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Abstracts of Award Winning and Honorable Mention Essays for 1992

Award Essays

First Award - Correlations Beyond the Horizon by Robert M. Wald, Enrico Fermi Institute and Department of Physics, University of Chicago, Chicago, IL 60637.

Abstract - It is a fundamental feature of quantum field theory that correlations between observable quantities occur over all spacetime regions. In particular, in cosmological models with horizons, such correlations will be present in regions which "lie outside of each other's horizon". Such correlations may play an important role in processes occurring in the early universe.

Second Award - The Fate of Magnetically Charged Black Holes by Kimyeong Lee, V. P. Nair, and Erick J. Weinberg, Physics Department, Columbia University, New York, New York 10027.

Abstract - The magnetically charged Reissner-Nordström black hole solutions of Maxwell-Einstein theory cannot evaporate completely because their Hawking temperature tends to zero as their mass to charge ratio approaches unity. This situation changes when these solutions are considered in the context of a non-Abelian gauge theory containing nonsingular magnetic monopoles. If the horizon is sufficiently small, the Reissner-Nordström solution develops a classical instability and evolves into a new type of magnetically charged black hole solution. The temperature of these new solutions increases monotonically as the horizon contracts, so that there is no obstacle to the complete evaporation of a magnetically charged black hole.

Third Award - How the Jones Polynomial Gives Rise to Physical States of Quantum General Relativity by Bernd Brügmann[1], Rodolfo Gambini[2], Jorge Pullin[3], [1]Physics Department, Syracuse University, Syracuse, NY 13244, [2]Instituto de Física, Facultad de Ciencias, Tristan Narvaja 1674, Montevideo, Uruguay, [3]Department of Physics, University of Utah, Salt Lake City, UT 84112.

Abstract - Solutions to both the diffeomorphism and the hamiltonian constraint of quantum gravity have been found in the loop representation, which is based on Ashtekar's new variables. While the diffeomorphism constraint is easily solved by considering loop functionals which are knot invariants, there remains the puzzle why several of the known knot invariants are also solutions to the hamiltonian constraint. The authors show how the Jones polynomial gives rise to an infinite set of solutions to all the constraints of quantum gravity thereby illuminating the structure of the space of solutions and suggesting the existence of a deep connection between quantum gravity and knot theory at a dynamical level.

Fourth Award - Quantum Gravity, Random Geometry and Critical Phenomena by Mark J. Bowick and Enzo Marinari, Physics Department, Syracuse University, Syracuse, NY 13244-1130.

Abstract - The authors discuss the theory of non-critical strings with extrinsic curvature embedded in a target space dimension d greater than one. They emphasize the analogy between $2d$ gravity coupled to matter and non self-avoiding liquid-like membranes with bending rigidity. They first outline the exact solution for strings in dimensions $d < 1$ via the double scaling limit of matrix models and then discuss the difficulties of an extension to $d > 1$. Evidence from recent and ongoing numerical simulations of dynamically triangulated random surfaces indicate that there is a non-trivial crossover from a crumpled to an extended surface as the bending rigidity is increased. If the cross-over is a true second order phase transition corresponding to a critical point there is the exciting possibility of obtaining a well defined continuum string theory for $d > 1$.

Fifth Award - The Breakdown of Quantum Mechanics in the Presence of Time Machines by Dalia S. Goldwirth[1], Malcolm J. Perry[2], Tsvi Piran[3], [1]Center for Astrophysics, Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, [2]Department of Mathematics, MIT, Cambridge, MA 02139, [3]Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138.

Abstract - General Relativity allows for the existence of closed timelike curves. Various attempts have been made to exploit this possibility and build a "time machine," that is a spacetime that has closed timelike lines inside some compact domain. The authors examine a simple model of a time machine, and construct the quantum-mechanical propagator for free particles in the vicinity of the causality violating domain. They discover that it is impossible for such propagators to be consistent with the law of conservation of probability. They speculate on the possible deeper consequences of the calculations.

