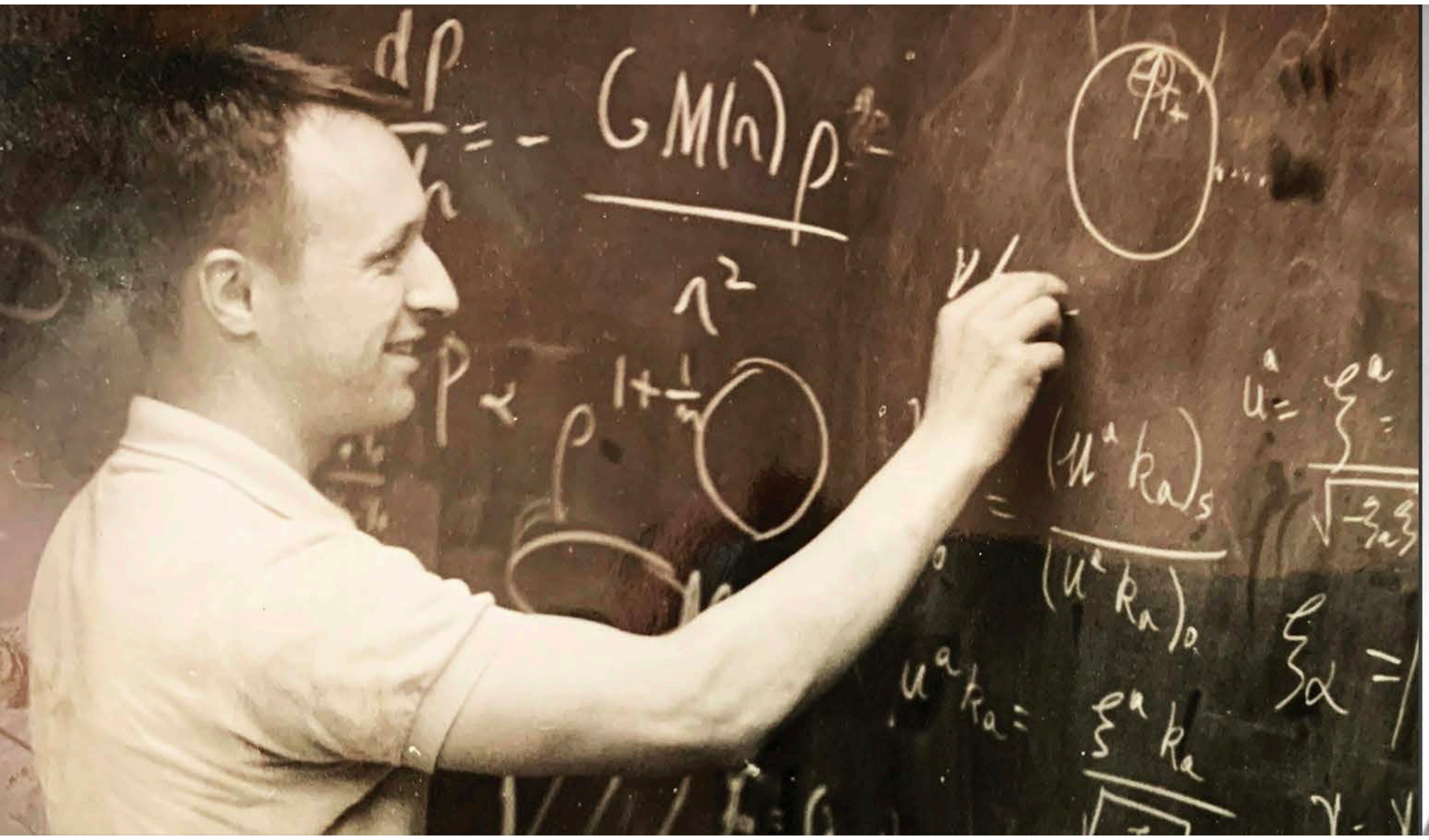
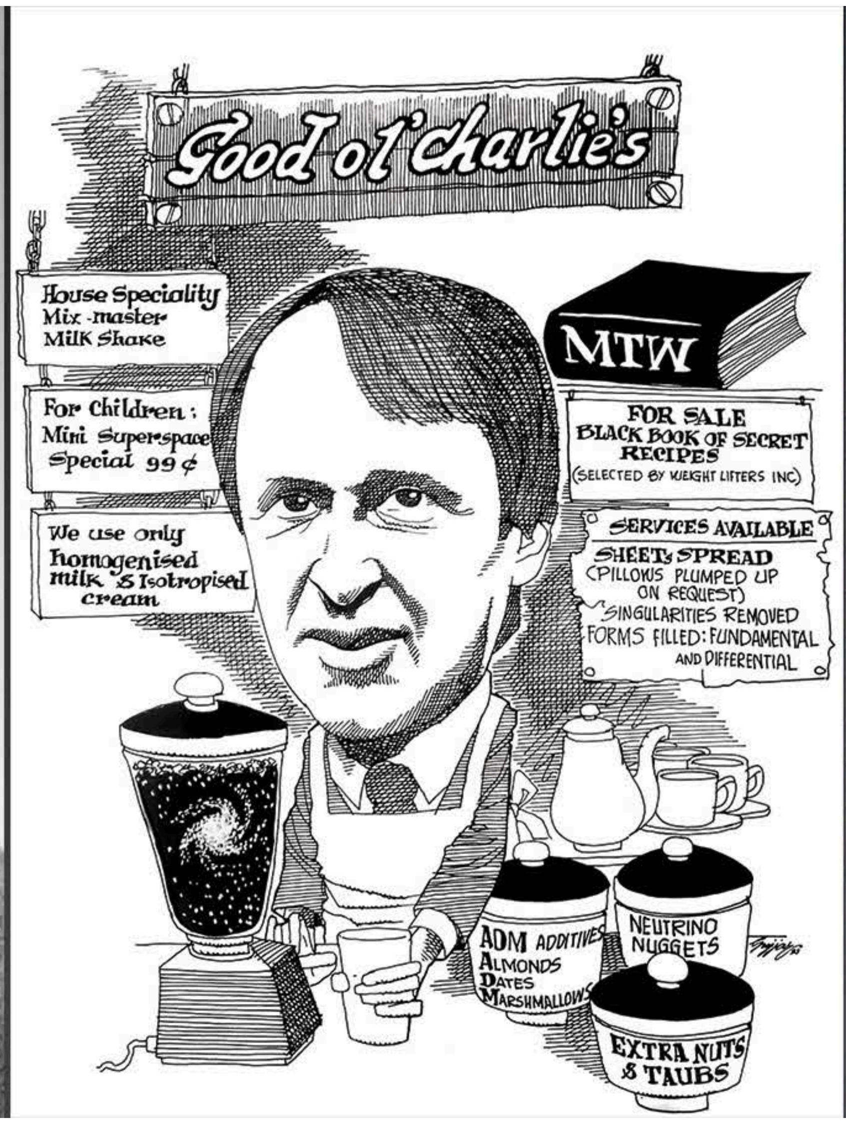
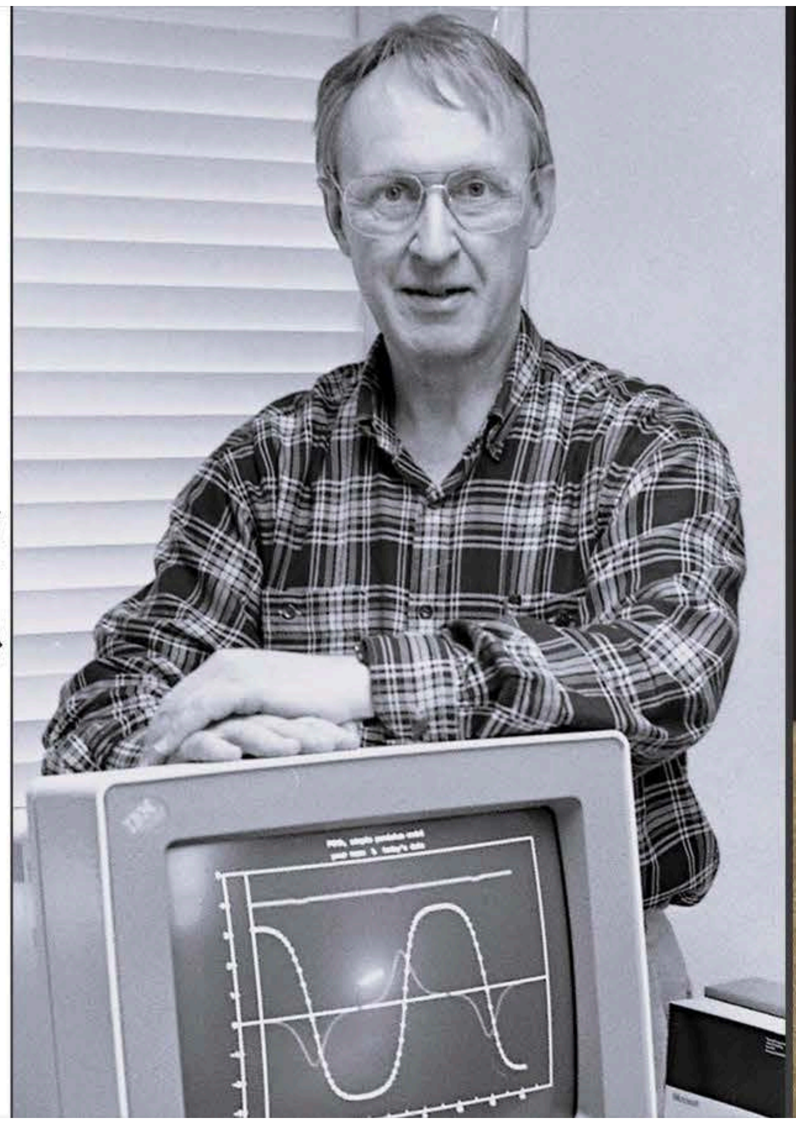
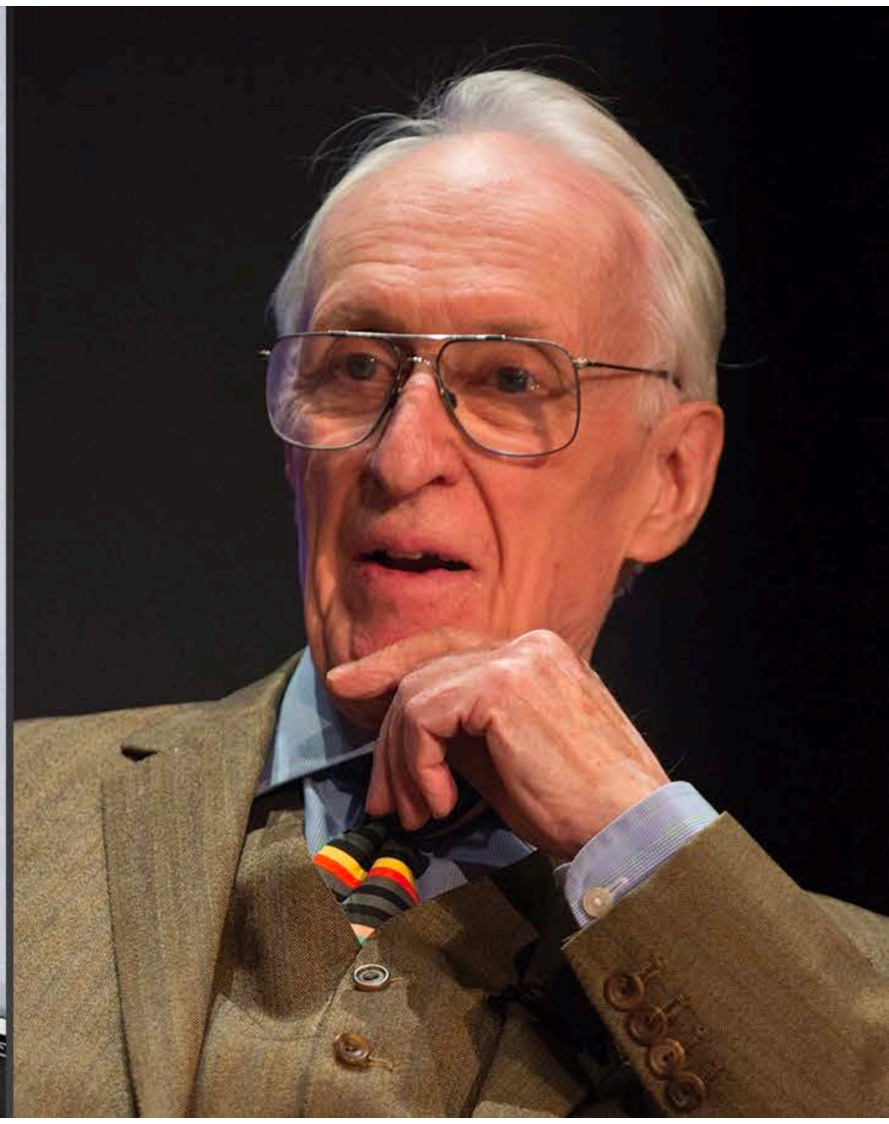
Charlie Misner
and
“the beauty and intelligibility of the universe“





