UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

In the Matter of	)	
PACIFIC GAS AND ELECTRIC COMPANY	)	Docket Nos. 50-275 O.L.
	)	50-323 O.L.
(Diablo Canyon Nuclear Power Plant, Units 1 and 2)	)	

JOINT INTERVENORS' RENEWAL OF APPLICATION FOR STAY

The Joint Intervenors in the above-entitled proceeding hereby renew their Application for Stay previously filed herein on October 31, 1983. As appears in their initial application and in the discussion below, the Joint Intervenors request the stay in order to prevent irreparable harm and to preserve the status quo pending (1) completion of administrative review of all matters underlying issuance of the low power operating license and (2) an opportunity for judicial review of those issues.

The basis for this application is essentially the same as that stated in the October 31, 1983 Application for Stay, and this Board is respectfully referred to that filing and the attachments thereto. In addition, the Joint Intervenors submit that the developments that have occurred in this proceeding since October 1983 provide further support for their stay request in that substantial additional evidence has been

disclosed indicating the continued existence of design and construction problems at Diablo Canyon. This evidence, provided by past and present workers at the plant and documented in thousands of pages of affidavits and other documentation, has been provided to the Board and all parties through Joint Intervenors' February 14, 1984 Motion to Augment or, in the Alternative, to Reopen the Record and their February 22, 1984 Motion to Reopen the Record on the Issues of Construction Quality Assurance and Licensee Character and Competence. Although it is undeniable that this substantial additional evidence is directly relevant to the critical question of whether Diablo Canyon has been completed consistent with the Commission's regulations, none of this evidence has been addressed on the record by PGandE, by the Commission, or by its licensing boards. Accordingly, the requisite confidence in the design and construction of Diablo Canyon does not exist and the requisite "definitive finding of safety" cannot be made. Power Reactor Development Co. v. International Union, 367 U.S. 396, 414 (1961); see also 10 C.F.R. § 50.57(a).

This Renewal of Application for Stay is supported also by the attached affidavit of Dr. Michio Kaku, Professor of Nuclear Physics at the City University of New York Graduate Center and the City College of New York. In his affidavit, Dr. Kaku describes the consequences of low power operation at Diablo Canyon, including the potential risk to public health and the environment in the event of an accident and the irreversible contamination of the reactor that will inevitably result. This

affidavit supplements the affidavit of Richard Hubbard previously submitted to document, through qualified experts, the likelihood of irreparable injury to the Joint Intervenors if their Application for Stay is not granted.

For all the reasons stated herein and in their October 31, 1983 Application for Stay, the Joint Intervenors hereby request this Appeal Board to grant the requested stay.

In the event that this Board is inclined to deny the foregoing application, the Joint Intervenors request that this Board grant a limited stay sufficient to permit the Joint Intervenors to apply to the United States Court of Appeals for the District of Columbia Circuit for an emergency stay pending appeal. The purpose of such a limited stay is solely to preserve the status quo for the period of several days to a week necessary for the U.S. Court of Appeals to review the Joint Intervenors' emergency motion. In the absence of such a stay, PGandE may commence low power operations immediately upon reissuance of the low power operating license by the Commission, thereby contaminating the nuclear fuel and related systems even before the court has an opportunity to review the Joint

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Intervenors' motion. After over ten years of participation in this proceeding, the Joint Intervenors submit that basic fairness requires that such a stay be granted.

DATED: March 20, 1984

Respectfully submitted,

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By [signature]
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CERTIFICATE OF SERVICE

I hereby certify that on this 20th day of March 1984, I have served copies of the foregoing JOINT INTERVENORS' RENEWAL OF APPLICATION FOR STAY mailing them through the U.S. mails, first class, postage prepaid, to the attached list.

Amanda Varona

Amanda Varona

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Declaration of Joel R. Reynolds

I, Joel R. Reynolds, hereby declare and say.

1. I am an attorney for the Joint Intervenors in the above-entitled proceeding.

2. The attached Affidavit has been prepared by Dr. Michio Kaku, who has authorized me to submit it in connection with the Joint Intervenors' Renewal of Application for Stay.

3. Because of the need to file said Renewal of Application for Stay as soon as possible, the attached affidavit is being submitted unsigned. A fully executed copy of the signature page will be provided to the Board and all parties by the end of this week.

