Stanford



Eva Silverstein

Professor of Physics

CONTACT INFORMATION

- **Administrative Contact**

  LITP

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Bio

BIO

Professor Silverstein conducts research in theoretical physics -- particularly gravitation and cosmology, as well as recently developing new methods and applications for machine learning.

What are the basic degrees of freedom and interactions underlying gravitational and particle physics? What is the mechanism behind the initial seeds of structure in the universe, and how can we test it using cosmological observations? Is there a holographic framework for cosmology that applies throughout the history of the universe, accounting for the emergent effects of horizons and singularities? What new phenomena arise in quantum field theory in generic conditions such as finite density, temperature, or in time dependent backgrounds?

Professor Silverstein attacks basic problems in several areas of theoretical physics. She develops concrete and testable mechanisms for cosmic inflation, accounting for its sensitivity to very high energy physics. This has led to a fruitful interface with cosmic microwave background research, contributing to a more systematic analysis of its observable phenomenology.
Professor Silverstein also develops mechanisms for stabilizing the extra dimensions of string theory to model the accelerated expansion of the universe. In addition, Professor Silverstein develops methods to address questions of quantum gravity, such as singularity resolution and the physics of black hole and cosmological horizons.

Areas of focus:
- optimization algorithms derived from physical dynamics, analyzing its behavior and advantages theoretically and in numerical experiments
- UV complete mechanisms and systematics of cosmic inflation, including string-theoretic versions of large-field inflation (with gravity wave CMB signatures) and novel mechanisms involving inflaton interactions (with non-Gaussian signatures in the CMB)
-Systematic theory and analysis of primordial Non-Gaussianity, taking into account strongly non-linear effects in quantum field theory encoded in multi-point correlation functions
-Long-range interactions in string theory and implications for black hole physics
- Concrete holographic models of de Sitter expansion in string theory, aimed at upgrading the AdS/CFT correspondence to cosmology
- Mechanisms for non-Fermi liquid transport and $2k_F$ singularities from strongly coupled finite density quantum field theory

- Mechanisms by which the extra degrees of freedom in string theory induce transitions and duality symmetries between spaces of different topology and dimensionality

ACADEMIC APPOINTMENTS

- Professor, Physics

ADMINISTRATIVE APPOINTMENTS

- Postdoctoral Fellow, Rutgers University, (1996-1997)
- Permanent Member and Visiting Professor of Physics, Kavli Institute for Theoretical Physics, University of California, Santa Barbara, (2009-2010)
- Assistant Professor, Stanford Linear Accelerator Center, Stanford University, (1997-2001)
- Associate Professor, Stanford University, SLAC and Physics Department, (2001-2006)
- Professor, Stanford University, SLAC and Physics Department, (2006-2017)
- Professor, Stanford University Department of Physics, (2006- present)

HONORS AND AWARDS

- Member, American Academy of Arts and Sciences (2020)
- Investigator, Simons Foundation (2017)
- Fellow, American Physical Society (2016)
- Bergmann Memorial Award, Israel-U.S. Binational Science Foundation (2000)
- Fellowship, MacArthur Foundation (1999-2004)
- Fellowship, Alfred P Sloan Foundation (1999)
- Outstanding Junior Investigator Award, Department of Energy (1999)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Advisory Board, Canadian Institute for Advanced Research, Gravity and Cosmology
- PI, Simons Foundation Origins of the Universe program, Modern Inflationary Cosmology (2017 - present)
- General Member, Aspen Center for Physics (2015 - 2020)
- Coordinator, KITP Primordial Cosmology program and conference (2013 - 2013)
- Co-director, ICTP Spring School (2011 - 2013)
- Advisory Council, Princeton University Department of Physics (2009)
- Member, Inflationary Theory Working Group: CMBPOL (2008 - 2008)
- Advisory Board, Kavli Institute for Theoretical Physics (2004 - 2007)
- General Member, Aspen Center for Physics (1999 - 2006)
- Member, Institute for Advance Study, Princeton (1999 - 1999)

PROFESSIONAL EDUCATION

- B.A., Harvard University , Physics (1992)
- PhD., Princeton University , Physics (1996)

