affiliate, Stanford Woods Institute for the Environment

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Elected Member, National Academy of Engineering (2013 - present)

PROFESSIONAL EDUCATION

- PhD, Caltech (1976)

LINKS

- <https://web.stanford.edu/~cantwell/>: <https://web.stanford.edu/~cantwell/>

Teaching

COURSES

2020-21

- Air and Space Propulsion: AA 103 (Spr)
- Aircraft and Rocket Propulsion: AA 283 (Win)
- Fundamentals of Compressible Flow: AA 210A (Aut)

2019-20

- Advanced Rocket Propulsion: AA 284A (Win)
- Aircraft and Rocket Propulsion: AA 283 (Win)
- Fundamentals of Compressible Flow: AA 210A (Aut)
- Introduction to Symmetry Analysis: AA 218 (Spr)

2018-19

- Air and Space Propulsion: AA 103 (Spr)
- Aircraft and Rocket Propulsion: AA 283 (Win)
- Fundamentals of Compressible Flow: AA 210A (Aut)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Jonathan Ho, Sean Young

Doctoral Dissertation Advisor (AC)

Eylul Bilgin, Veronika Korneyeva, Matt Subrahmanyam

Orals Evaluator

Sean Young

Doctoral Dissertation Co-Advisor (AC)

Efaine Chang

Master's Program Advisor

Max Newport, JJ Parson, Ashwyn Sam, Tal Schwartz, Preston Wang, Shouyang You

Publications

PUBLICATIONS

- **Similarity solution of fuel mass transfer, port mass flux coupling in hybrid propulsion** *JOURNAL OF ENGINEERING MATHEMATICS*
Cantwell, B. J.
2014; 84 (1): 19-40
- **Nitrogen removal with energy recovery through N₂O decomposition** *ENERGY & ENVIRONMENTAL SCIENCE*
Scherson, Y. D., Wells, G. F., Woo, S., Lee, J., Park, J., Cantwell, B. J., Criddle, C. S.
2013; 6 (1): 241-248
- **Review and evaluation of models for self-pressurizing propellant tank dynamics**
ZIMMERMAN, J., E., WAXMAN, B., S., CANTWELL, B., J., ZILLIAC, G.
2013
- **Hybrid rocket propulsion and in-situ propellant production for future Mars missions**
BOIRON, A., J., CANTWELL, B., J.
2013
- **Mass flow rate and isolation characteristics of injectors for use with self-pressurizing oxidizers in hybrid rockets**
WAXMAN, B., S., ZIMMERMAN, J., E., CANTWELL, B., J., ZILLIAC, G.