Honorable Mention Awards
Alphabetical Order

1. The Global Problem of Time by Arlen Anderson, Department of Physics, McGill University, Montréal PQ H3A 2T8 Canada.

Abstract - Time does not obviously appear amongst the coordinates on the constrained phase of general relativity in the Hamiltonian formulation. Recent work in finite-dimensional models claims that topological obstructions generically make the global definition of time impossible. It is shown here that a time coordinate can be globally defined on a constrained phase space by patching together local time coordinates, just as coordinates are defined on topologically non-trivial manifolds.

2. Inflation Without Inflation by M. I. Beciu, Department of Physics, Institute of Constructions, Lacul Tei 124, Bucarest, Romania.

Abstract - The author brings to attention a class of cosmological models which exhibits a friction term for the cosmological fluid and which accounts for an inflationary era. The inflation scenario possesses two main features: it does not require a reheating phase and at the same time it solves in a simple way the graceful exit problem.

3. Cohomological Gravity by Danny Birmingham[1] and Mark Rakowski[2], [1]CERN, Theory Division, CH-1211, Geneva 23, Switzerland, [2]Institut für Physik, Johannes-Gutenberg-Universität, Staudinger Weg 7, D-6500 Mainz, Germany.

Abstract - The authors construct a theory of cohomological gravity in arbitrary dimensions based upon a local vector supersymmetry algebra. The observables in this theory are polynomial, but generally non-local operators, and have a natural interpretation in terms of a universal bundle for gravity. As such, their correlation functions correspond to cohomology classes on moduli spaces of Riemannian connections. In this uniformization approach, different moduli spaces are obtained by introducing curvature singularities on condimension two submanifolds via a puncture operator. This puncture operator is constructed from a naturally occurring differential form of co-degree two in the theory, and the authors are led to speculate on connections between this continuum quantum field theory and the discrete Regge calculus.

4. Inflation Pressures by Kevin Cahill and Jiří Podolský, Department of Physics and Astronomy, University of New Mexico, Albuquerque, NM 87131-1156.

Abstract - If the sum of the energy density ρ and thrice the pressure p is negative, then a Robertson-Walker universe can inflate or even oscillate. For a generic grandly unified model, the authors show at the one-loop level that if the Higgs field lies at the absolute minimum of the finite-temperature effective potential, then $\rho + 3p$ must be positive. Thus the condition $\rho + 3p < 0$ is a constraint upon inflation and particularly upon oscillation. Yet the effects of gravitational friction and anti-friction may allow even for oscillations, at least for those portions of a collapsing universe for which the timing is right.

5. Tests of General Relativity and Newtonian Gravity at Large Distances and Dark Matter by Arnon Dar, Department of Physics and Space Research Institute, Technion-Israel Institute of Technology, Haifa 32000, Israel.

Abstract - There is considerable evidence from the dynamics of galaxies and clusters of galaxies that if Einstein's theory of General Relativity (EGR) and its weak field limit, Newtonian Gravity, are valid over large astronomical distances than most of the gravitating matter in the Universe is dark. However, Newton's laws and EGR have been verified, so far, only within the solar system and within close binary systems whose sizes are billions of times smaller. That has led some authors to question the validity of EGR over large astronomical distances and to suggest that perhaps a correct theory of gravity will eliminate the dark matter problem. However, in this essay the author uses observations on the most simple known cases of gravitational lensing of quasars and distant galaxies by galaxies and clusters of galaxies for testing EGR and its weak field limit, Newtonian Gravity, over galactic and intergalactic distances. The observations confirm within error bars the validity of EGR and Newtonian Gravity over such distances, and consequently also the existence of large quantities of dark matter in galaxies and clusters of galaxies. Uncertainties and incomplete observational data limit the present statistical accuracy of the tests to about 30%. Future observations may significantly improve this accuracy and reduce the possibilities for systematic errors.

6. Evolutionary Universe by John Bruce Davies, Department of Physics, University of Colorado, Boulder, CO 80309.

Abstract - Recent observations have shown that the Universe has seen new groups of galaxies being formed throughout its history. It appears to be populated by dominant species of galaxies at different times. These luminous galaxies are considered to be the product of the collapse of isothermal rotating self-gravitating gas spheroids. The author develops a virial analysis of these protogalactic spheroids and predicts the effects of Universe expansion on the stability of these systems. As the pressure and temperature of the Universe decreases in time, the largest mass spheroids are the first to become unstable to collapse. Subsequently, as the temperature falls further, lower mass systems collapse and form observable galaxies. These general trends correlate with the recent observations of the size and type of galaxies emerging at different times in the Universe history.