LINKS

- ArXiv papers: https://arxiv.org/search/?query=silverstein%2C+eva&searchtype=all&abstracts=show&order=-announced_date_first&size=50

Teaching

COURSES

2024-25

- Advanced Topics in Theoretical Physics: PHYSICS 450 (Aut)
- Quantum Field Theory III: PHYSICS 332 (Spr)

2023-24

- Advanced Theoretical Physics I: Fundamentals of Cosmic Acceleration: PHYSICS 450 (Aut)
- Quantum Field Theory III: PHYSICS 332 (Spr)

STANFORD ADVISEES

Postdoctoral Faculty Sponsor

Beatriz Tucci Schiewaldt

Doctoral Dissertation Advisor (AC)

Gauri Batra, Tung Tran

Doctoral (Program)

Taj Dyson, Sarah Gaiser, Gowri Sundaresan

Publications

PUBLICATIONS

- **Optimizers for stabilizing likelihood-free inference** *PHYSICAL REVIEW D*
  De Luca, B., Nachman, B., Silverstein, E., Zheng, H.
  2025; 112 (9)
- **Timelike-bounded dS₄ holography from a solvable sector of the T² deformation** *JOURNAL OF HIGH ENERGY PHYSICS*
  Silverstein, E., Torroba, G.
  2025
- **Bulk-local dS₃ holography: the matter with TT<overline> + Λ₂** *JOURNAL OF HIGH ENERGY PHYSICS*
  Batra, G., De Luca, G., Silverstein, E., Torroba, G., Yang, S.
  2024
- **Black hole to cosmic horizon microstates in string/M theory: timelike boundaries and internal averaging** *JOURNAL OF HIGH ENERGY PHYSICS*
  Silverstein, E.
  2023
- **Microcanonical Hamiltonian Monte Carlo** *JOURNAL OF MACHINE LEARNING RESEARCH*
  Robnik, J., De Luca, G., Silverstein, E., Seljak, U.
  2023; 24
- **De Sitter microstates from T(T)over-bar + Lambda(2) and the Hawking-Page transition** *JOURNAL OF HIGH ENERGY PHYSICS*
  Coleman, E., Mazenc, E. A., Shyam, V., Silverstein, E., Soni, R. M., Torroba, G., Yang, S.
  2022
- **Hyperbolic compactification of M-theory and de Sitter quantum gravity** *SCIPOST PHYSICS*
  De Luca, G., Silverstein, E., Torroba, G.
  2022; 12 (3)

- **Born-Infeld (BI) for AI: Energy-Conserving Descent (ECD) for Optimization**
  De Luca, G., Silverstein, E.
  edited by Chaudhuri, K., Jegelka, S., Song, L., Szepesvari, C., Niu, G., Sabato, S.
  JMLR-JOURNAL MACHINE LEARNING RESEARCH.2022
- **A new branch of inflationary speed limits** *JOURNAL OF HIGH ENERGY PHYSICS*
  Mathis, D., Mousatov, A., Panagopoulos, G., Silverstein, E.
  2021
- **Quantum connections** *NATURE REVIEWS PHYSICS*
  Hartnoll, S., Sachdev, S., Takayanagi, T., Chen, X., Silverstein, E., Sonner, J.
  2021
- **T(T)over-bar and EE, with implications for (A)dS subregion encodings** *JOURNAL OF HIGH ENERGY PHYSICS*
  Lewkowycz, A., Liu, J., Silverstein, E., Torroba, G.
  2020
- **dS/dS and T(T)over-bar** *JOURNAL OF HIGH ENERGY PHYSICS*
  Gorbenko, V., Silverstein, E., Torroba, G.
  2019
- **De Sitter holography and entanglement entropy** *JOURNAL OF HIGH ENERGY PHYSICS*
  Dong, X., Silverstein, E., Torroba, G.
  2018
- **Joseph Gerard Polchinski Jr OBITUARY** *PHYSICS TODAY*
  Marolf, D., Silverstein, E.
  2018; 71 (5): 66
- **Productive interactions: heavy particles and non-Gaussianity** *JOURNAL OF COSMOLOGY AND ASTROPARTICLE PHYSICS*
  Flauger, R., Mirbabayi, M., Senatore, L., Silverstein, E.
  2017
- **Drifting oscillations in axion monodromy** *JOURNAL OF COSMOLOGY AND ASTROPARTICLE PHYSICS*
  Flauger, R., McAllister, L., Silverstein, E., Westphal, A.
  2017
- **String-theoretic breakdown of effective field theory near black hole horizons** *PHYSICAL REVIEW D*
  Dodelson, M., Silverstein, E.
  2017; 96 (6)
- **Varying dilaton as a tracer of classical string interactions** *PHYSICAL REVIEW D*
  Dodelson, M., Silverstein, E., Torroba, G.
  2017; 96 (6)
- **Long-range nonlocality in six-point string scattering: Simulation of black hole infallers** *PHYSICAL REVIEW D*
  Dodelson, M., Silverstein, E.
  2017; 96 (6)
- **POP goes the universe** *SCIENTIFIC AMERICAN*
  Guth, A. H., Kaiser, D. I., Linde, A. D., Nomura, Y., Bennett, C. L., Bond, J., Bouchet, F., Carroll, S., Efstathiou, G., Hawking, S., Kallosh, R., Komatsu, E., Krauss, et al
  2017; 317 (1): 5–7
- **Inflation in string theory confronts data** *COMPTES RENDUS PHYSIQUE*
  Silverstein, E.
  2015; 16 (10): 1003-1011
- **Neutrino physics from the cosmic microwave background and large scale structure** *ASTROPARTICLE PHYSICS*