2013

- **Similarity solution of fuel mass transfer, port mass flux coupling in hybrid propulsion.** *Journal of Engineering Mathematics*
CANTWELL, B., J.
2013; 84 (1)
- **A thermal model for analysis and control of drilling in icy formations on mars** *PLANETARY AND SPACE SCIENCE*
Szwarc, T., Aggarwal, A., Hubbard, S., Cantwell, B., Zacny, K.
2012; 73 (1): 214-220
- **Visualization of the liquid layer combustion of paraffin fuel for hybrid rocket applications**
CHANDLER, A., A., JENS, E., CANTWELL, B., J., HUBBARD, G., S.
2012
- **Initial experimental investigations of self-pressurizing propellant dynamics**
ZIMMERMAN, J., E., CANTWELL, B., J., ZILLIAC, G.
2012
- **Peregrine Hybrid Rocket Motor Ground Test Results**
ZILLIAC, G., WAXMAN, B., S., DYER, J., KARABEYOGLU, M., A., CANTWELL, B., J.
2012
- **Effects of injector design and impingement techniques on the atomization of self-pressurizing oxidizers**
WAXMAN, B., S., CANTWELL, B., J., ZILLIAC, G.
2012
- **Feasibility of a single port Hybrid Propulsion system for a Mars Ascent Vehicle** *ACTA ASTRONAUTICA*
Chandler, A. A., Cantwell, B. J., Hubbard, G. S., Karabeyoglu, A.
2011; 69 (11-12): 1066-1072
- **Surface Structure and Reactivity of Rhodium Oxide** *JOURNAL OF PHYSICAL CHEMISTRY C*
Scherson, Y. D., Aboud, S. J., Wilcox, J., Cantwell, B. J.
2011; 115 (22): 11036-11044
- **High performance hybrid upper stage motor**
KARABEYOGLU, M., A., STEVENS, J., GEYZEL, D., CANTWELL, B., J.
2011
- **Hybrid propulsion for solar system exploration**
CHANDLER, A., A., CANTWELL, B., J., HUBBARD, G., S.
2011
- **Thin film stability of melting solid fuels with application to hybrid propulsion**
CANTWELL, B., J.
2011
- **A Small-scale planar nitrous oxide monopropellant thruster for “green” propulsion and power generation**
SCHERSON, Y., D., LOHNER, K., CANTWELL, B., J., KENNY, T.
2010
- **A two-stage single port hybrid propulsion system for a Mars ascent vehicle**
CHANDLER, A., CANTWELL, B., J., HUBBARD, G., S.
2010
- **Recent advances In hybrid propulsion.** *International Journal of Energetic Materials and Chemical Propulsion*
CANTWELL, B., J., KARABEYOGLU, M., A., ALTMAN, D., A
2010; 4 (9): 305–326
- **Status update report for the Peregrine sounding rocket project: part III**
DORAN, E., DYER, J., MARZONA, M., T., KARABEYOGLU, M., A., ZILLIAC, G., MOSHER, R., Cantwell, B. J.

2009

- **Recent Advances In Hybrid Propulsion.**

CANTWELL, B., J., KARABEYOGLU, M., A., ALTMAN, D., A.

2009

- **A monopropellant gas generator based on N₂O decomposition for “green” propulsion and power applications**

SCHERSON, Y., D., LOHNER, K., CANTWELL, B., J., KENNY, T.

2009

- **Modeling of N₂O decomposition events**

KARABEYOGLU, M., A., DYER, J., STEVENS, J., CANTWELL, B., J.

2008

- **Development of scalable space-time averaged regression rate expressions for hybrid rockets** *AIAA/ASME/SAE/ASEE 41st Joint Propulsion Conference*

Karabeyoglu, M. A., Cantwell, B. J., Zilliack, G.

AMER INST AERONAUT ASTRONAUT.2007: 737–47

- **Gravity currents in horizontal porous layers: transition from early to late self-similarity** *JOURNAL OF FLUID MECHANICS*

Hesse, M. A., Tchelepi, H. A., Cantwell, B. J., Orr, F. M.

2007; 577: 363-383

- **Test Facility Development for the 15,000 lb Thrust Peregrine Hybrid Sounding Rocket**

DUNN, Z., DYER, J., LOHNER, K., DORAN, E., Cantwell, B. J.

2007

- **Nitrous oxide hybrid rocket motor fuel regression rate characterization**

DORAN, E., DYER, J., LOHNER, K., DUNN, Z., CANTWELL, B., J., ZILLIAC, G.

2007

- **Design and development of a sub-scale nitrous oxide monopropellant gas generator**

LOHNER, K., DYER, J., DUNN, Z., DORAN, E., KRIEGER, B., DECKER, V., Cantwell, B. J.

2007

- **Modeling feed system flow physics for self-pressurizing propellants**

DYER, J., DORAN, E., DUNN, Z., LOHNER, K., ZILLIAC, G., CANTWELL, B., J.

2007

- **Investigation of feed system coupled low frequency combustion instabilities in hybrid rockets**

KARABEYOGLU, M., A., STEVENS, J., CANTWELL, B., J.

2007

- **Modeling of hybrid rocket low frequency instabilities** *AIAA/ASME/SAE/ASEE 39th Joint Propulsion Conference*

Karabeyoglu, M. A., De Zilwa, S., Cantwell, B., Zilliack, G.

AMER INST AERONAUT ASTRONAUT.2005: 1107–16

- **Development of scaleable space-time averaged regression rate expressions for hybrid rockets**

KARABEYOGLU, M., A., CANTWELL, B., J., ZILLIAC, G.