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Feynman Quantization of General Relativity

Misner, Charles W.

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Classical physics as geometry

Misner, Charles W.; Wheeler, John A.

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Some new conservation laws

Finkelstein, David; Misner, Charles W.

1959PhRv..116.1045M 1959/11 cited: 32

Active Gravitational Mass

Misner, Charles W.; Putnam, Peter

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Wormhole Initial Conditions

Misner, Charles W.

* This research was supported by the Office of Naval Research.

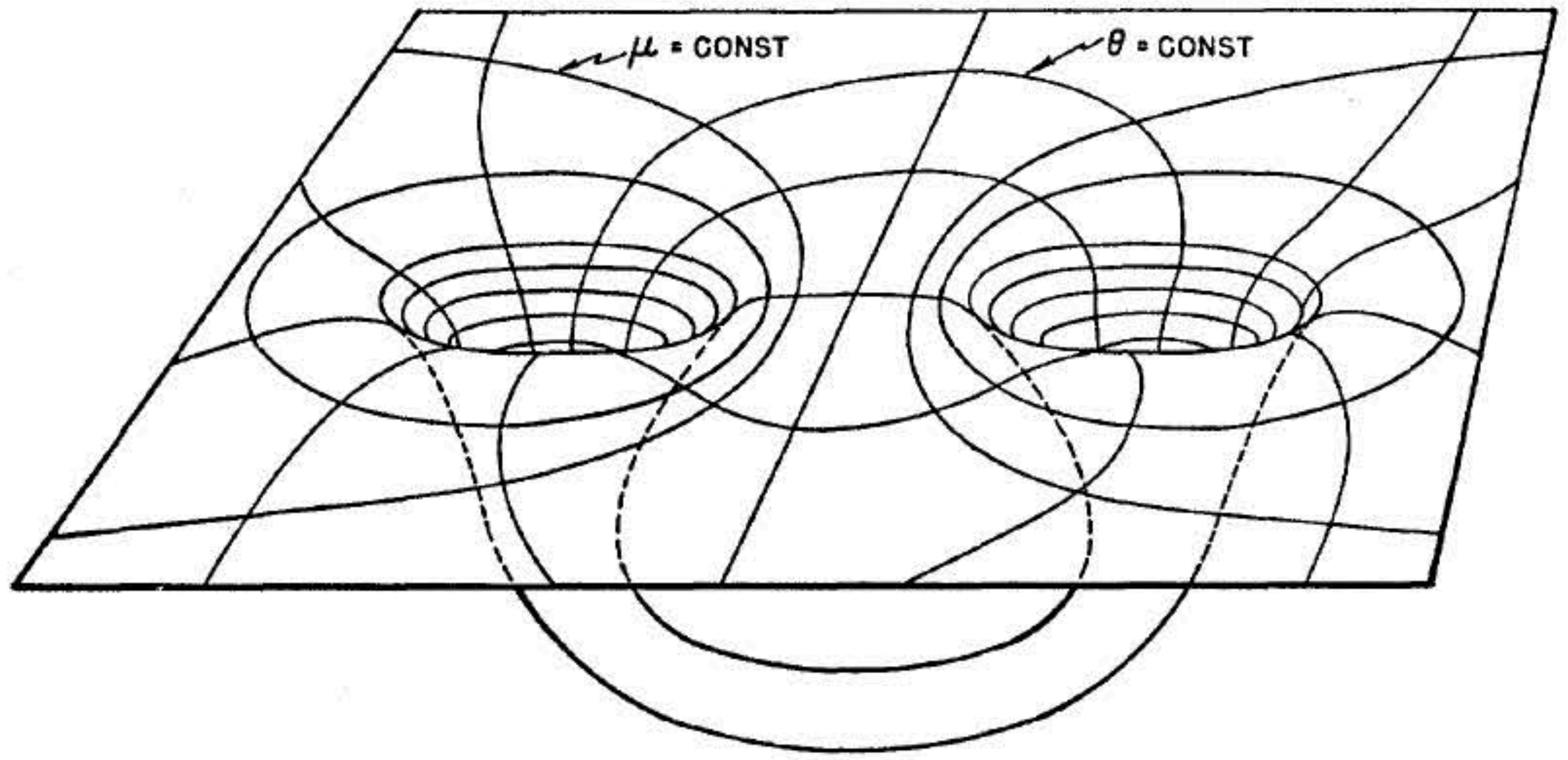
Wormhole Initial Conditions*

CHARLES W. MISNER†
Palmer Physical Laboratory, Princeton University, Princeton, New Jersey