Abazajian, K. N., Arnold, K., Austermann, J., Benson, B. A., Bischoff, C., Bock, J., Bond, J. R., Borrill, J., Calabrese, E., Carlstrom, J. E., Carvalho, C. S., Chang, C. L., Chiang, et al
2015; 63: 66-80

- **Inflation physics from the cosmic microwave background and large scale structure** *ASTROPARTICLE PHYSICS*
  Abazajian, K. N., Arnold, K., Austermann, J., Benson, B. A., Bischoff, C., Bock, J., Bond, J. R., Borrill, J., Buder, I., Burke, D. L., Calabrese, E., Carlstrom, J. E., Carvalho, et al
  2015; 63: 55-65
- **Gravitational waves and the scale of inflation** *PHYSICAL REVIEW D*
  Mirbabayi, M., Senatore, L., Silverstein, E., Zaldarriaga, M.
  2015; 91 (6)
- **Inflationary observables and string theory**
  Silverstein, E.
  edited by Deffayet, C., Peter, P., Wandelt, B., Zaldarriaga, M., Cugliandolo, L. F.
  OXFORD UNIV PRESS.2015: 459–500
- **New solutions with accelerated expansion in string theory** *JOURNAL OF HIGH ENERGY PHYSICS*
  Dodelson, M., Dong, X., Silverstein, E., Torroba, G.
  2014
- **The powers of monodromy** *JOURNAL OF HIGH ENERGY PHYSICS*
  McAllister, L., Silverstein, E., Westphal, A., Wrase, T.
  2014
- **New sources of gravitational waves during inflation** *JOURNAL OF COSMOLOGY AND ASTROPARTICLE PHYSICS*
  Senatore, L., Silverstein, E., Zaldarriaga, M.
  2014
- **Anomalous dimensions and non-gaussianity** *JOURNAL OF HIGH ENERGY PHYSICS*
  Green, D., Lewandowski, M., Senatore, L., Silverstein, E., Zaldarriaga, M.
  2013
- **Moduli stabilization and the holographic RG for AdS and dS** *JOURNAL OF HIGH ENERGY PHYSICS*
  Dong, X., Horn, B., Silverstein, E., Torroba, G.
  2013
- **Dual purpose landscaping tools: Small extra dimensions in AdS/CFT** *Memorial Conference for Maximilian Kreuzer*
  Polchinski, J., Silverstein, E.
  WORLD SCIENTIFIC PUBL CO PTE LTD.2013: 365–390
- **Benefits of stress: Resolution of the Lifshitz singularity** *PHYSICAL REVIEW D*
  Bao, N., Dong, X., Harrison, S., Silverstein, E.
  2012; 86 (10)
- **Perturbative critical behavior from spacetime dependent couplings** *PHYSICAL REVIEW D*
  Dong, X., Horn, B., Silverstein, E., Torroba, G.
  2012; 86 (10)
- **Large-density field theory, viscosity and '2k(F)' singularities from string duals** *CLASSICAL AND QUANTUM GRAVITY*
  Polchinski, J., Silverstein, E.
  2012; 29 (19)
- **Unitarity bounds and renormalization-group flows in time dependent quantum field theory** *PHYSICAL REVIEW D*
  Dong, X., Horn, B., Silverstein, E., Torroba, G.
  2012; 86 (2)
- **FRW solutions and holography from uplifted AdS/CFT systems** *PHYSICAL REVIEW D*
  Dong, X., Horn, B., Matsuura, S., Silverstein, E., Torroba, G.