2005

- **Design of an orbital hybrid rocket vehicle launched from Canberra air platform**

KARABEYOGLU, M., A., FALCONER, T., CANTWELL, B., J., STEVENS, J.

2005

- **Evaluation of the homologous series of normal-alkanes as hybrid rocket fuels**

KARABEYOGLU, M., A., CANTWELL, B., J., STEVENS, J.

2005

- **Scale-up tests of high regression rate paraffin-based hybrid rocket fuels** *AIAA 41st Aerospace Sciences Meeting and Exhibit*

Karabeyoglu, A., Zilliack, G., Cantwell, B. J., DeZilwa, S., Castellucci, P.

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- **Transient modeling of hybrid rocket low frequency instabilities.**
KARABEYOGLU, M., A., DEZILWA, S., CANTWELL, B., J., ZILLIAC, G.
2003
- **Modeling the slump characteristics of the hydrocarbon-based hybrid rocket fuels.**
KILIC, S., KARABEYOGLU, M., A., STEVENS, J., CANTWELL, B., J.
2003
- **Scale-up tests of high regression rate paraffin-based hybrid rocket fuels.**
KARABEYOGLU, M., A., ZILLIAC, G., CANTWELL, B., J., DEZILWA, S., CASTELLUCCI, P.
2003
- **Development of high-burning-rate hybridrocket- fuel flight demonstrators.**
KARABEYOGLU, M., A., ZILLIAC, G., CASTELLUCCI, P., URBANCZYK, P., STEVENS, J., INALHAN, G., Cantwell, B. J.
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Karabeyoglu, M. A., Altman, D., Cantwell, B. J.
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KARABEYOGLU, M., A., ALTMAN, D., A., CANTWELL, B., J.
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- **Introduction to Symmetry Analysis, Cambridge Texts on Applied Mathematics number 29,**
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Cambridge University Press. The book is 656 pages plus a CD containing symmetry analysis software developed by the author..2002
- **Combustion of liquefying hybrid propellants: Part II stability of liquid films.** *AIAA Journal of Propulsion and Power*
KARABEYOGLU, M., A., CANTWELL, B., J.
2002; 18 (3): 621-630
- **Development and testing of paraffin-based hybrid rocket fuels**
KARABEYOGLU, M., A., CANTWELL, B., J., ALTMAN, D., A.
2001
- **Self-similar, slightly compressible, free vortices** *JOURNAL OF FLUID MECHANICS*
von Ellenrieder, K. D., Cantwell, B. J.
2000; 423: 293-315
- **Elliptic curves and three-dimensional flow patterns** *NONLINEAR DYNAMICS*
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2000; 22 (1): 29-38
- **Dynamics of a low Reynolds number turbulent boundary layer** *JOURNAL OF FLUID MECHANICS*
Chacin, J. M., Cantwell, B. J.
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- **Oscillatory flow states in an enclosed cylinder with a rotating endwall** *JOURNAL OF FLUID MECHANICS*
Stevens, J. L., Lopez, J. M., Cantwell, B. J.
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- **Turbulence structures of wall-bounded shear flows found using DNS data** *JOURNAL OF FLUID MECHANICS*
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- **Turbulent structures of wall-bounded shear flows found using DNS data.** *Journal of Fluid Mechanics*
CHONG, M., SORIA, J., PERRY, A., E., CHACIN, J., J., CANTWELL, B., NA, Y.
1998; 357: 225-248
- **Correlation of wingtip noise with mean flow parameters**
MATHIAS, D., L., PYE, J., D., CANTWELL, B., J.
1998
- **Pipes and Channels.** *In the Report of AGARD fluid dynamics panel working group 21 A Selection of Test Cases for the Validation of Large-Eddy Simulations of Turbulent Flows*
MOSER, R., D., CANTWELL, B., J., PURTELL, L., P.
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- **Discriminant-based analysis of the dynamics of turbulent flow**
CANTWELL, B., J.
1998
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CANTWELL, B., J.
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1998
- **Near wall turbulence: A remembrance of Steve Kline.**
CANTWELL, B., J.
1998
- **Low speed flow studies using the pressure sensitive paint technique.**
BROWN, O., C., MEHTA, R., D., CANTWELL, B., J.
1997
- **Vortical Flow Field Investigation Using the Pressure Sensitive Paint Technique at Low Speed**
SHIMBO, Y., MEHTA, R., D., CANTWELL, B., J.
1997
- **Direct Numerical Simulation of a Temporally Evolving Incompressible Plane Wake: Effect of Initial Conditions on Evolution and Topology, JIAA-TR 118,**
SONDERGAARD, R., CANTWELL, B., MANSOUR, N.
1997
- **Reynolds number invariance and the dilation group of turbulence**
CANTWELL, B., J.
1997
- **On the dynamics of turbulent boundary layers.** *In Self-sustaining Mechanisms of Wall Turbulence*
CANTWELL, B., J., CHACIN, J., M., BRADSHAW, P.
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- **Study of turbulent boundary layer structure using the invariants of the velocity gradient tensor. TF Report 70** *Department of Mechanical Engineering, Stanford University.*
CHACIN, J., M., CANTWELL, B., J.
1997
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Chacin, J. M., Cantwell, B. J., KLINE, S. J.
1996; 13 (4): 308-317
- **Topology of fine-scale motions in turbulent channel flow** *JOURNAL OF FLUID MECHANICS*
Blackburn, H. M., Mansour, N. N., Cantwell, B. J.