Executed this 20th day of March, 1984, at Los Angeles, California.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

[signature]
Joel R. Reynolds

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AFFIDAVIT OF DR. MICHIO KAKU

DR. MICHIO KAKU, being duly sworn, deposes and says as follows:

1. I am a Professor of Nuclear Physics at the City University of New York Graduate Center and the City College of New York. I received a B.A. degree in physics from Harvard in 1968 and a Ph.D. in nuclear physics from the University of California at Berkeley (Lawrence Radiation Laboratory) in 1972. I taught on the faculty of Princeton University from 1972 to 1983. Since that time, I have been a professor of nuclear physics at the CUNY Graduate Center and CCNY in New York. I have published over 35 physics papers, contributed to five books, and co-authored a book on nuclear power. I have testified as an expert in reactor physics at NRC licensing hearings for several nuclear facilities, including the Big Rock reactor in Michigan, V.C. Summer in South Carolina, Byron near Chicago, and the research reactor at the University of

California at Los Angeles, California. In addition, I appeared as an expert advisor to the Governor's Commission on the Shoreham Nuclear Power Plant in New York, and I have testified in civil suits involving the Comanche Peak reactor. A full statement of my qualifications is attached.

2. The purpose of this affidavit is to address the question of low power testing up to 5% power at the Diablo Canyon Nuclear Power Plant, Unit 1. To the layperson, the jump from zero to 5% power may seem a small one, while that from 5% to 100% power seems quite large. To a nuclear physicist, however, the transition between zero and 5% power is important because it is a qualitative jump -- from subcritical to critical -- while the jump from 5% to 100% power is only a quantitative one. Because a reactor at zero power and a reactor operating at 5% power are entirely different in terms of radiation inventory, this is not an idle distinction. A reactor operating for only one to two months at 5% power has about half a billion curies stored inside, which is more than the entire radiation inventory of many reactors built in the early 1960s. Certain isotopes, like iodine, may approach their maximum inventory in a few days, while others, like xeron, may take a few weeks. Within one to two months, however, we expect most of the volatile fission products to reach their maximum value.

3. Half a billion curies of radiation generated by the Diablo Canyon reactor operating at 5% power is not only a source of radioactive contamination of the reactor and a hazard to plant workers, but it is an enormous amount of radiation from

a health standpoint. For example, government documents like WASH-740 (1957), which analyzed the serious consequences of major reactor accidents in areas hundreds of miles downwind from a reactor, were based on reactors that had no more radiation stored in them than the much larger 1140 megawatt Diablo Canyon reactor operating at 5% power.

I. CONTAMINATION

4. Once a reactor is turned on, even at low power, several permanent changes occur in terms of contamination, caused by the accumulation of fission products, neutron activation products, corrosion in the steam generators, and increased stress on pipes. First, the entire primary system, including the vessel and the primary loop, will become permanently contaminated, and the process of permanently creating radioactive reactor steel is begun. This is caused by "neutron activation," which means that the nuclei in the reactor steel have absorbed excess neutrons and have become radioactive. Cobalt-60 contamination in the steam generators, for example, is a permanent problem which will result from low power testing. This means that workers making routine repairs in a steam generator due to corrosion will be exposed to radiation. The half-lives of many of these neutron activation products are large enough to make the reactor quite radioactive even years after it has been brought back to zero power. Radiation exposure, by operation at up to 5% power, in turn, complicates considerably the process of decommissioning of the reactor, due

to the presence of neutron activation products, some of which were previously neglected by the NRC and only recently discovered by Prof. Robert Pohl of Cornell University to have unusually long halflives. This complication exists both in terms of increased potential for worker exposure and escalated costs of decommissioning. Further, radiation exposure causes structural weakening of the reactor vessel. The average neutron, for example, dislodges about 20 atoms of steel before finally coming to rest. The physics behind brittle fracture is not yet understood, but operating a reactor at low power will begin the irreversible process of degrading the structural integrity of the pressure vessel. Although operating the reactor at low power will not by itself cause "spontaneous vessel rupture," which is a catastrophic nuclear accident, it will certainly speed up the process of causing microfractures in the steel.

5. Second, in addition to irradiating the steel, you will also have the problem of radioactive fission products contaminating the primary cooling water. Small microleaks in the fuel rods of any reactor, for example, will allow gaseous radioactive fission products to be leaked into the cooling water. These are the "noncondensibles," like hydrogen or the noble gases (krypton-85, xenon-133, etc.) which cannot be condensed back into the cooling loop. In addition, you will accumulate small amounts of water soluble fission products (e.g., iodine-131) which will be dissolved in the cooling water. Further, if there are any breaks in the thousands of tubules in

the steam generators, then this radioactive contamination will leak into the secondary system as well. Contamination in the secondary, due to salt-water corrosion found in many reactors like Diablo Canyon that are cooled by sea water, can cause radiation to slowly leak throughout the plant, causing considerable complications for workers making routine repairs.