(Received December 21, 1959)

Initial conditions for the source-free Einstein equations are exhibited which represent, in a singularity-free manner on a manifold with the topology of Wheeler's "wormhole," two neutral objects of equal positive masses instantaneously at rest.

At the time Wheeler first showed[1] that classical objects (geons) behaving like massive particles could be constructed theoretically from gravitational and electromagnetic fields, he suggested that charged particles could also be constructed from these fields. The existence of charged particles in the Einstein-Maxwell theory, with the charge-current density everywhere zero, requires a departure from Euclidean topology. One example of a suitable topology, the "wormhole," is shown in Fig. 1. It has been shown[2] that



solutions of the Einstein-Maxwell equations actually exist which can be interpreted (in a classical idealization) as spaces containing charged, massive, particles; these examples have topologies somewhat different from the wormhole. In this note we shall show that a solution of the Einstein equations exists having the form shown in Fig. 1. The solution given here refers to the special case of a wormhole free of electromagnetic field, and therefore, the two ends or "mouths" of the wormhole behave as *neutral* concentrations of mass energy.

Rather than attempt to solve the entire set of Einstein equations in the wormhole topology we restrict ourselves to the initial value equations,[2] $R_\mu{}^0-\frac{1}{2}\delta_\mu{}^0R=0$, on one fixed hypersurface $t=0$. These equations (analogous to $\nabla\cdot\mathbf{E}=0=\nabla\cdot\mathbf{H}$ in electromagnetism) and free of second time derivatives and, therefore, impose restrictions on the initial values to be specified for $g_{\mu\nu}$ and $\partial g_{\mu\nu}/\partial t$. (The remaining Einstein equations serve to determine the second time derivatives.) Choosing for simplicity a time symmetric problem[3] where, initially, $\partial g_{\mu\nu}/\partial t=0$ and $g_{0\mu}=-\delta_\mu{}^0$, these

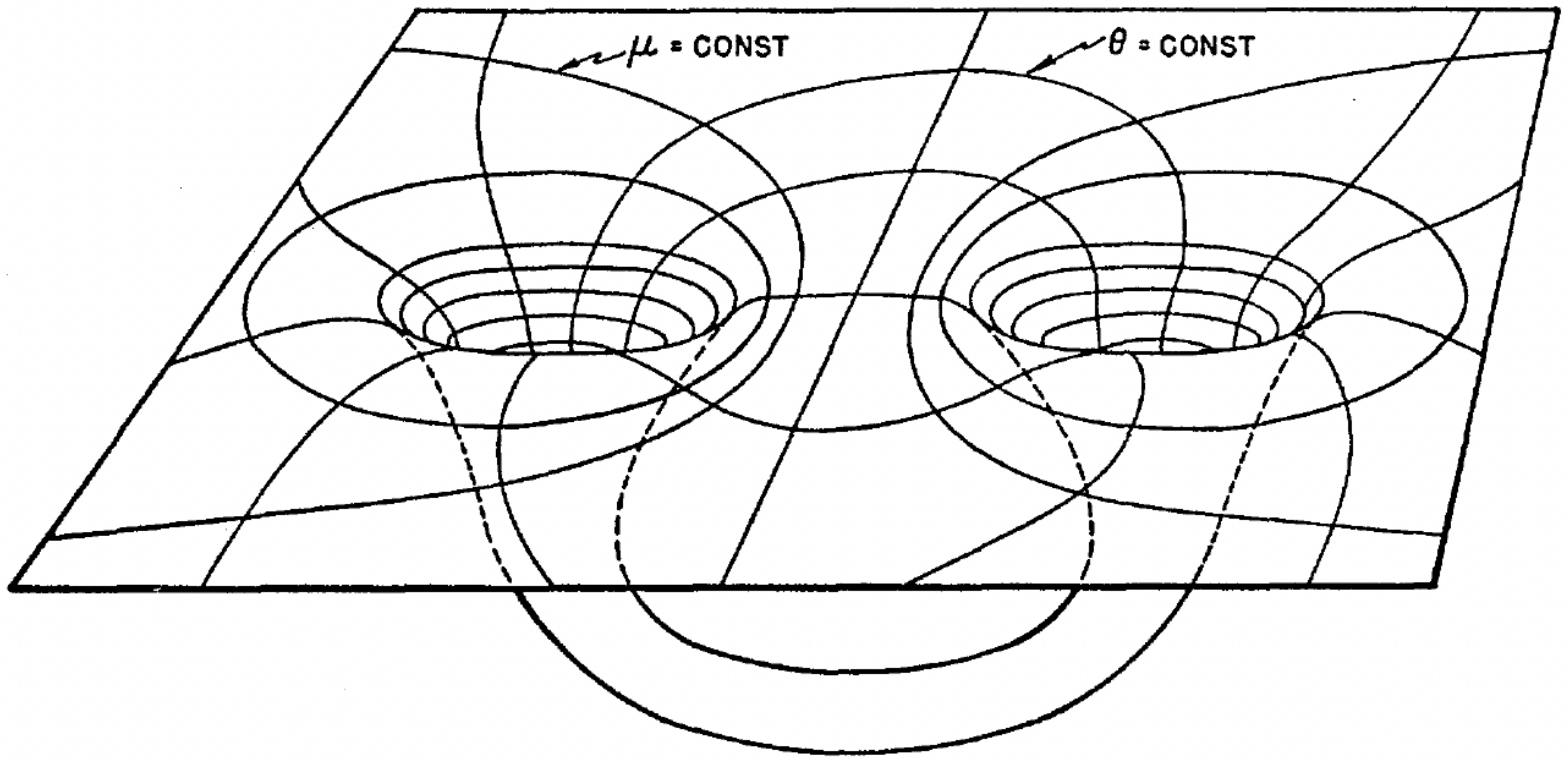
We will obtain a wormhole solution of Eq. (1) by modifying the metric

$$ds_D{}^2 = d\mu^2 + (d\theta^2 + \sin^2\theta d\varphi^2), \quad -\pi < \mu \leq \pi, \tag{2}$$

which represents a 3-dimensional doughnut $D = S^1 \times S^2$ whose cross section ($\mu = \text{const}$) is a sphere.

We limit attention to those wormhole metrics which may be written in the form

$$ds_W{}^2 = \phi^4 ds_D{}^2. \tag{4}$$



The possibilities for obtaining information about the time development of this "wormhole" metric by using an electronic computer are being investigated by R. W. Lindquist.

Initially static, conformally flat 3d geometry, with vanishing Ricci curvature scalar

MISNER summarized the discussion of this session: "First we assume that you have a computing machine better than anything we have now, and many programmers and a lot of money, and you want to look at a nice pretty solution of the Einstein equations. The computer wants to know from you what are the values of $g_{\mu\nu}$ and $\frac{\partial g_{\mu\nu}}{\partial t}$ at some initial surface, say at $t = 0$. Now, if you don't watch out when you specify these initial conditions, then either the programmer will shoot himself or the machine will blow up. In order to avoid this calamity you must make sure that the initial conditions which you prescribe are in accord with certain differential equations in their dependence on x, y, z at the initial time. These are what are called the "constraints." They are the equations analogous to but much more complicated than $\mathbf{div}\,\overrightarrow{E} = 0$. They are the equations to which we have been finding particular solutions; and on the other hand, Mme. Fourès has shown the existence of more general kinds of solutions. Mme. Fourès has told us that to get these initial conditions you must specify something else on a two-dimensional surface and hand over that problem, the *problem of the initial values*, to a smaller computer first, before you start on what Lichnerowicz called the *evolutionary problem*. The small computer would prepare the initial conditions for the big one. Then the theory, while not guaranteeing solutions for the whole future, says that it will be some finite time before anything blows up."