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- **Study of the velocity gradient tensor in turbulent flow. JIAA-TR 114**
CHENG, W., CANTWELL, B., J.
1996
- **Application of the Pressure Sensitive Paint Technique to Steady and Unsteady Flow, JIAA-TR 115**
SHIMBO, Y., MEHTA, R., CANTWELL, B.
1996
- **Experimental Study of Vortex Breakdown in a Cylindrical, Swirling Flow**
STEVENS, J., L., CELIK, Z., Z., CANTWELL, B., LOPEZ, J., M.
1996
- **Lagrangian study of velocity gradient tensor dynamics in turbulent flow.**
CHENG, W., CANTWELL, B., J., SONDERGAARD, R., KERR, R., M.
edited by Chew, Y., T., Tso, C., P.
1995
- **TOPOLOGICAL VISUALIZATION OF FOCAL STRUCTURES IN FREE SHEAR FLOWS** *IUTAM Symposium on Eddy Structure Identification in Free Turbulent Shear Flows*
Soria, J., Cantwell, B. J.
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- **A STUDY OF THE FINE-SCALE MOTIONS OF INCOMPRESSIBLE TIME-DEVELOPING MIXING LAYERS** *Symposium on Turbulence, in honor of the 60th Birthday of William Craig Reynolds*
Soria, J., Sondergaard, R., Cantwell, B. J., Chong, M. S., Perry, A. E.
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- **The effect of initial conditions on the development of temporally evolving planar three-dimensional incompressible wakes.**
SONDERGAARD, R., MANSOUR, N., N., CANTWELL, B., J.
1994
- **ON THE BEHAVIOR OF VELOCITY-GRADIENT TENSOR INVARIANTS IN DIRECT NUMERICAL SIMULATIONS OF TURBULENCE** *PHYSICS OF FLUIDS A-FLUID DYNAMICS*
Cantwell, B. J.
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- **VORTEX DRIFT .1. DYNAMIC INTERPRETATION** *PHYSICS OF FLUIDS A-FLUID DYNAMICS*
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1993; 5 (6): 1443-1450
- **VORTEX DRIFT .2. THE FLOW POTENTIAL SURROUNDING A DRIFTING VORTICAL REGION** *PHYSICS OF FLUIDS A-FLUID DYNAMICS*
Rott, N., Cantwell, B.
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- **On the behavior of velocity gradient tensor invariants in direct numerical simulations of turbulence.** *Physics of Fluids A*
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- **Vortex drift I: Dynamic interpretation.** *Physics of Fluids A*
ROTT, N., CANTWELL, B., J.
1993; 6 (5): 1443-1450
- **INVESTIGATION OF A COFLOWING BUOYANT JET - EXPERIMENTS ON THE EFFECT OF REYNOLDS-NUMBER AND RICHARDSON-NUMBER** *JOURNAL OF FLUID MECHANICS*
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- **EXACT SOLUTION OF A RESTRICTED EULER EQUATION FOR THE VELOCITY-GRADIENT TENSOR** *PHYSICS OF FLUIDS A-FLUID DYNAMICS*
Cantwell, B. J.
1992; 4 (4): 782-793
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SORIA, J., HONG, M., SONDERGAARD, R., PERRY, A., E., CANTWELL, B., J.
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Mahalingam, S., Cantwell, B. J., FERZIGER, J. H.
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- **Local topology of small scale motions in turbulent shear flows.**
SONDERGAARD, J., CHEN, R., SORIA, J., CANTWELL, B.
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- **Stability of low speed reacting flows.** *Physics of Fluids A*
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- **THE EFFECT OF MACH NUMBER ON THE STABILITY OF A PLANE SUPERSONIC WAKE** *PHYSICS OF FLUIDS A-FLUID DYNAMICS*
Chen, J. H., Cantwell, B. J., Mansour, N. N.