7. Multidimensional Cosmological Models, Dimensional Reduction and Gravitational Wave Background by Marek Demiański[1] and Alexander G. Polnarev[2], [1]Institute for Theoretical Physics, University of Warsaw, Warsaw, Poland, [2]Astro-Space Center, Lebedev Physics Institute, Moscow, Russia.

Abstract - The authors study the stochastic background of gravitational waves in multidimensional cosmological models. They show that the process of dimensional reduction which transforms the multidimensional spacetime into 4-dimensional physical spacetime leaves an imprint on the spectrum of primordial gravitational waves. The high frequency part of the spectrum of cosmological gravitational waves could contain important information on the very early (multidimensional) evolution of the universe and on the process of dimensional reduction. No other laboratory experiments could reach the energy scale $> 10^{14}$GeV

necessary to test the hypothesis of the multidimensional nature of spacetime at high energies.

8. A Born-Infeld Type of Modification of General Relativity with Maximal Curvature: Consequences for Black Holes Physics by Venzo de Sabbata[1], C. Sivaram[2] and Wang Dingxiong[3], [1]Department of Physics, University of Ferrara, Italy, [2]Indian Astrophysical Institute, Bangalore, India, [3]Hubei Institute for Nationalities, Enshi, China.

Abstract - Based on the fact that torsion is related to fundamental unit of spin $\hbar$, defects in space-time topology should occur in multiples of the Planck length that follow from the intrinsic defect built into the structure of space-time, implying a minimal fundamental length which, in turn, imply a maximal curvature. This has some physical consequences: entropy does not become infinite as the collapsing object approaches the Schwarzschild radius and moreover there is also a minimal mass ($\neq 0$ and $= M_{pl}$) of black holes that can form in early universe or survive as a remnant in the evaporation of larger black holes.

9. Quantum Coherence and String Black Holes by John Ellis[1], N. E. Mavromatos[1], and D. V. Nanopoulos[2], [1]Theory Division, CERN, CH-1211, Geneva 23, Switzerland, [2]Center for Theoretical Physics, Department of Physics, Texas A&M University, College Station, TX 77843-4242.

Abstract - The authors identify in string theory an infinite set of generalized gauge symmetries and conserved quantum numbers - W-hair - that preserve quantum coherence in processes involving black holes. W-symmetries conserve the phase-space volume for *s*-wave scattering off black holes. The black hole decays are quantum-mechanical, not thermal, and are subject to selection rules analogous to those holding in πp or quark-monopole scattering. W-hair is also in principle measurable via an infinite set of generalized Aharonov-Bohm effects.

10. Asymmetric Cosmological Models by Arthur E. Fischer, Department of Mathematics, University of California, Santa Cruz, CA 95064.

Abstract - A spacelike hypersurface in a spacetime is *maximal* if the trace of its second fundamental form is zero, and is *asymmetric* if the induced Riemannian metric on the hypersurface admit no continuous group of symmetries. By a cosmological model the author means an inextendible spacetime that satisfies Einstein's equations for some matter model that satisfies the weak energy condition.

The author considers cosmological models that admit compact asymmetric maximal spacelike hypersurfaces Σ. He calls such models *asymmetric cosmological models.* Let $D(\Sigma)$ denote the maximal Cauchy development of Σ. Under the assumption that the Poincaré conjecture is true, he gives the complete diffeomorphism classification of the compact spacelike hypersurfaces that can occur in $D(\Sigma)$.

More generally, en route to this classification, and for Σ a compact maximal spacelike hypersurface, not necessarily asymmetric, he also gives the diffeomorphism classification of all compact spacelike hypersurfaces in $D(\Sigma)$. In both cases, in the flat case, the classification is up to isometry.