II. POTENTIAL ACCIDENTS AND CONSEQUENCES

6. A reactor operating at 5% power will, during its normal operation, be susceptible to a range of nuclear accidents. Small nuclear accidents are made possible by the presence of nuclear materials in the reactor. Fuel handling accidents, which can potentially create enormous radiation exposures to workers, can happen once the fuel rods have been loaded and irradiated. Radiation levels of thousands of rads per hour (when 600 will kill an average adult) can be generated by fuel rods that have been irradiated.

7. A reactor operating at 5% power will also be exposed to the possibility of larger accidents, known as Class VIII and Class IX accidents. Although less likely to happen, these accidents cannot be ruled out for a number of reasons. I will first discuss the consequences of a major off-site release and then consider how likely such a release may be. A fission product inventory of half a billion curies is quite large. (For the purpose of comparison, a hydrogen bomb has a radiation inventory after the first day about <u>50 times smaller</u> than the inventory of a large reactor at 5% power. Of course, a reactor

cannot explode, but the inventory even at 5% power is enough to cause the death of tens of thousands of individuals if the fission products could somehow be dispersed into the environment.) It is important to realize that a reactor operating at 5% power has enough energy to cause melting and ultimately breach of the containment. For example, the meltdown scenarios that have been postulated in WASH-740 and WASH-1400 are based on reactors that have been "scrammed" (i.e., control rods inserted). A scrammed reactor is sub-critical but its "decay heat," which is about 5% of the reactor's full-power value, is sufficient to raise temperatures to 5,000 degrees F., which is sufficient to cause the fuel to melt.

8. Any number of mechanisms can eventually cause large amounts of hot, gaseous fission products (iodine-131, strontium-90, cesium-137) to be sprayed as steam into the environment. For example, an accident called Class IX, PWR 3, could cause the slow release of 20% of the iodines and 20% of the alkali metals into the atmosphere (and probably 100% of the noble gases). Given the fact that the reactor contains half a billion curies of radiation at 5% power, then it is possible that as much as a hundred million curies may escape into the environment. Much of this will be in the form of water soluble fission products like iodine, cesium, and strontium as well as noble gases. The fission products will be dispersed as a fine, invisible mist into the air. Winds blowing moderately at 5 mph will create a 15-degree wedge of radioactive steam moving steadily downwind. Within two hours, the radioactive plume will

have reached the 10 mile evacuation zone.

9. The potential health risks in the surrounding environment associated with even a 1% to .1% release fraction may be considerable. Iodine-131, which concentrates in the thyroid gland, has a half-life of 8 days, so it is reasonable to assume that in 80 days (10 half-lives) the radioactivity will have reduced down to acceptable levels. However, cesium-137 and strontium-90 have half-lives of around 30 years, and will contaminate the area for roughly 300 years. Since both cesium and strontium can occur in water soluble form, this means that the top soil surrounding the area will be unfit for agricultural uses for several centuries. An area containing several thousand square miles of land may eventually be quarantined, with the crops confiscated, the milk impounded, and the area sealed off.

10. There is some precedent for this scenario. In October 1957, the British had a nuclear accident several times more severe than that which occurred at TMI in 1979. The experienced a large uranium fire in the Windscale Pile #1, which sent roughly 50,000 curies of fission products (mainly strontium) into the surrounding area. This amount of contamination was sufficient to cause the contamination of several hundred square miles of land. Milk had to be impounded in a 200 square mile area, and cattle were slaughtered and their thyroid glands removed. Unfortunately, no adequate health records were kept, so it is not known what the long-term effects of this accident have been. This type of emergency, caused by the leakage of 50,000 curies, could be dwarfed by a major

accident at Diablo Canyon during low power operation.

11. Furthermore, areas even hundreds of miles away from the contaminated area may also experience a drop in business because of psychological reasons. In the past, even rumors of contamination of certain foods have adversely affected the market. For example, the rumored contamination of shellfish and oysters in the Chesapeake River caused a rather dramatic drop in consumption of these foods and a loss of tens of millions of dollars to business. Similarly, areas bordering on contaminated areas may also experience a sudden drop in sales.

