

The Huge Impact that Charlie and His Students Have Had on Me

Kip Thorne

**Charles W. Misner Memorial Symposium on Gravitation and the Cosmos
University of Maryland, 11 November 2023**

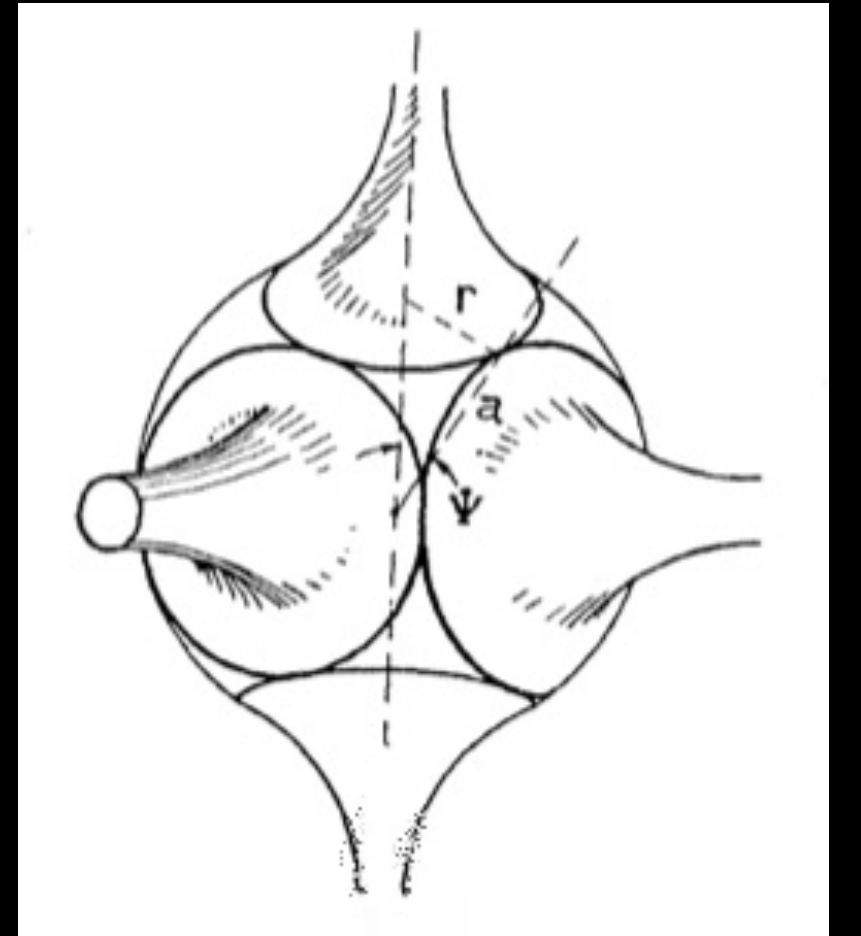
1958 - 62: Student at Caltech

Winter 61-62 ..
My senior year