Charlie commenting on numerical relativity

from the 1957 Chapel Hill Conference "The Role of Gravitation in Physics"

The ADM collaboration

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Canonical variables, expression for energy, and the criteria for radiation in general relativity
Arnowitt, R.; Deser, S.; Misner, C. W.

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Arnowitt, R.; Deser, S.; Misner, C. W.

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Arnowitt, Richard; Deser, Stanley; Misner, Charles W.

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Arnowitt, R. L.; Deser, S.; Misner, C. W.

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Arnowitt, R.; Deser, S.; Misner, C. W.

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Arnowitt, Richard; Deser, Stanley; Misner, Charles W.

PHYSICAL REVIEW VOLUME 117, NUMBER 6 MARCH 15, 1960

Canonical Variables for General Relativity

R. ARNOWITT*
Department of Physics, Syracuse University, Syracuse, New York

S. DESER*
Department of Physics, Brandeis University, Waltham, Massachusetts

AND

C. W. MISNER†
Universitetets Institut Teoretisk for Fysik, Copenhagen, Denmark
(Received October 12, 1959)

The general theory of relativity is cast into normal Hamiltonian form in terms of two pairs of independent conjugate field variables. These variables are explicitly exhibited and obey ordinary Poisson bracket relations. This form is reached by imposing a simple set of coordinate conditions. It is shown that those functionals of the metric used as invariant coordinates do not appear explicitly in the Hamiltonian and momentum densities, so that the standard differential conservation laws hold. The bearing of these results on the quantization problem is discussed.

ANNALS OF PHYSICS: 6, 230–243 (1959)