12. The scenario presented above may be challenged because of the probability calculations in the Reactor Safety Study, WASH-1400, which estimates very low probabilities for Class IX accidents. The methodology used in WASH-1400 to calculate the probability of Class IX accidents is very much in dispute within the scientific community, and WASH-1400 by no means represents the final verdict on the issue. Its executive summary was even repudiated by the NRC itself in the Lewis Report. The methodology of WASH-1400 has been challenged on several grounds. First, the analysis uses the "single event tree analysis," which is based on taking a single event (i.e., one pipe crack) and calculating its effects as this defect propagates and creates more failures. This methodology essentially neglects the question of common and multiple mode failures, which are the likely modes of an accident at Diablo Canyon in the event of an earthquake. A common mode failure

could be initiated by even a small earthquake, causing, for example, several pipes to break simultaneously. Each pipe break could in turn cause a cascade of several smaller breaks. When these cascading trees of small accidents begin to overlap and influence each other, the capability of any computer on this planet to model the accident accurately is quickly exhausted. Even single mode failures push the limit of known computers; common mode failures for anything as complex as a nuclear reactor are beyond the known computer technology available at present. If working experience is any guide, single mode failures are simply too idealized to give us an accurate assessment of the probabilities of a Class IX accident.

13. Multiple mode failures are also a big problem. Almost all the major nuclear accidents of the past, including the Class IX accident at Three Mile Island ("TMI"), have been multiple mode failures. According to the utility's own Final Safety Analysis Report ("FSAR"), a Class VIII accident (e.g., loss of coolant accident ("LOCA")) may create a situation which will strain the emergency systems but will eventually be brought under control. But given the history of design problems at Diablo Canyon, it is possible that a Class VIII accident may slide into a Class IX accident. The transition from a Class VIII accident (which must be analyzed by law in the FSAR) to a Class IX accident is much easier to make if there are hidden defects in the reactor. For example, assuming a Class VIII accident at Diablo Canyon, similar to the one considered in the FSAR for the reactor, and assuming an

earthquake that causes a double-ended guillotine break in the "cold-leg" of the primary system, the highly pressurized cooling water could blast out of the vessel, completely uncovering the core within a matter of minutes. In the FSAR for Diablo Canyon, it is postulated that the high pressure injection ("HPI") pumps will automatically activate, pouring cooling water on the core and terminating the accident. However, if the HPI pumps and pipes have been damaged during the earthquake because they were not installed correctly, a design-basis Class VIII accident will slide into a "beyond design basis" Class IX accident.

14. Given a multiple mode failure, where a Class VIII accident is pushed into a Class IX accident by the failure of the HPI system because of problems peculiar to the Diablo Canyon reactor, it is possible to have fuel melting. There is enough energy at 5% power to cause temperatures to soar to 5,000 degrees F. The failure pressure for a PWR containment is roughly 100 pounds per square inch, which can be achieved through a number of mechanisms: (a) steam explosions when molten fuel comes in contact with cold water (steam explosions can cause local over-pressures reaching several thousand psi), (b) over-pressurization due to the generation of large amounts of steam and hydrogen (from oxidation of the zirconium; even WASH-1400 admits that overpressure beyond 100 psi can be generated by steam and hydrogen), or (c) simple leakage of radiation to the environment by failures in the isolation valves, the penetrations, etc. (this is the mode found at TMI). Once the containment has been breached, the Class IX scenario

progresses like a full-scale accident. The 5% power level effects primarily the time scale over which the accident takes place. The potential magnitude of the accident is still quite severe, given the inventory of a half billion curies. (See WASH-740, Fig. 5-8, which estimates considerable damage from releases of approximately .5 billion curries.)

15. The probabilities contained in WASH-1400 have been challenged on other grounds as well. First, WASH-1400 is based on a large amount of sheer guesswork. In using event tree analysis, one must know the probability of each failure within the tree. But it is impossible to estimate the failure rate of a given component if it has been on the open market for only a few years. Remarkably, WASH-1400 will estimate that, for example, a certain pump will fail in, say, 100 years of operation when it has only been tested for two years. Second, there are accident sequences that have not been included in WASH-1400 and cannot be quantified. For example, the precise sequence found at TMI was never even mentioned in all the operating manuals of the industry. The nuclear industry never foresaw the scenario in which the control panel would read "full" yet the reactor vessel was actually "empty." How many more unforeseen accident sequences are there that have not yet been quantified by the industry? Third, there is always the question of human failure or sabotage. At TMI, for example, the HPI had a calculated failure rate that was astronomically small. They failed, however, because the operators simply turned them off in the first few hours of the accident.