Reviews of Modern Physics, July 1957

Lindquist & **Wheeler** - *Dynamics of Lattice Universe by Schwarzschild Cells*



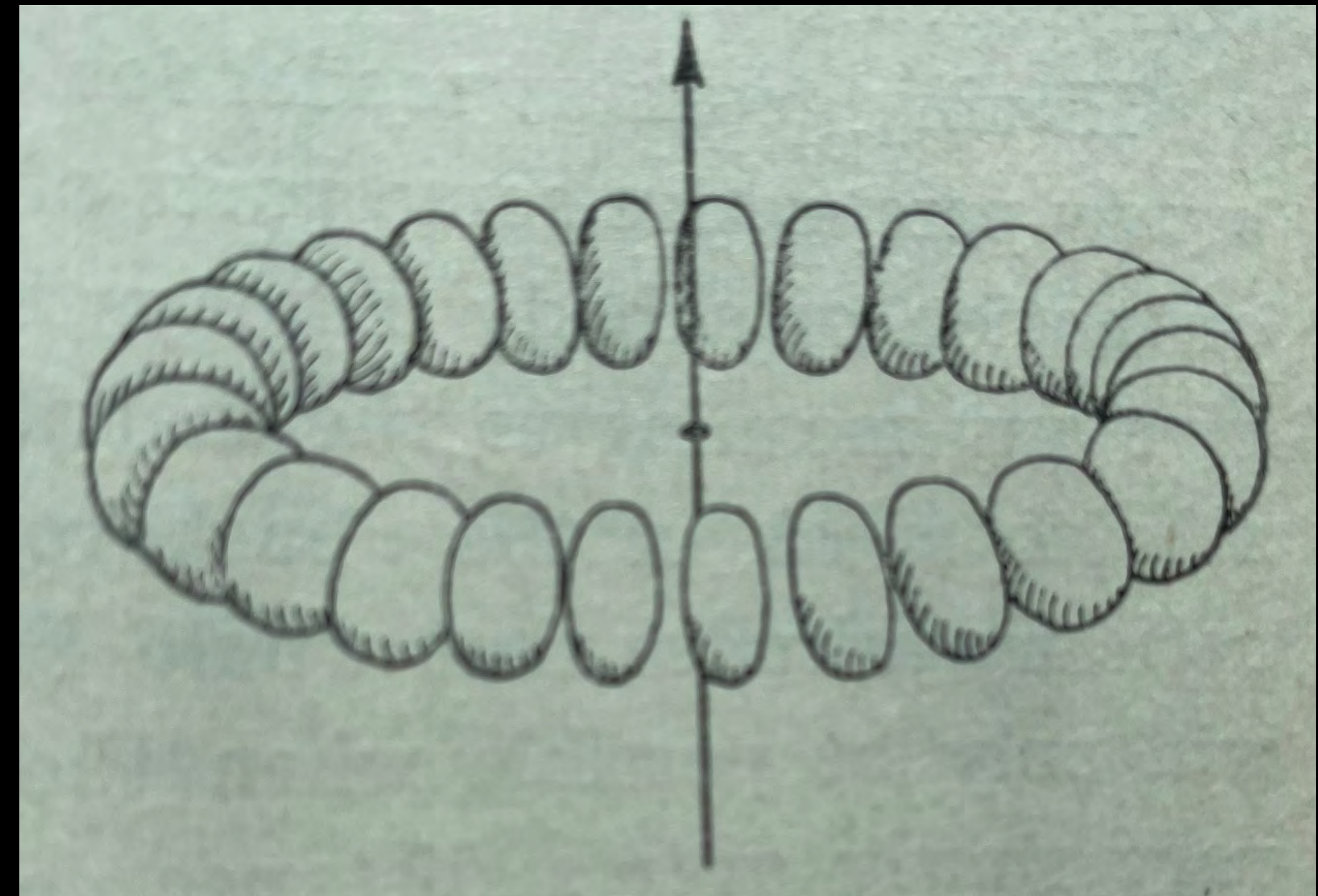
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Weber & Wheeler - *Reality of Cylindrical **Gravitational Waves***