Some New Conservation Laws*

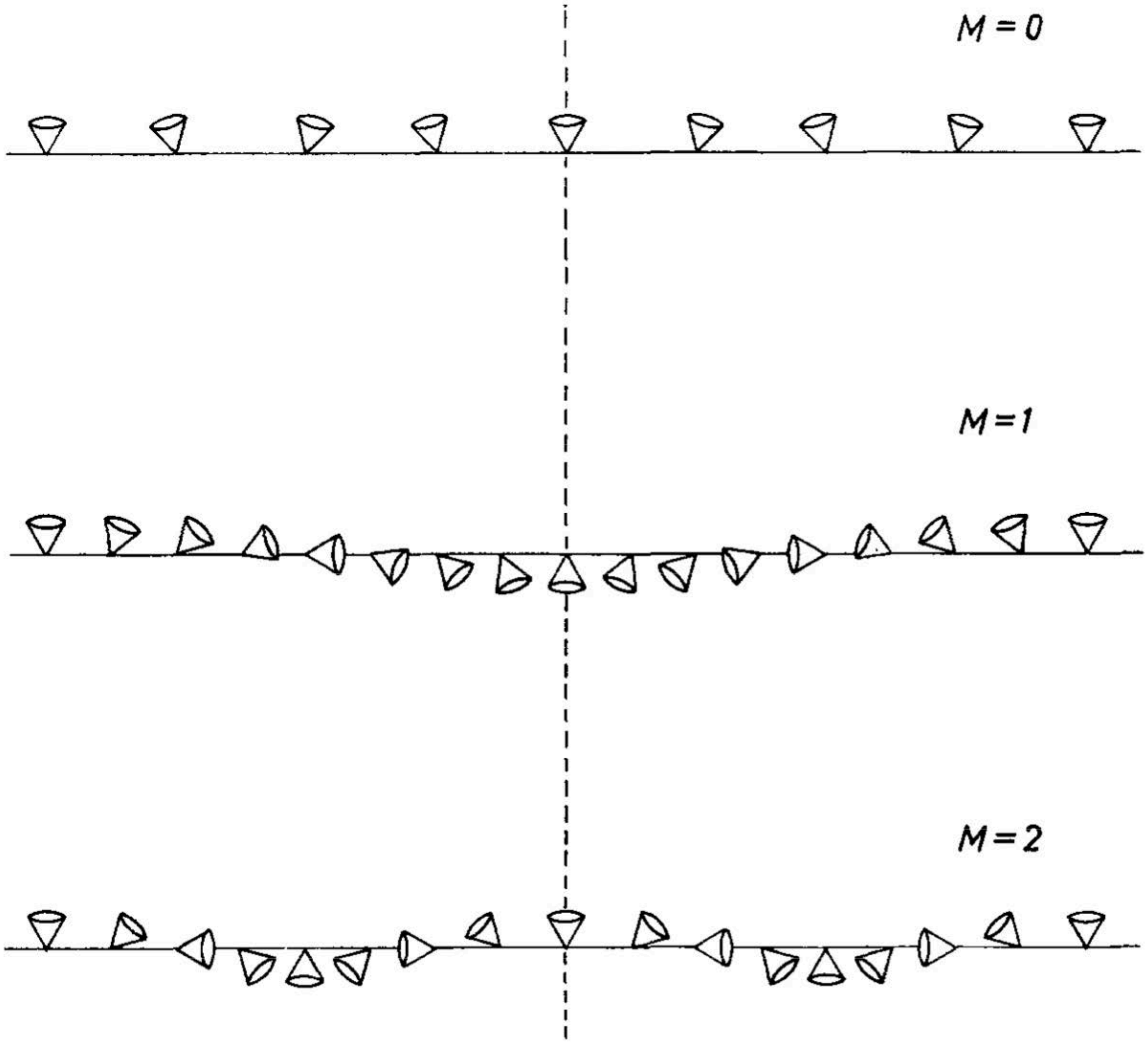
DAVID FINKELSTEIN†

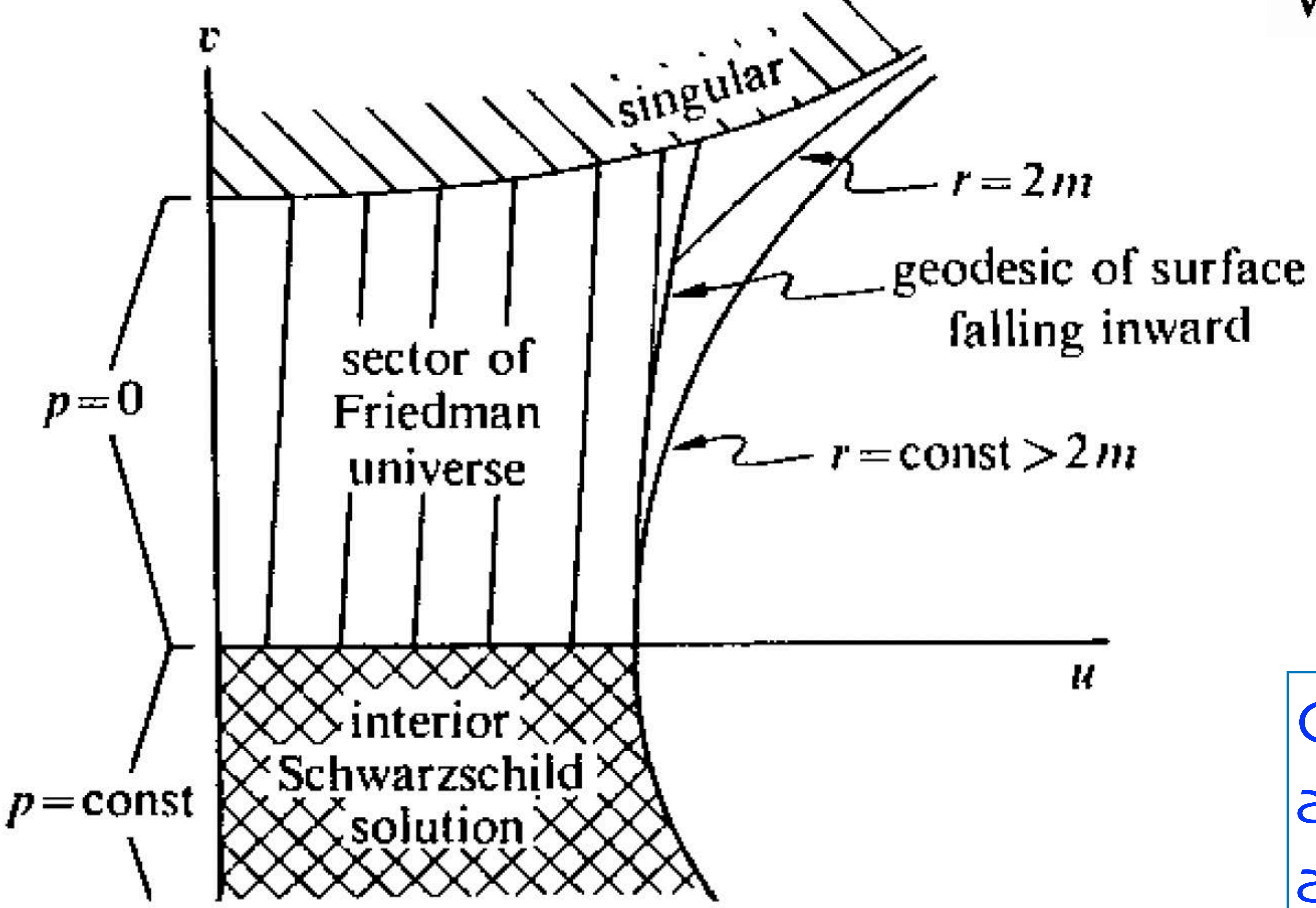
CERN, Geneva, Switzerland

AND

CHARLES W. MISNER‡

Palmer Physical Laboratory, Princeton University, Princet





(Based on the undergraduate thesis project of David Beckedorff, directed by Charlie.)

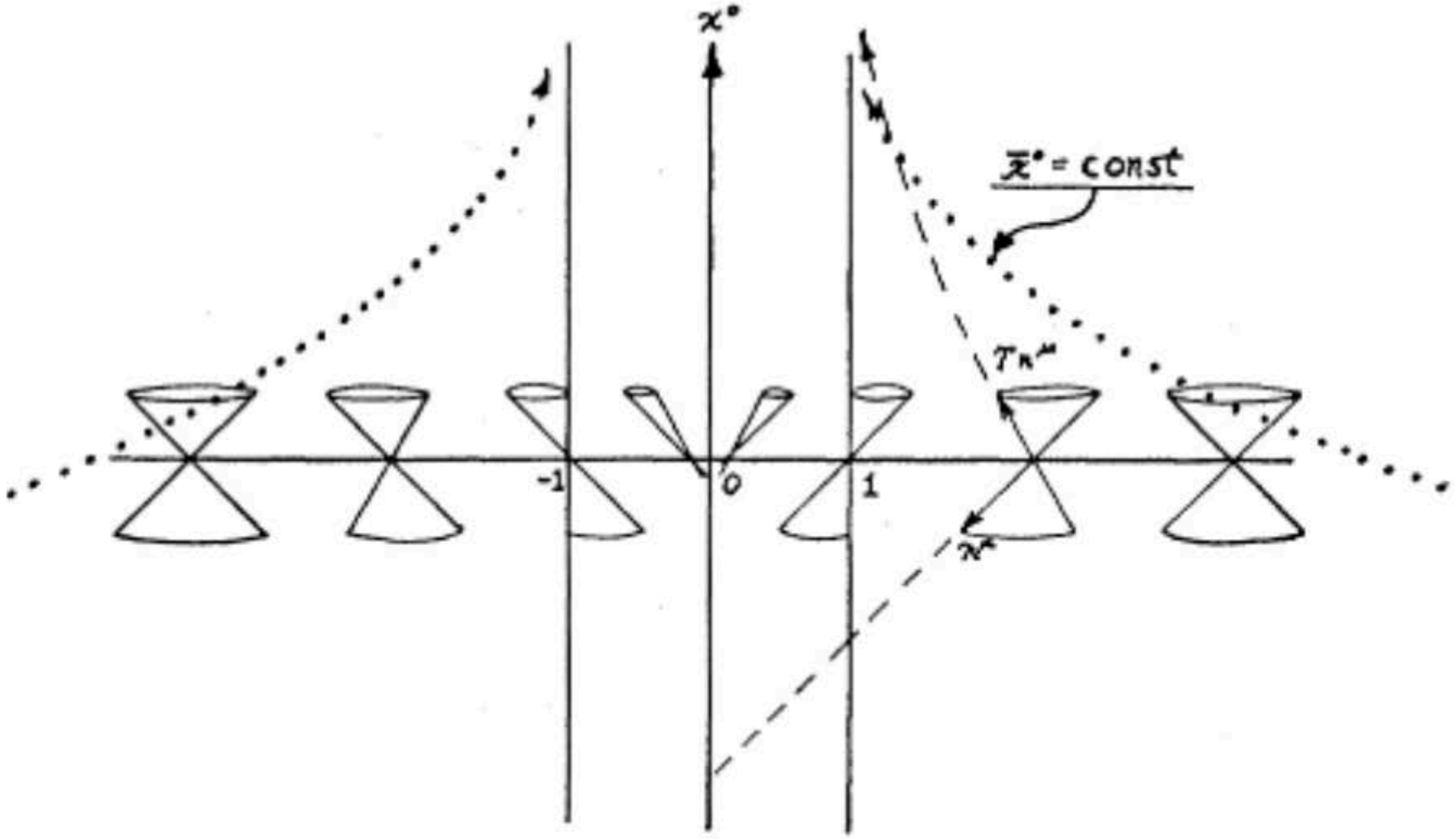
VI. Infinite Red-Shifts in General Relativity

(C. Misner, 1963)

The Nature of Time

Edited by T. GOLD
WITH THE ASSISTANCE OF
D. L. SCHUMACHER

Charlie's interior view of collapse to a black hole, combining
a collapsing cosmology with a vacuum Schwarzschild exterior,
obtaining an <u>inside view</u> of collapse formation of a black hole.



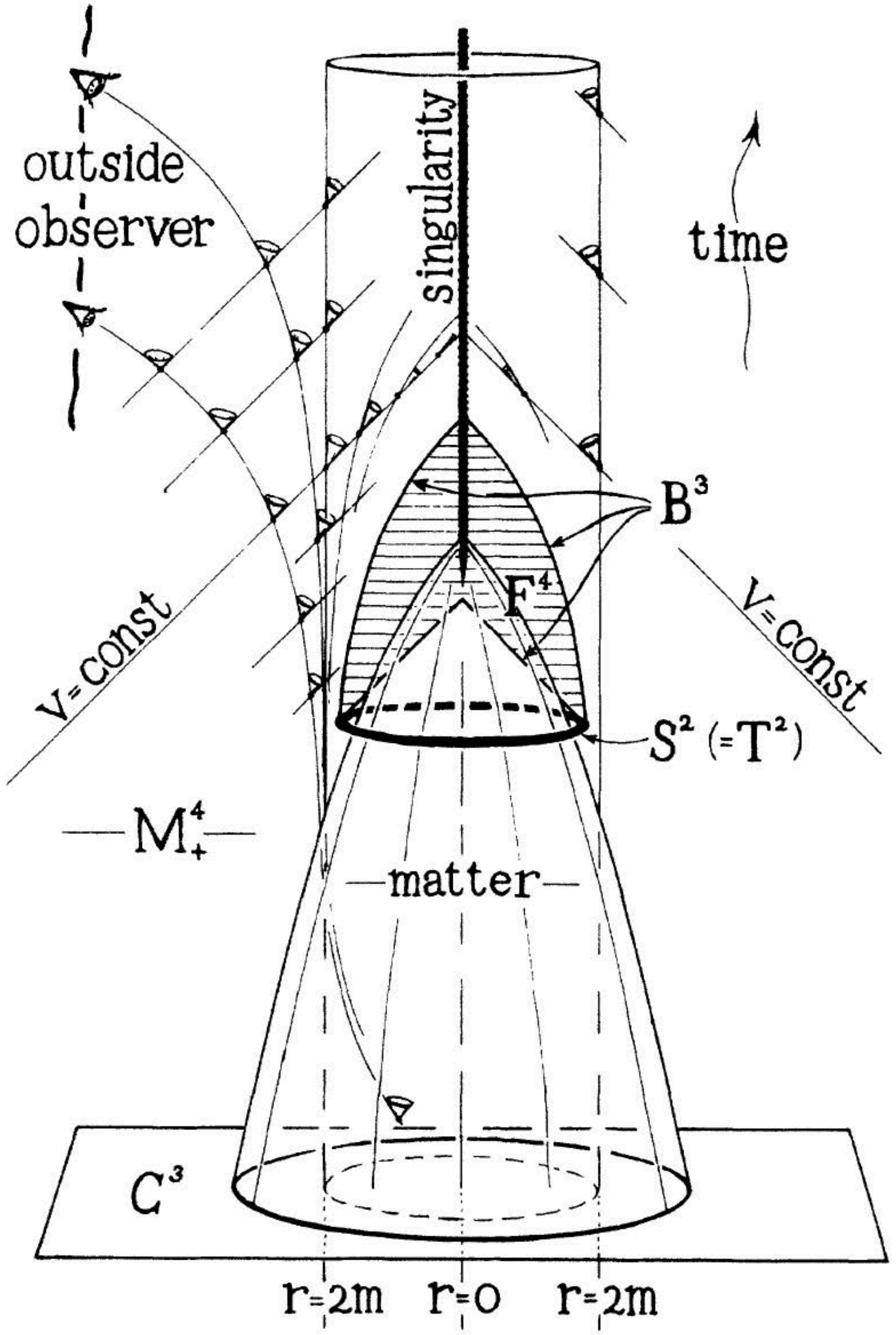
PHYSICAL REVIEW VOLUME 110, NUMBER 4 MAY 15, 1958