III. CONCLUSION

16. The transition from zero to 5% power is a qualitative one. Certain of the major accidents that are postulated for a reactor operating at 100% full power can also occur within a longer timeframe in a reactor operating at low power. This is because the radioactive inventory stored in a reactor operating at 5% is roughly half a billion curies, which is similar to the radiation inventory studied in WASH-740 and is 10,000 times the radiation released at Windscale in 1957. The probability calculations done in WASH-1400 have been largely undermined by other scientists. Quite frankly, no one knows how to calculate the probability of Class IX accidents correctly.

Consequently, I conclude that even the routine operation of the Diablo Canyon reactor at up to 5% power presents a significant safety hazard to the surrounding environment and to plant workers and poses a risk of the irreversible contamination of the reactor.

Executed this ____ day of March, 1984, at New York City, New York.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

DR. MICHIO KAKU

BIOGRAPHY OF DR. MICHIO KAKU

Dr. Michio Kaku is a Full Professor of Nuclear Physics and holds a dual appointment at the Graduate Center of the City University of New York (CUNY) and the City College of New York.

Education and Professional Background:

B.S. in Physics, Harvard University, 1968, Phi Beta Kappa, Summa Cum Laude.

Ph.D. in Nuclear Physics, University of California at Berkeley (Lawrence Radiation Laboratory), 1972.

Lecturer, Princeton University, 1972 to 1973.

Professor, CUNY Graduate Center and CCNY, 1973 to present.

Fellow, American Physical Society.

Publications:

35 articles published in various physics journals (see attached); contributed to five books in nuclear and theoretical physics.

Co-author of book on commercial nuclear power entitled Nuclear Power: Both Sides (W.W. Norton) with Jennifer Trainer.

Research Areas:

Research and published articles in principal areas:

a. unified field theories (supergravity, superconformational gravity, quantum gravity)
b. high energy physics (relativistic string models for hadronic physics, lattice gauge theory)
c. nuclear physics (neutron transport theory)
d. reactor physics (computer modeling of reactor accidents).

Testimony:

Qualified as a reactor physicist by the Nuclear Regulatory Commission in various reactor hearings around the country (Big Rock in Michigan, V.C. Summer in South Carolina, UCLA, Byron

near Chicago); appeared as an expert advisor to Governor Cuomo's Commission on the Shoreham Power Plant, and testified in civil suits involving the Comanche Peak Reactor.

Lectures:

Numerous international conferences on theoretical and nuclear physics, including, for example, Moscow, as a guest of the Soviet Academy of Sciences, 1978 and Cambridge, England, as a lecturer in the Supergravity Conference, 1980.

Lectures at the following campuses: Harvard University, Yale University, UCLA, Amhearst, New York University, Columbia, University of Rochester, Syracuse University, University of Michigan at Ann Arbor, Michigan State University at Lansing, University of Chicago, University of Southern California, Massachusetts Institute of Technology, Princeton Unviersity, Rutgers University, George Washington University, Georgia Institute of Technology, Circle College (Chicago), Queens College, Brooklyn College, Hunter College, University of California at San Diego, University of California at Irvine, Cal State at Sacramento, University of Maryland, University of Georgia at Athens, University of Cincinnati, University of New Mexico, University of California at Berkeley, California Institute of Technology, Guilford College in North Carolina, Virginia Polytechnic Institute, Cambridge University in England, Ecole Normale Superieur in Paris, and many others.

Articles in Scientific Literature:

1. "Unitary Nonplanar Closed Loops" (with C.B. Thorn), Physical Review D1, 2860 (1970).

2. "Divergence of the Two-Loop Planar Graph in the Dual Resonance Model" (with J. Scherk), Physical Review D3, 430 (1971).

3. "The General Multi-loop Veneziano Amplitude" (with L.P. Yu), Physics Letters 33B, 166 (1970).

4. "Divergence of the N-loop Planar Graph in the Dual Resonance Model" (with J. Scherk), Physical Review D3, 2000 (1971).

5. "Unitarization of the Dual Resonance Amplitude I. Planar N-loop Amplitude" (with L.P. Yu), Physical Review D3, 2997 (1971).

6. "Unitarization of the Dual Resonance Amplitude II. The Non-planar N-Loop Amplitude" (with L.P. Yu), Physical Review D3, 3007 (1971).

7. "Unitarization of the Dual Resonance Amplitude III. General Rules for the Orientable and Non-orientable Multi-loop Amplitudes" (with L.P. Yu), Physical Review D3, 3020 (1971).