Power & Wheeler - *Thermal **Geons***

Ernst - *Linear and Toroidal **Geons***



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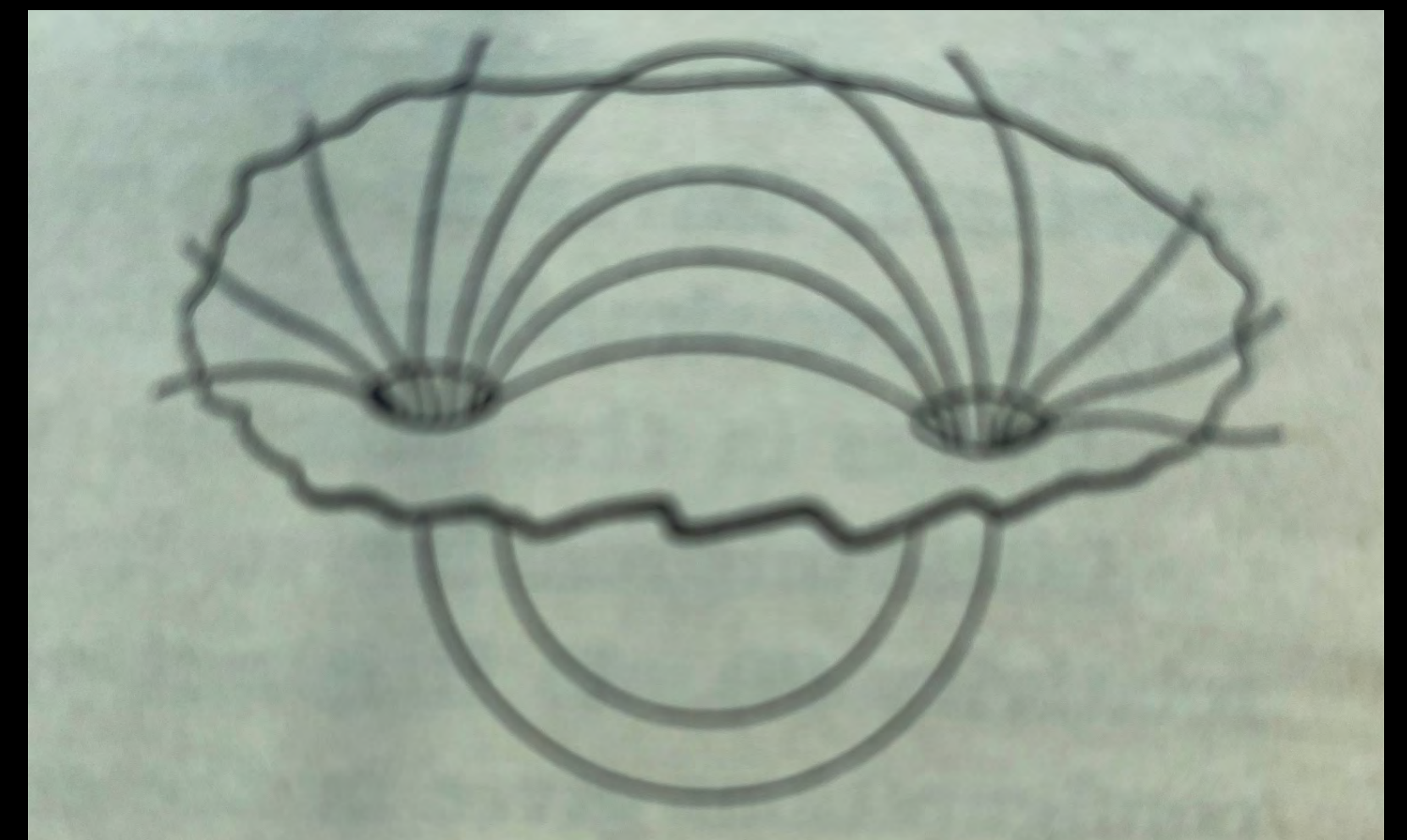
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Everett - *“Relative State **[Many Worlds]** Formulation of Quantum Mechanics*

Wheeler - *Assessment of Everett’s **[Many Worlds]** Formulation*

Misner - ***Feynman Quantization of General Relativity***

Conversations with Jim Hartle

Brill & Hartle:

Gravitational Geon -

Two-lengthscale expansion

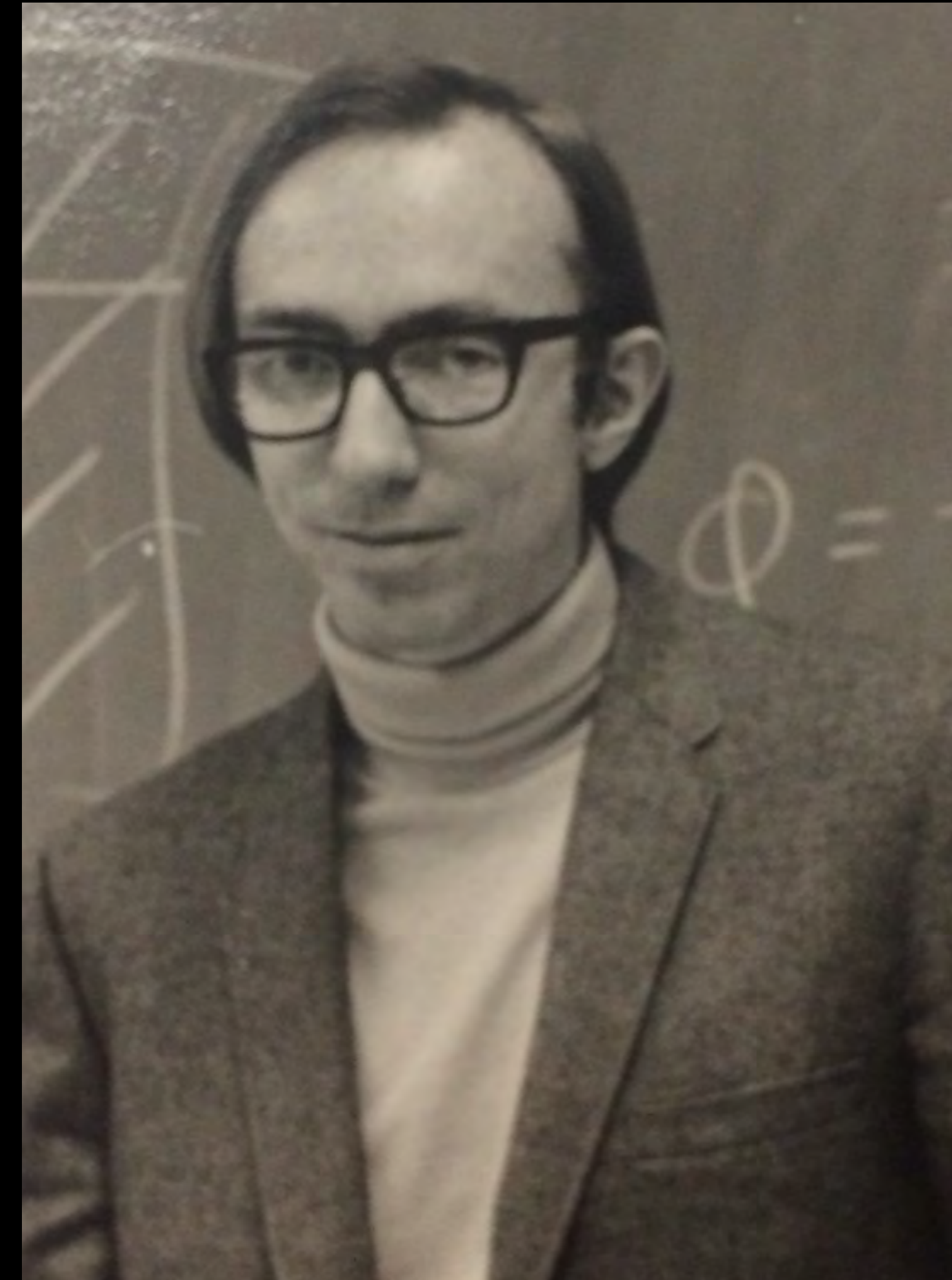


June 1962 - To Princeton for Graduate School

John Wheeler
Professor

Charlie Misner
Grad St. 54-57
Asst. Prof. 56-63

Kip
1962-66

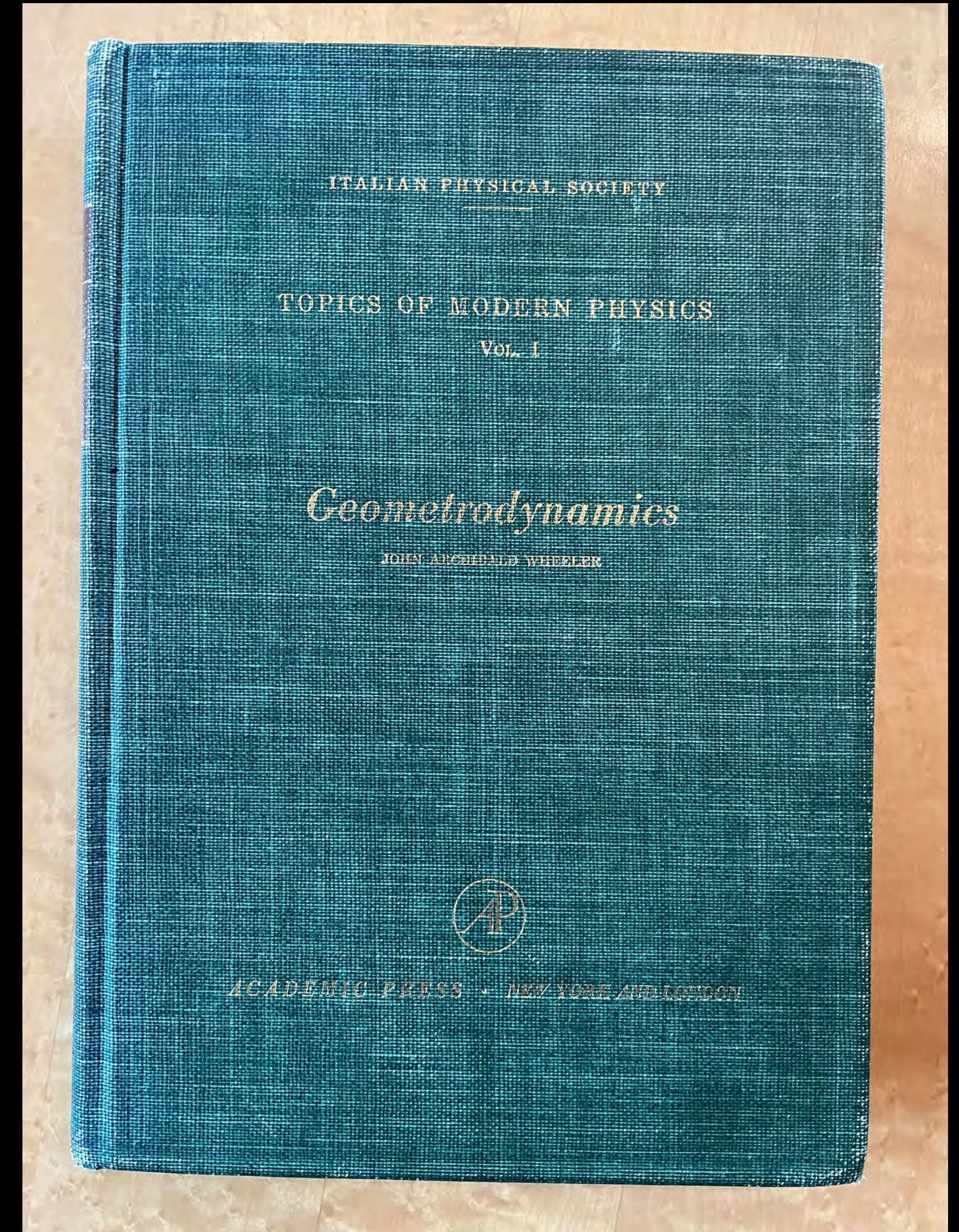


Interactions Between Charlie and Johnny

- Charlie: Superb mastery of mathematics
- Johnny: No slouch mathematically;
 - . Deep interest in the math
 - Feynman story