Past-Future Asymmetry of the Gravitational Field of a Point Particle

DAVID FINKELSTEIN
Stevens Institute of Technology, Hoboken, New Jersey, and New York University, New York, New York
(Received January 9, 1958)

GRAVITATIONAL COLLAPSE AND SPACE-TIME SINGULARITIES

Roger Penrose
Department of Mathematics, Birkbeck College, London, England
(Received 18 December 1964)



The tumbling light cones and the interior view of collapse formation of a black hole showed up in Finkelstein's "one-way membrane" and Penrose's trapped surface singularity theorem

Prof. C.W. Misner
Dept. of Physics & Astronomy
U. of Maryland
College Park
Md. 20740 U.S.A

Dear Charlie,

Thank you for the cheque which was the more welcome for coming after devaluation. I will pay £18-2-6 into your Cambridge account.

I want to propose a new definition of what should be regarded as a physical singularity; space-time is singularity-free if and only if the it is geodesically bounded. By this I mean that under the exponential map every compact set in the timelike and null region of the tangent bundle maps into a set in the manifold with compact closure. One has:

geodesically complete $\Longrightarrow$ geodesically bounded $\Longrightarrow$ distant boundaries

The arrows in the reverse direction hold if the strong causality condition holds.

I can show that if there is a compact slice with converging normals and if the density is non-zero at some point of the slice then space-time is not geodesically bounded.

Thank you for the Christmas card of the children. I hope the one we sent you of Robert did not get lost in the New York postal fire.

Yours sincerely

Stephen Hawking

Prof. C.W. Misner

"I want to propose a new definition of what should be regarded as a physical singularity. Space-time is singularity-free if and only if it is geodesically bounded. By this I mean that under the exponential map every compact set in the timelike and null region of the tangent bundle maps into a set in the manifold with compact closure. One has geodescially complete -> geodesically bounded -> distant boundaries. The arrows in the reverse direction hold if the strong causality condition holds. I can show that if there is a compact slice with converging normal and if the density is non-zero at some point of the slice then space-time is not geodesically bounded."

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geodesically complete ⟹ geodesically bounded ⟹ distant boundaries

The arrows in the reverse direction hold if the strong causality condition holds. I can show that if there is a compact slice with converging normals and if the density is non-zero at some point of the slice then space-time is not geodesically bounded.

Thank you for the Christmas card of the children. I hope the one we sent you of Robert did not get lost in the New York postal fire.

Yours sincerely

Stephen Hawking

UNIVERSITY OF CAMBRIDGE
Department of Applied Mathematics and Theoretical Physics
Silver Street, Cambridge

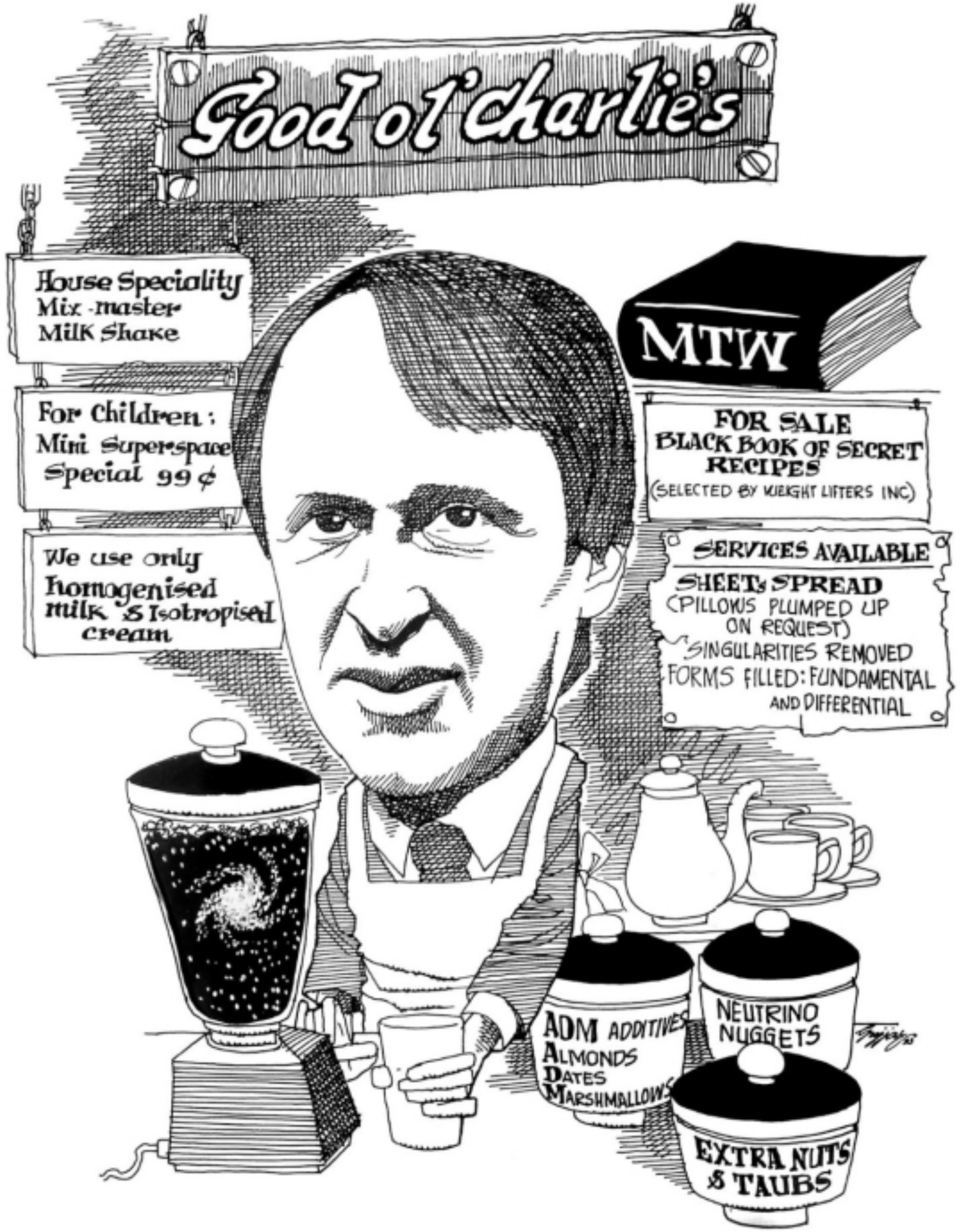
10 November, 1970

Professor C. W. Misner,
Department of Physics, and Astronomy,
University of Maryland,
College Park, Maryland 20740,
U.S.A.