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- **Towards a holographic marginal Fermi liquid** *PHYSICAL REVIEW D*
  Jensen, K., Kachru, S., Karch, A., Polchinski, J., Silverstein, E.
  2011; 84 (12)
- **Stimulated superconductivity at strong coupling** *JOURNAL OF HIGH ENERGY PHYSICS*
  Bao, N., Dong, X., Silverstein, E., Torroba, G.
  2011
- **Simple exercises to flatten your potential** *PHYSICAL REVIEW D*
  Dong, X., Horn, B., Silverstein, E., Westphal, A.
  2011; 84 (2)
- **The Shape of Inner Space (Review)** *Nature Physics*
  Silverstein, E.
  2011
- **Micromanaging de Sitter holography** *CLASSICAL AND QUANTUM GRAVITY*
  Dong, X., Horn, B., Silverstein, E., Torroba, G.
  2010; 27 (24)
- **Gravity waves and linear inflation from axion monodromy** *PHYSICAL REVIEW D*
  McAllister, L., Silverstein, E., Westphal, A.
  2010; 82 (4)
- **Towards strange metallic holography** *JOURNAL OF HIGH ENERGY PHYSICS*
  Hartnoll, S. A., Polchinski, J., Silverstein, E., Tong, D.
  2010
- **Trapped inflation** *PHYSICAL REVIEW D*
  Green, D., Horn, B., Senatore, L., Silverstein, E.
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- **Insightful D-branes** *JOURNAL OF HIGH ENERGY PHYSICS*
  Horowitz, G., Lawrence, A., Silverstein, E.
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- **Probing Inflation with CMB Polarization** *CMB Polarization Workshop*
  Baumann, D., Jackson, M. G., Adshead, P., Amblard, A., Ashoorioon, A., Bartolo, N., Bean, R., Beltran, M., De Bernardis, F., Bird, S., Chen, X., Chung, D. J., Colombo, et al
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- **CMBPol Mission Concept Study: Probing Inflation with CMB Polarization** *AIP Conf. Proc.*
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- **Monodromy in the CMB: Gravity waves and string inflation** *PHYSICAL REVIEW D*
  Silverstein, E., Westphal, A.
  2008; 78 (10)
- **Simple de Sitter solutions** *PHYSICAL REVIEW D*
  Silverstein, E.
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- **String cosmology: a review** *GENERAL RELATIVITY AND GRAVITATION*
  McAllister, L., Silverstein, E.
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- **Simple stringy dynamical supersymmetry breaking** *PHYSICAL REVIEW D*
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- **Dimensional duality** *PHYSICAL REVIEW D*
  Green, D., Lawrence, A., McGreevy, J., Morrison, D. R., Silverstein, E.
  2007; 76 (6)
- **Supercritical stability, transitions, and (pseudo)tachyons** *PHYSICAL REVIEW D*
  Aharony, O., Silverstein, E.
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- **New dimensions for wound strings: The modular transformation of geometry to topology** *PHYSICAL REVIEW D*
  McGreevy, J., Silverstein, E., Starr, D.
  2007; 75 (4)
- **Retrofitting O'Raifeartaigh models with dynamical scales** *PHYSICAL REVIEW D*
  Dine, M., Feng, J. L., Silverstein, E.
  2006; 74 (9)
- **Attractor explosions and catalyzed vacuum decay** *PHYSICAL REVIEW D*
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- **Dimensional mutation and spacelike singularities** *PHYSICAL REVIEW D*
  Silverstein, E.
  2006; 73 (8)
- **The inside story: Quasilocal tachyons and black holes** *PHYSICAL REVIEW D*
  Horowitz, G. T., Silverstein, E.
  2006; 73 (6)
- **A new handle on de sitter compactifications** *JOURNAL OF HIGH ENERGY PHYSICS*
  Saltman, A., Silverstein, E.
  2006
- **Things fall apart: topology change from winding tachyons** *JOURNAL OF HIGH ENERGY PHYSICS*
  Adams, A., Liu, X., McGreevy, J., Saltman, A., Silverstein, E.
  2005
- **The tachyon at the end of the universe** *JOURNAL OF HIGH ENERGY PHYSICS*
  McGreevy, J., Silverstein, E.
  2005
- **Holography** *JOURNAL OF HIGH ENERGY PHYSICS*
  Alishahiha, M., Karch, A., Silverstein, E.
  2005
- **TASI/PiTP/ISS lectures on moduli and microphysics** *Conference on Progess in String Theory*
  Silverstein, E.
  WORLD SCIENTIFIC PUBL CO PTE LTD.2005: 381–415
- **TASI/PITP/ISS LECTURES ON MODULI AND MICROPHYSICS** *PROGRESS IN STRING THEORY: TASI 2003 LECTURES NOTES*
  Silverstein, E.
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- **D-Sitter space: causal structure, thermodynamics, and entropy** *JOURNAL OF HIGH ENERGY PHYSICS*
  Fabinger, M., Silverstein, E.
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- **DBI in the sky: Non-Gaussianity from inflation with a speed limit** *PHYSICAL REVIEW D*
  Alishahiha, M., Silverstein, E., Tong, D.