 - MTW: Geometrization of Newtonian Gravity;
Boundary of a Boundary
- Johnny: Superb intuition
- Charlie: No slouch at intuition

Major Research Foci - Late 50s, Early 60s

- ***Geometrodynamics***
Misner and Wheeler
- ***Gravitational Collapse*** -
focus on singularity:
Issue of the Final State



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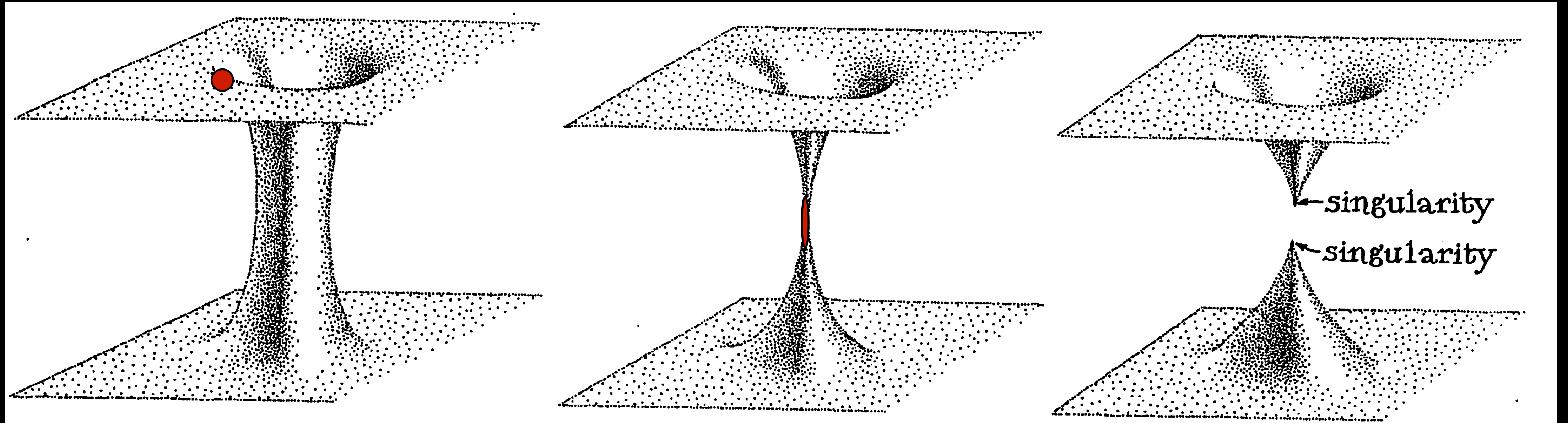
Issue of the Final State