Some notable features of this classification are that, firstly, the Poincaré conjecture plays such a prominent role, and secondly, that in the asymmetric case, there is a 3-parameter family of flat models, which are affinely equivalent. Thus, as a consequence of the author's results, up to affine equivalence, there exists a unique flat globally hyperbolic asymmetric cosmological model that admits a flat compact asymmetric maximal spacelike hypersurface. The author calls this model an F_6-*universe.* One can only speculate about the physical significance of its uniqueness.

11. Gravity Waves from Primordial Dimensional Reduction by M. Gasperini and M. Giovannini, Dipartimento di Fisica Teorica dell'Università, Via P. Giuria 1, 10125 Torino, Italy, and Instituto Nazionale di Fisica Nucleare, Sezione di Torino.

Abstract - The authors show that the dynamical contraction of *n* "internal" spacelike dimensions leads, in general, to the formation of a cosmic graviton background, similar to that produced by inflation. By using a simple phenomenological model they obtain information and constraints on the total number of extra dimensions, on their compactification scale and on the kinematics of the dimensional reduction process.

12. Quantum Effects Do not Protect Chronology - by James D. E. Grant, Department of Applied Mathematics and Theoretical Physics, Silver Street, Cambridge, England CB3 9EW, and Theoretical Astrophysics, California Institute of Technology, Pasadena, CA 91125.

Abstract - J. R. Gott has recently discovered a space consisting of two rapidly moving cosmic strings which contains closed timelike curves. The global structure of Gott's space is analysed and is found to be closely related to that of Misner space. The vacuum expectation value for the energy momentum tensor of a conformally coupled scalar field is calculated on the spacetime. This is found to diverge very weakly on the chronology horizon and on each of the polarised hypersurfaces of the space. This divergence is so weak that by the time the back reaction on the space has grown large enough for there to be any observable effect, quantum gravitational effects will be expected to dominate, and semi-classical approximations will have broken down. Finally, some recent criticisms of the space are discussed, and the author considers the implications of the Gott's space regarding Hawking's 'Chronology Protection Conjecture'.

13. Gravitational Action Densities Bounded from Below by E. I. Guendelman, Department of Physics, Ben Gurion University of the Negev, Beer Sheva 84105, Israel.

Abstract - The author discusses ways of constructing theories of gravity where the action density is bounded from below. This property can make the euclidean path integral better defined than in the standard Einstein case. For a class of action densities which depend (non linearly) on the scalar curvature, such models are at the classical level equivalent to scalar tensor theories of gravity with scalar potentials that imply a stable vacuum (which can be flat space) and where there is the possibility of an inflationary phase, as well as other interesting features. Scalars with such types of potentials appear naturally in some Kaluza Klein and other theories. When integrating out the scalars in such theories, one could end up with the models discussed here.

14. A Quantum Gravitational Schrodinger Equation for Spatially Bounded Systems by Geoff Hayward[1] and Ken Wong[2], [1]Department of Physics, University of British Columbia, Vancouver, B.C. V6T 2A6, Canada, [2]Department of Mathematics, University of British Columbia, Vancouver, B.C. V6T 2A6, Canada.

Abstract - The authors focus on the quantum geometrodynamics of a spatially bounded system. Such a system may be interpreted physically as a detector. They vary the propagator for the detector/system with respect to the lapse and shift in a small bubble on the spatial boundary. In this way, they derive 'bubble variation' forms of a boundary Schrödinger equation and boundary shift equations. While the authors do not obtain operator forms of these equations, they are---at a formal level---completely general and compatible with the Wheeler-DeWitt and momentum operator equations. In the weak gravity limit, the boundary Schrödinger equation reduces to the Schrödinger equation for the matter fields on a flat background.

15. Dynamical Instabilities in Self-Gravitating Objects by L. Herrera[1] and N. O. Santos[2], [1]Física Teórica, Facultad de Ciencias, Universidad del Pais Vasco, apartado 644, 48080 Bilbao, Spain, [2]Observatório Nacional CNPq Departamento de Astrofísica, rua General Cristino 77, 20921 Rio de Janeiro, Brazil.

Abstract - The authors analyse and discuss the influence that different kinds of deviations from the condition of perfect fluid may have on the stability of self-gravitating objects. Particular emphasis is placed on the occurrence of local anisotropy, which may lead, even for small anisotropic perturbation, to drastic changes in the stability of the system. Some speculations based on different processes of fragmentation, induced by local anisotropy, are presented.