Dear Charlie,

A student of mine, Gary Gibbons, will be attending the A.P.S. meeting in New Orleans from November 23rd to 25th, where he will report on the British work on the design and construction of gravitational wave detectors. We think that, without the use of liquid helium, we can improve the sensitivity by a factor of 100. The first of these detectors should be operating before the end of the year, and the second one at Reading should follow soon after.

As he is getting his fare paid to New Orleans I though that Gary might as well stay on and attend the relativistic astrophysics meeting in Austin. I asked Howard Laster to write to Weber to try and arrange for Gary to visit Maryland for a few days after the New Orleans meeting. Weber replied that he was very busy and would not be able to devote more than a very short time to showing Gary round. However, although Gary has devoted quite a time to the design of gravitational wave detectors, he is primarily a theoretician and is interested in the problem of how much gravitational radiation would be emitted by a collapsing object. He would very much like to have an opportunity to discuss this with you and Brill. I wonder, therefore, if you could possibly arrange for Gary to spend several days at Maryland and reassure Weber that he will not have to devote all his time to him.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AND DIFFERENTIAL
ADM ADDITIVES
ALMONDS
DATES
MARSHMALLOWS
NEUTRINO
NUGGETS
EXTRA NUTS
& TAUBS

MIXMASTER UNIVERSE*

Charles W. Misner
Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742
(Received 14 April 1969)

The generic, nonrotating, homogeneous cosmological model for a closed space (Bianchi type IX) has a very complex singularity which can, however, be described in detail. It appears that only the exceptional (previously studied) cases will have particle horizons. Thus these models may lead to some insight into how the broad-scale homogeneity of the universe may have been produced at very early times.

Particle horizons[1] in cosmological models are limits on the possibilities of causal interactions between different parts of the universe in the time available since the initial singularity. In the standard metric $ds^2 = \eta^2\{-d\eta^2 + dx^2 + dy^2 + dz^2\}$ for the radiation-dominated early phase of a Robertson-Walker (RW) cosmological model, it is clear that the coordinate time $\Delta\eta$ required for a light signal ($ds^2 = 0$) to connect two regions of spatial-coordinate separation Δx is $\Delta\eta = |\Delta x|$. Thus at a fixed epoch $\eta_0 > 0$, no causal interactions subsequent to the singularity at $\eta = 0$ have occurred between regions of coordinate separation $|\Delta x| > \eta_0$.

The Astrophysical Journal, Vol. 151, February 1968

THE ISOTROPY OF THE UNIVERSE

Charles W. Misner*
Peterhouse, Cambridge, England
Received June 22, 1967

ABSTRACT

Solutions of the Einstein equations with flat homogeneous spacelike hypersurfaces but anisotropic expansion rates are given in which the effects of viscosity in the radiation, and of anisotropic pressures from collisionless radiation, are included. These show that the present anisotropy of the black-body photon temperature should be less than 0 03 per cent, independent of the amount of initial anisotropy, if the Universe has cooled to its present state from temperatures above about 2×10^{10} ° K.

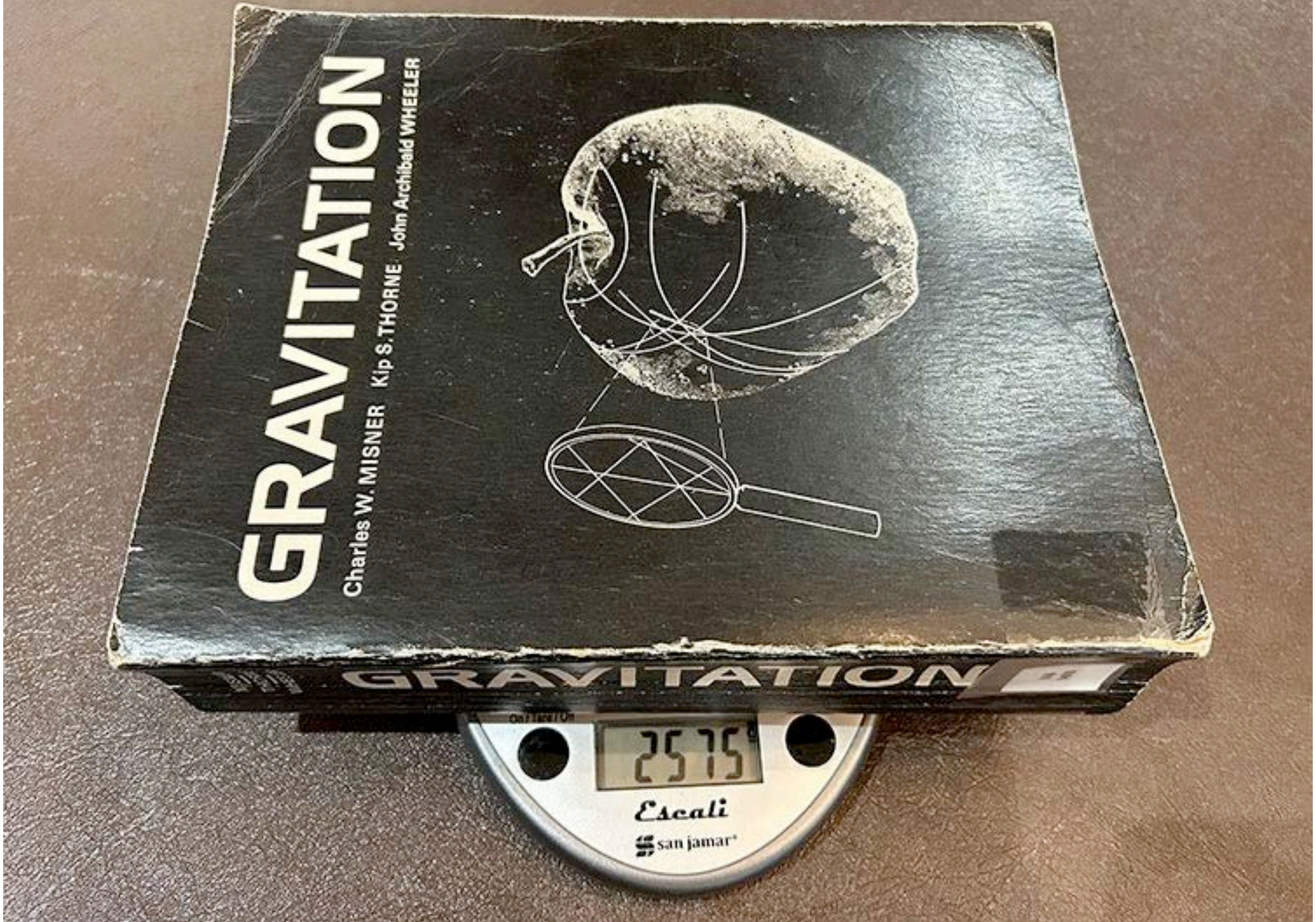
I wish to approach relativistic cosmology from an unfamiliar point of view. Rather than taking the unique problem of relativistic cosmology to be the collection and correlation of observational data sufficient to distinguish among a small number of simple cosmological solutions of Einstein's equations, I suggest that some theoretical effort be devoted to calculations which try to "predict" the presently observable Universe.

Interpretation of Gravitational-Wave Observations*

C. W. Misner
Center for Theoretical Physics, Department of Physics and Astronomy, University of Maryland, College Park, Maryland 20742
(Received 22 November 1971; revised manuscript received 13 March 1972)

If Weber's gravitational-wave observations are interpreted in terms of a source at the Galactic center, both the intensity and the frequency of the waves are more reasonable if the source is assumed to emit in a synchrotron mode (narrow angles, high harmonics). Although presently studied sources for such modes are astrophysically unsatisfactory —high-energy, nearly circular, scattering orbits—other possible sources are under study.