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- **FULL NUMERICAL-SIMULATION OF COFLOWING, AXISYMMETRIC JET DIFFUSION FLAMES** *PHYSICS OF FLUIDS A-FLUID DYNAMICS*
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- **Full numerical simulation of co-flowing, axisymmetric jet diffusion flames.** *Physics of Fluids A*
MAHALINGAM, S., CANTWELL, B., J., FERZIGER, J., H.
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- **A study of the topology of dissipating motions in direct numerical simulations of time-developing compressible and incompressible mixing layers.**
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- **Future directions in turbulence research and the role of organized motion: Turbulence at the Crossroads or Whither Turbulence** *Cornell University, Lecture Notes in Physics, Springer-Verlag March*
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- **A general classification of three-dimensional flow fields.**
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1989
- **Topology of three-dimensional, variable density flows.**
CANTWELL, B., J., LEWIS, G., L., CHEN, J., H.
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- **Direct Numerical Simulations of Transition in a Compressible Wake.**
CHEN, J., H., MANSOUR, N., N., CANTWELL, B., J.
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- **The topology and vorticity dynamics of a three-dimensional plane compressible wake.**
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1989
- **THE DECAY OF A VISCOUS VORTEX PAIR** *PHYSICS OF FLUIDS*
Cantwell, B., Rott, N.
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LEWIS, G., S., CANTWELL, B., J., VANDSBURGER, U., BOWMAN, C., T.
1988
- **Numerical simulation of viscous vortex rings using a spectral method.** *NASA TM 101041*
STANAWAY, S., K., CANTWELL, B., J., SPALART, P., R.
1988
- **Computation of transonic separated wing flows using an Euler/Navier-Stokes zonal approach.** *Journal of Aircraft*
KAYNAK, U., HOLST, T., L., CANTWELL, B., J., SORENSON, R., L.
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- **Viscous starting jets.** *Journal of Fluid Mechanics.*
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ALLEN, G., A., CANTWELL, B., J.
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- **A full simulation of a vortex ring.**
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- **Visualization of the structure of a pulsed methane-air diffusion flame.** *Physics of Fluids*
STRAWA, A., W., CANTWELL, B., J.
1985; 28: 2317-2320
- **Transition and mixing in impulsively started jets and vortex rings.**
CANTWELL, B., J., ALLEN Jr., G., A.
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1984
- **AN EXPERIMENTAL-STUDY OF ENTRAINMENT AND TRANSPORT IN THE TURBULENT NEAR WAKE OF A CIRCULAR-CYLINDER** *JOURNAL OF FLUID MECHANICS*
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1983; 136: 321-374
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- **Proceedings 1980 - 81 AFOSR-HTTM - Stanford Conference on Complex Turbulent Flows Vol. III: Comparison of Computation with Experiment, and Computers' Summary Reports.**
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Cantwell, B. J.
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