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- **Scalar speed limits and cosmology: Acceleration from D-cceleration** *PHYSICAL REVIEW D*
  Silverstein, E., Tong, D.
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- **The scaling of the no-scale potential and De-Sitter model building** *JOURNAL OF HIGH ENERGY PHYSICS*
  Saltman, A., Silverstein, E.
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- **Generating small numbers by tunneling in multi-throat compactifications** *INTERNATIONAL JOURNAL OF MODERN PHYSICS A*
  Dimopoulos, S., Kachru, S., Kaloper, N., Lawrence, A., Silverstein, E.
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- **Beauty is attractive: moduli trapping at enhanced symmetry points** *JOURNAL OF HIGH ENERGY PHYSICS*
  Kofman, L., Linde, A., Liu, X., Maloney, A., McAllister, L., Silverstein, E.
  2004
- **DBI in the sky** *Phys. Rev. D*
  Alishahiha, M., Silverstein, E., Tong, D.
  2004; 70: 123505
- **The dS/dS correspondence** *Conference on Strings and Cosmology*
  Alishahiha, M., Karch, A., Silverstein, E., Tong, D.
  AMER INST PHYSICS.2004: 393–409
- **TASI / PiTP / ISS lectures on moduli and microphysics** *TASI*
  Silverstein, E.
  2003
- **Clean time-dependent string backgrounds from bubble baths** *JOURNAL OF HIGH ENERGY PHYSICS*
  Aharony, O., Fabinger, M., Horowitz, G. T., Silverstein, E.
  2002
- **Nonlocal string theories on AdS(3)xS(3) and stable nonsupersymmetric backgrounds** *PHYSICAL REVIEW D*
  Aharony, O., Berkooz, M., Silverstein, E.
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- **Small numbers from tunneling between brane throats** *PHYSICAL REVIEW D*
  Dimopoulos, S., Kachru, S., Kaloper, N., Lawrence, A., Silverstein, E.
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- **Closed string tachyons, AdS/CFT, and large N QCD** *PHYSICAL REVIEW D*
  Adams, A., Silverstein, E.
  2001; 64 (8)
- **Don't panic! Closed string tachyons in ALE spacetimes** *JOURNAL OF HIGH ENERGY PHYSICS*
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  2001
- **Extended objects from warped compactifications of M theory** *JOURNAL OF MATHEMATICAL PHYSICS*
  Silverstein, E.
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- **Gauge symmetry and localized gravity in M-theory** *JOURNAL OF HIGH ENERGY PHYSICS*
  Kaloper, N., Susskind, L., Silverstein, E.