In this paper, among many other things, the possibility of a wave version of the Penrose process —super radiant scattering — was discussed. In recent years, a fantastic version of this mechanism has been predicted if an ultralight axion field exists, realizing the "black hole bomb" idea of Press and Teukolsky


GRAVITATION
Charles W. MISNER
Kip S. THORNE
John Archibald WHEELER
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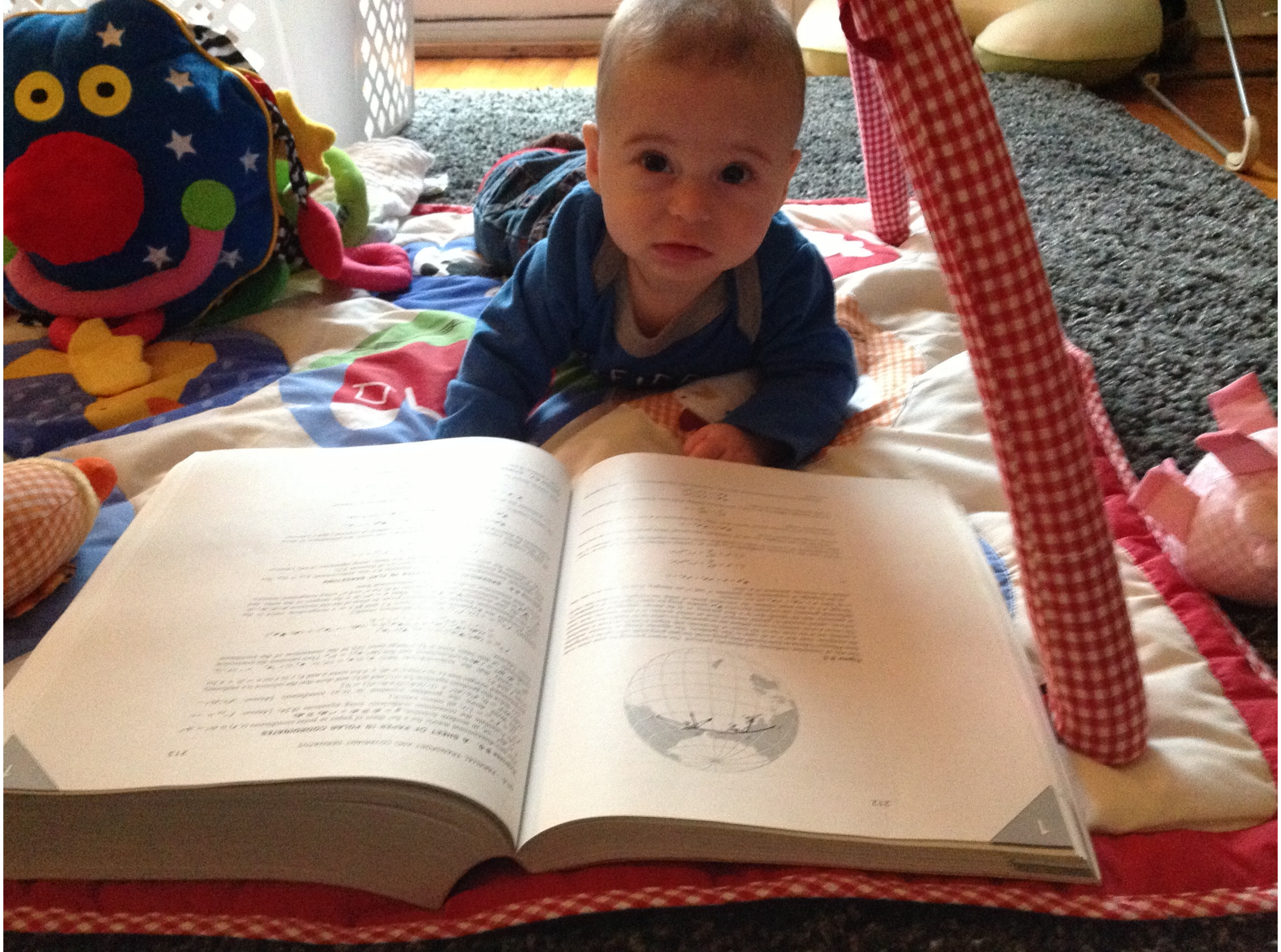
Allen Brailey: "I was probably holding on to the book as we were coming off a flight and it was our entertainment."
Johnny Powell: "we worked on several problems during the epic train ride from Jarkarta to Jog Jakarta."
on Peace Corps travel in Malaysia 1975



never too
early to
start
on track 1

Marc
Kamionkowski's
son

A One-World formulation of quantum mechanics

Use the density matrix and its dynamics as the fundamental law of quantum mechanics.

Charles W. Misner
University of Maryland

Physica Scripta, Volume 90, Issue 8, article id. 088014 (2015).

Everett QM

- Hugh Everett III was a grad school roommate of mine.
- I heard a lot from him and respected his views of QM, but steered clear of making the fundamentals of QM an area in which to become expert.
- With the celebrations in 2009 of the 50^{th} anniversary of Hugh's Ph.D. thesis, I was led to think more about it.

Everett QM

- Although I found Everett's logic solid, I didn't like it and expected someone to do better.
- I joined Everett in rejecting the Copenhagen view that the Schrödinger equation is a fundamental law of physics which is violated in every quantum measurement.
- Another reliably logical contributor to the question was Jim Hartle, and one of his presentations on the "no boundary" initial conditions offered a clue.

Everett QM

- Hartle began a presentation with (approx.) “Since the Universe is a physical system, it has a wave function”
- This offered the clue: don’t question Hartle’s logic, but challenge his hypotheses. How about physical systems without wave functions?
- What alternative is there that doesn’t deny QM?

Isolation is impossible

- Every describable physical system has an environment!
- For the now observable universe, particles possibly entangled with accessible particles are in spacelike related regions beyond the post-inflation horizon.
- Currently known black holes may have hidden within their horizons possibly entangled partner quanta to those we can observe.

Changing the Theme

We are not in control of our knowledge!

Information carrying objects and quanta fall into black holes and are lost. Their conditions are in a spacelike relation to our own world lines. Through entanglement their status may put restrictions on ours, and a density matrix involving their degrees of freedom cannot be evolved nor verified.

Changing the Theme

We are not in control of our knowledge!

Information carrying objects and quanta fall into black holes and are lost. Their conditions are in a spacelike relation to our own world lines. Through entanglement their status may put restrictions on ours, and a density matrix

[Submitted on 12 May 2022 (v1), last revised 28 Nov 2022 (this version, v2)]

Black Holes Decohere Quantum Superpositions

Daine L. Danielson, Gautam Satishchandran, Robert M. Wald

We show that if a massive body is put in a quantum superposition of spatially separated states, the mere presence of a black hole in the vicinity of the body will eventually destroy the coherence of the superposition. This occurs because, in effect, the gravitational field of the body radiates soft gravitons into the black hole, allowing the black hole to acquire "which path" information about the superposition. A similar effect occurs for quantum superpositions of electrically charged bodies. We provide estimates of the decoherence time for such quantum superpositions. We believe that the fact that a black hole will eventually decohere any quantum superposition may be of fundamental significance for our understanding of the nature of black holes in a quantum theory of gravity.

Historical Humility

Copernicus and Galileo were treated as heretics because they demoted humanity from the center of the Universe.

LaPlace, in view of Newton, had no need of that (anthropocentric) hypothesis, but extended humanity's reach to a much larger Universe. In potential knowledge, humanity dominated all.

Now we must face the possibility that our brains are not capable of knowing all that is.

Lightman:

Let me end with a couple of philosophical questions. You may have to put your natural scientific caution aside a bit. If you could design the universe in any way you wanted to, how would you do it?

Misner:

I never have thought about designing the universe. I am interested in the question of the design of the universe. I have published papers[26] on philosophy and cosmology and theology. I do see the design of the universe as essentially a religious question. That is, one should have some kind of respect and awe for the whole business, it seems to me. It's very magnificent and shouldn't be taken for granted.

AIP Oral History Interview of Charles W. Misner by Alan Lightman (1989)
https://www.aip.org/history-programs/niels-bohr-library/oral-histories/33955

Lightman:

If you were allowed to conceive of a theory yourself, or if you were allowed to build certain properties into the universe, what would you do?

Misner:

I find the universe I see is always more beautiful and preferable to any I could have previously imagined — the more details I see of it. So in that sense I like" the present universe. If I wanted to put that into a phrase, I would say "a universe which is inexhaustibly intelligible," where you could keep understanding things and the game never gets boring.

Lightman:

That's a beautiful way of stating it. Let me ask you one last question. There is a place in Steven Weinberg's book The First Three Minutes where he says that the more the universe seems comprehensible, the more it also seems pointless.[28]

Misner:

Yes, I come down on just the opposite side of that. I'm saying how impressed I am with the beauty and intelligibility of the universe.