8. "Linear Depenences and the Multi-loop Veneziano Amplitude," Physical Review D3, 908 (1971).

9. "Functional Approach to Dual Models with Spin" (with M. Virasoro and M. Yoshimura), Nuclear Physics B33, 109 (1971).

10. "Dual Pion Model with Zero Intercept and Nine Dimensions," Physical Review D9, 2850 (1974).

11. "The Field Theory of Spinning Strings," Physical Review D10, 3943 (1974).

13. "The Field Theory of Relativistic Strings II: Loops and Pomerons" (with K. Kikkawa), Physical Review D10, 1923 (1974).

14. "Ghost-Free Formulation of Quantum Gravity in the Light Cone Gauge," Nuclear Physics B91, 99 (1975).

15. "Calculation of the Functional Measure in Quantum Gravity" (with P. Senjanovic), Physical Review.

16. "Soliton Dictionary for Massive Quantum Electrodynamics," Physical Review, D12, 2330 (1975).

17. "Time-Dependent Generalizations of 't Hooft-type Monopoles," Physical Review, 1975.

18. "SU(4) and a New Class of Exact, Time-dependent Classical Solutions to Gauge Theories," Physical Review D13, 2881 (1975).

19. "Gauge Theory of the Conformal and Superconformal Group" (with P.K. Townsend and P. van Nieuwenhuizen), Physics Letters 69B, 304 (1977).

20. "Superconformal Unified Field Theory" (with P.K. Townsend and P. van Nieuwenhuizen), Physical Review Letters 39, 1109 (1977).

21. "Unified Field Theories with U(N) Internal Symmetries: Gauging the Superconformal Group" (with S. Ferrara, P.K. Townsend and P. van Nieuwenhuizen), Nuclear Physics B12, 3179 (1978).

23. "Poincare Supergravity as Broken Superconformal Gravity" (with P.K. Townsend), Physics Letters 76B, 54 (1978).

24. "Unified Approach to Matter Coupling in Weyl and Einstein Supergravity" (with A. Das and P.K. Townsend), Physical Review Letters 40, 1215 (1978).

25. "Supersymmetry at High Temperatures" (with A. Das), Physical Review D18, 4540 (1978).

26. "Observations on the Gribov Ambiguity in General Relativity in the Coulomb Gauge" (with A. Das), Nuovo Cimento 50B, 303 (1979).

27. "Lattice Formulation of General Relativity" (with A. Das and P.K. Townsend), Physics Letters 81B, 11 (1979).

28. "Conformal Gravity in Hamiltonian: Another Approach to the Renormalization of Gravity," Nuclear Physics B203, 285 (1982).

29. "Strong Coupling Approach to Conformal Gravity," Physical Review D27, 2819 (1983).

30. "Superconformal Gravity in Hamiltonian Form," Physical Review D27, 2809 (1983).

31. "Effective Potentials in Differential Supergravities," Physics Letters 126B, 18[illegible] (1983).

32. "Gauge Theory on a Random Supersymmetric Lattice," Physical Review Letters, 1983.

33. "Super Lattice and Gauge Theory," submitted to Physical Review, 1983.

34. "Generally Covariant Lattices, the Random Calculus, and the Strong Coupling Expansion to Quantum Gravity," submitted to Nuclear Physics, 1983.

35. "The Fissioning Universe: A Kaluza-Klein solution to the Problem of Homogeneity and Isotropy," (with J. Lykken), in preparation.

36. "Dimensional Transmutation on the Lattice as the Origin of the Planck Length," in preparation.

Articles in Popular Press:

37. "Nuclear Power, and Incomplete Technology?" Technology Review, MIT, June-July 1980.

38. "Wasting Space," Progressive Magazine, July 1983.

39. "New Era in the Arms Race?" Op Ed article in Newsday, Oct. 3, 1983.

Contributions to Books:

40. "Strings and Quantum Gravity," and "Quantum Gravity in the Light Cone Gauge." Proceedings of the 2nd Latin American Conference on General Relatively, Caracas, 1976.

41. "Einstein's Unified Field Theory and Supergravity." Einstein Centennial Lecturers, St. George Campus of the University of Staten Island.

42. "Lattices and Supergravity." Superspace and Supergravity. S. Hawking and M. Rocek. Cambridge University Press, 1981.

43. "Conformal Supergravity." Supergravity, P. van Nieuwenhuizen, ed. 1980.