2001

- **Gauge fields, scalars, warped geometry, and strings** *International Superstrings Conference (STRINGS 2000)*
  Silverstein, E.
  WORLD SCIENTIFIC PUBL CO PTE LTD.2001: 641–49
- **(A)dS backgrounds from asymmetric orientifolds** *Strings 2001 Proceedings*
  Silverstein, E.
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- **Bounds on curved domain walls in 5D gravity** *PHYSICAL REVIEW D*
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- **Self-tuning flat domain walls in 5D gravity and string theory** *PHYSICAL REVIEW D*
  Kachru, S., Schulz, M., Silverstein, E.
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- **On the critical behavior of D1-brane theories** *JOURNAL OF HIGH ENERGY PHYSICS*
  Silverstein, E., Song, Y. S.
  2000
- **Tension is dimension** *JOURNAL OF HIGH ENERGY PHYSICS*
  Harvey, J. A., Kachru, S., Moore, G., Silverstein, E.
  2000
- **Vacuum energy cancellation in a nonsupersymmetric string** *PHYSICAL REVIEW D*
  Kachru, S., Kumar, J., Silverstein, E.
  1999; 59 (10)
- **On vanishing two loop cosmological constants in nonsupersymmetric strings** *JOURNAL OF HIGH ENERGY PHYSICS*
  Kachru, S., Silverstein, E.
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  Harvey, J. A., Kachru, S., Silverstein, E.
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- **Closing the generation gap** *International Conference - STRINGS 97*
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- **Matrix description of Calabi-Yau compactifications** *PHYSICAL REVIEW LETTERS*
  Kachru, S., Lawrence, A., Silverstein, E.
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- **Matrix description of (1,0) theories in six dimensions** *PHYSICS LETTERS B*
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- **Self-dual nonsupersymmetric type II string compactifications** *JOURNAL OF HIGH ENERGY PHYSICS*
  Kachru, S., Silverstein, E.

1998

- **On the Matrix Description of Calabi-Yau Compactification** *Phys. Rev. Lett.*
  Kachru, S., Lawrence, A., Silverstein, E.
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- **Zero and one-dimensional probes with N=8 supersymmetry** *PHYSICS LETTERS B*
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- **On gauge bosons in the matrix model approach to M theory** *PHYSICS LETTERS B*
  Kachru, S., Silverstein, E.
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- **Duality, compactification, and e(-1/lambda) effects in the heterotic string theory** *PHYSICS LETTERS B*
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- **New N=1 superconformal field theories in four dimensions from D-brane probes** *NUCLEAR PHYSICS B*
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- **Matrix Description of Interacting Theories in Six Dimensions** *Adv. Theor. Math. Phys.*
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- **Singularities, gauge dynamics, and non-perturbative superpotentials in string theory** *NUCLEAR PHYSICS B*
  Kachru, S., Silverstein, E.
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- **SUSY gauge dynamics and singularities of 4d N=1 string vacua** *NUCLEAR PHYSICS B*
  Kachru, S., Seiberg, N., Silverstein, E.
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- **Singularities, Gauge Dynamics, and Nonperturbative Superpotentials in String Theory** *Nuclear Physics B*
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- **NONSUPERSYMMETRIC STRING SOLITONS** *NUCLEAR PHYSICS B*
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- **CRITERIA FOR CONFORMAL-INVARIANCE OF (0,2)-MODELS** *NUCLEAR PHYSICS B*
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  Silverstein, E.
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- **GLOBAL U(1) R-SYMMETRY AND CONFORMAL-INVARIANCE OF (0,2) MODELS** *PHYSICS LETTERS B*
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- **LARGE SMALL EQUIVALENCE IN STRING THEORY** *PHYSICS LETTERS B*
  Silverstein, E.
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  Reid, M. J., Silverstein, E.
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