16. The Instability of the Kerr Cauchy Horizons by Andrzej Krolak[1] and Wieslaw Rudnicki[2], [1]Institute of Mathematics, Polish Academy of Sciences, Sniadeckich 8, 00-950 Warsaw, Poland, [2]Institute of Physics, Pedagogical University, Rejtana 16A, 35-311 Rzeszow, Poland.

Abstract - Using global techniques of Geroch, Hawking and Penrose, the authors prove a theorem which shows that the Cauchy horizons of the type occurring in the Reissner-Nordstrom and Kerr space-times are unstable.

17. The Fragility and Rigidity of Cosmological Theories by James E. Lidsey, Theoretical Astronomy Unit, School of Mathematical Sciences, Queen Mary and Westfield, Mile End Road, London E1 4NS U.K.

Abstract - The concepts of fragility and rigidity in theories containing a minimally coupled, self-interacting scalar field are introduced and defined for an arbitrary space-time dimension, D, by using the field as the dynamical variable. It is proved that inflation is rigid and the case of an exponential self-interaction is studied. The fragility of higher-order, scalar-tensor and Kaluza-Klein gravity theories is investigated by using their conformal equivalence to general relativity plus a scalar field. Whilst most higher-order theories are rigid, the conditions for Kaluza-Klein theories to become fragile depend strongly on D.

18. Asymptotically Flat Magnetised Kerr Metric by V. S. Manko[1] and N. R. Sibgatullin[2], [1]Física Teórica, Universidad del País Vasco, Apartado 644, 48080 Bilbao, Spain, [2]Department of Hydrodynamics, Moscow State University, Moscow 119899, Russia.

Abstract - An exact asymptotically flat solution of the Einstein-Maxwell equations representing the nonlinear superposition of the Kerr Metric with a massless magnetic dipole is obtained. This solution describes correctly the exterior field of a magnetised spinning mass.

19. Midisuperspace-Induced Corrections to the Wheeler DeWitt Equation by Francisco D. Mazzitelli, International Centre for Theoretical Physics, P.O. Box 586 - 34100, Trieste, Italy.

Abstract - The author considers the midisuperspace of four dimensional spherically symmetric metrics and the Kantowski-Sachs minisuperspace contained in it. He discusses the quantization of the midisuperspace using the fact that the dimensionally reduced Einstein Hilbert action becomes a scalar-tensor theory of gravity in two dimensions. The author shows that the covariant regularization procedure in the midisuperspace induces modifications into the minisuperspace Wheeler DeWitt equation.

20. ACBDE; The Symmetry Groups of G.R., Particle Spins, Quantum Gravity, Polyhedra, Instantons by Patrick J. McCarthy, School of Mathematical Sciences, Queen Mary and Westfield College, Mile End Road, London E1 4NS U.K.

Abstract - This essay is a nontechnical description both of some relatively old, and of some very recent, work done by the author. For classical Lorentzian general relativity, the Bondi-Metzner-Sachs group B may be taken to be the fundamental symmetry group, for asymptotic null directions. B has analogues for all other asymptotic directions, in spacetimes of any signature, and also three C^∞ complexification, one, CB, for B itself. It is argued that representations of these groups provide unconstrained solution sets for the (as yet unknown) equations for quantum gravity, and that gravity is responsible for the observed discreteness of elementary particle spins. The representations are linked to the "A,D,E" series, and appear to be connected with the "path integral" approach to quantum gravity via moduli spaces of Euclidean gravitational instantons.

21. Why Do Clocks Tick? by David A. Meyer, Department of Physics and Institute for Pure and Applied Physical Sciences, University of California, San Diego, LaJolla, CA 92093-0075.

Abstract - Drawing on recent developments in the matrix model approach to string theory and the causal set program for quantum gravity, the author addresses the question of the origin of time as one aspect of the phase transition from a topological quantum field theory to a quantum theory of gravity. He constructs a model which demonstrates that while a theory based on causal sets may appear to have inherent notions of time and causality, the existence of a phase transition means, that as Saint Augustine wrote in his *Confessions*, "the 'time', if such we may call it, when there was no time was not time at all".

22. The Solar Neutrino Problem and The Electron-Neutrino Resonance by Lloyd Motz, Department of Astronomy, Columbia University, New York, NY 10027.

Abstract - The observed deficiency of solar neutrinos striking the earth has led to a serious astrophysical crisis in which the standard model of stellar structure is under attack. Since the standard model is basically a gravitational model, the observed neutrino deficiency, if not properly explained, challenges gravitational theory itself. In this essay, the author shows that the observed neutrino deficiency can be explained if an electron-neutrino resonance exists and if the sun has a polar magnetic dipole field.

23. Weak Equivalence Principle and Gravitomagnetic Field by Huei Peng[1] and K. Wang[2], [1]Institute of Applied Mathematics, Beijing, China, [2]Department of Physics, Penn. State University, New Kensington, PA 15068.

Abstract - It has been considered by a number of authors that spin-dependent effects in gravitation may violate the weak equivalence principle (WEP). The authors of this essay restudy WEP for the situation of a rotating test body in a gravitomagnetic field, and find that the rotating body may violate WEP too through the coupling of its angular momentum (the classical analogue of spin) to the gravitomagnetic field.

24. On the Estimates to Measure Hawking Effect and Unruh Effect in the Laboratory by H. Rosu, International Centre for Theoretical Physics, Trieste, Italy.

Abstract - A comparison between the proposals made to measure Hawking-like effects and the Unruh effect in the laboratory is given at the level of their estimates. No satisfactory scheme exists as yet for their detection.

25. Naked Singularities cannot Be Observed (An Information-Theoretic Approach to the Cosmic Censorship Conjecture) by M. Schiffer, CERN, CH-1211 Geneva 23, Switzerland.

Abstract - In this essay the author reviews some recent results obtained in the interplay between field theory in curved space-time and information theory. He explains how the Weyl tensor becomes responsible for the creation of quantum noise which, in turn, degrades a considerable fraction of the information conveyed by quanta. This noise might preclude the observation of very distant objects in the Universe. Naked singularities are surrounded by a very intense 'cloud' of noise and certainly cannot be observed. This leads to the intriguing possibility that the 'no-hair' theorem might be more general than was thought earlier.

26. Physical Condition of Gravitational Collapse With Neither a Black Hole or a Central Singularity by Shi Yong-Cheng, Shaoxing RTV University, 312000, P.R. China.

Abstract - In this essay the author first gets stress-energy tensors of the spherically symmetric zero rest mass field from the Einstein field equations with the component $T_{00}=0$ in spite of positive energy conditions. Then he obtains a physical condition which rules out both the black hole and the central singularity in spherically symmetric collapse.

27. Can Textures Solve the Horizon Problem? by Jerzy Stelmach, Institute of Physics, University of Szczecin, Wielkopolska 15, 70-451 Szczecin.

Abstract - The possibility of solving the horizon problem in closed FRW universe due to textures is discussed in detail. A realistic model, in which the universe is filled with relativistic matter and textures until the recombination and with dust, radiation and textures after the recombination is taken into account. The upper and lower limit of texture energy density, which cause the MBR observed today appear to be isotropic, is calculated. The interval of time Δt over which the universe remains in the "isotropic era" turns out to be four times smaller than the estimate given by Davis and for $\Omega_{m0} = 0.2$ and $H_0 = 50$km/sMpc is of order of 1 billion years. It is noted that for bigger values of Ω_{m0} and H_0, Δt becomes shorter reaching 270 mlns of years for $\Omega_{m0} \approx 1$ and $H_0 = 100$km/sMpc. For the "isotropic era" to be consistent with the age of the universe the texture density must be restricted to a very narrow range. Hence the scenario is improbable.

28. The Gravitoelectrodynamics of Superconductors: A Theoretical Basis for a Principle of Electrically Induced Gravitation by Douglas G. Torr and Ning Li, Physics Department and Center for Space Plasma and Aeronomic Research, The University of Alabama in Huntsville, Huntsville, AL 35899.

Abstract - The authors solve a time dependent coupled system of Maxwell's equations and their gravitational counterparts which represent the field equations of general relativity in the low-velocity, weak-field limit and an associated generalized set of coupled London equations to determine the electric and gravitational fields induced in a half-infinite superconductor in the presence of time dependent London gauge magnetic and gravitomagnetic vector potentials. The results indicate that a time change of the London gauge vector potential could induce a detectable internal gravitational field, which results from gravitational effects and a unique property of superconductors, namely the near-zero permeability. The results would further validate general relativity and establish the existence of the gravitational analogs of the electric and magnetic fields.

29. Is General Relativity an "Already Parametrized" Theory? by C. G. Torre, Department of Physics, Utah State University, Logan, UT 84322-4415.

Abstract - Beginning with the work of Dirac and Arnowitt, Deser, Misner in the late fifties and early sixties, and then after subsequent development by Kuchař, the canonical dynamical structure of general relativity has often been viewed as that of a parametrized field theory in which the many-fingered spacetime variables are hidden amongst the geometrodynamical field variables. This paradigm of general relativity as an "already parametrized theory" forms the basis for one of the most satisfactory resolutions of the problems of time and observables in classical and quantum gravity. However, despite decades of effort, no identification of many-fingered spacetime variables has ever been satisfactory obtained for vacuum general relativity. The author points out that there is an obstruction to identifying the constraint surface of general relativity (for the case of a closed universe) with that of any parametrized theory. Therefore, strictly speaking, general

relativity cannot be viewed as a parametrized field theory. The author discusses implications for the canonical quantization program.

30. Dirty Blackholes: the Hawking Temperature by Matt Visser, Physics Department, Washington University, St. Louis, MO 63130-4899.

Abstract - Considerable interest has recently been expressed in blackholes interacting with various forms of classical matter. A common feature of these investigations is that the Hawking temperature of such "dirty" blackholes appears to be suppressed relative to that of a vacuum blackhole of equal horizon area. That is: $kT_H \leq \hbar/(4\pi r_H) \equiv \hbar\sqrt{4\pi A_H}$. This essay will argue that this suppression is generic. Specifically, the Hawking temperature is given by

$$kT_H = \frac{\hbar}{4\pi r_H}(1 - 8\pi G\rho_H r_H^2)\exp -\phi(r_H).$$

Here $\phi(r_H)$ is an integral quantity, depending on the distribution of matter, that is guaranteed to be positive if the Weak Energy Condition is satisfied. Generalizations of this behavior to non-symmetric non-static blackholes are conjectured.

31. New Concepts in Cosmology: the Gravitational Inflation by Wang Mian, Department of Physics, Henan Normal University, Xinxiang, Henan 453002, China.

Abstract - A new approach to inflationary cosmology is proposed. It is suggested that the inflation of the early universe is a gravity effect and the inflation can be identified with the gravitational scalar field of a scalar-tensor theory of gravity. This scalar ϕ undergoes a slow-rolling along a double-well potential which results from the coupling function $\omega(\phi)$ and the cosmological function $\lambda(\phi)$ of the proposed gravity theory. This potential ensures ϕ to approach an asymptotic value ϕ_c. The function $\lambda(\phi)$ acts as a very large cosmological constant for the early universe and turns to be very small for the present day universe. The model not only satisfied the constraint of density fluctuation but also yields a Harrison-Zel'dovich scale invariant spectrum.

32. Density Fluctuations in the Inflationary Universe - by W. Zimdahl, Institut für Theoretische Physik, Universität Düsseldorf, D-4000 Düsseldorf 1, Germany.

Abstract - According to general fluctuation-dissipation theorems a nonzero bulk viscosity is necessarily connected with energy density fluctuations. In an expanding universe these fluctuations are proportional to the ratio of the relevant mean free time between the collisions and the Hubble time scale. While the Hubble scale remains constant during an intermediate inflationary stage the mean free collision time may grow. For a fluid with bulk viscosity, moving on the background of a de Sitter spacetime the corresponding fractional energy density fluctuations may be exponentially unstable. Possibly, this provides an alternative approach to the problem of initial conditions for large-scale structure formation in the early universe.