**WHEELER- OPPENHEIMER
CONFRONTATION
SOLVAY - JUNE 58**

- ***Wormholes*** -

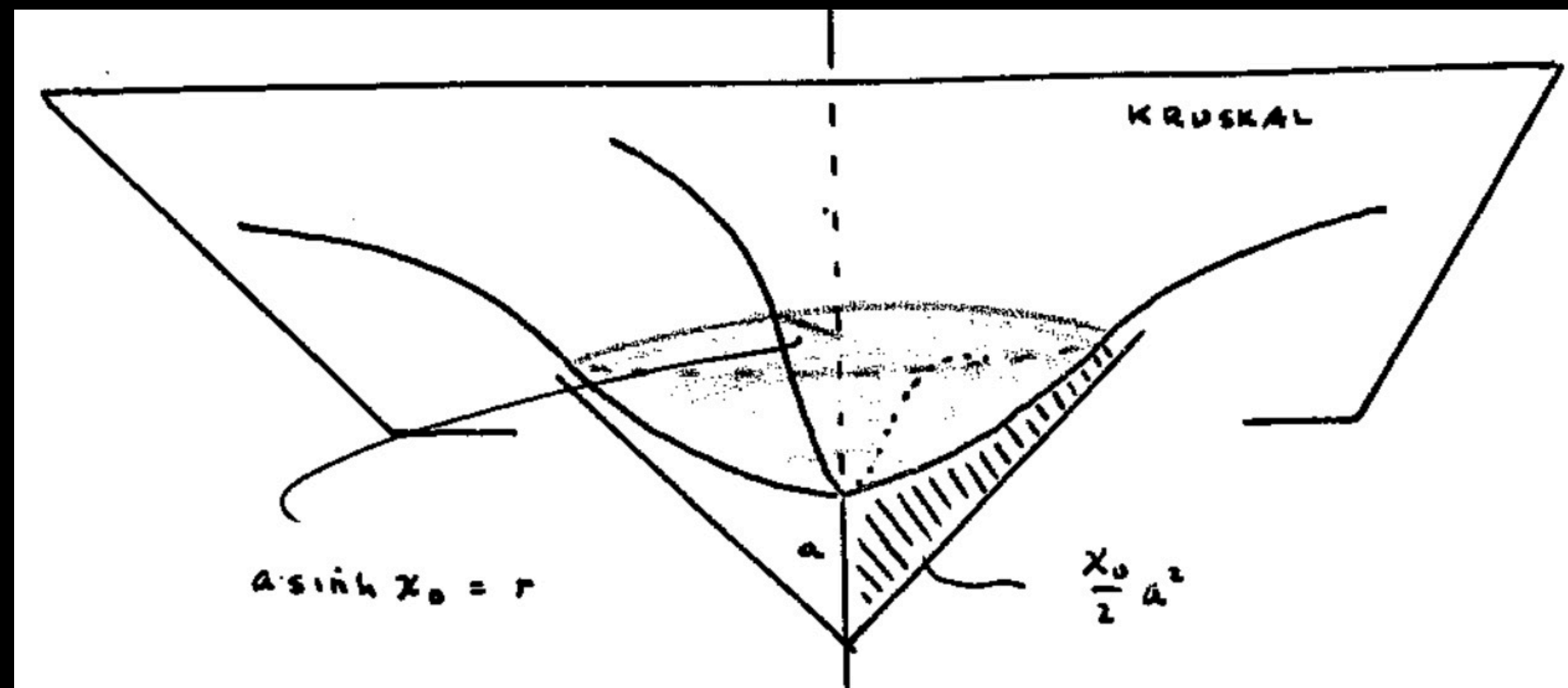
**REGGE & WHEELER 57
“STABILITY OF A
SCHWARZSCHILD SINGULARITY”**

Kruskal and Wheeler (1960) - Wormhole Implosion



Sept 1962 - Misner Seminar on Beckedorff

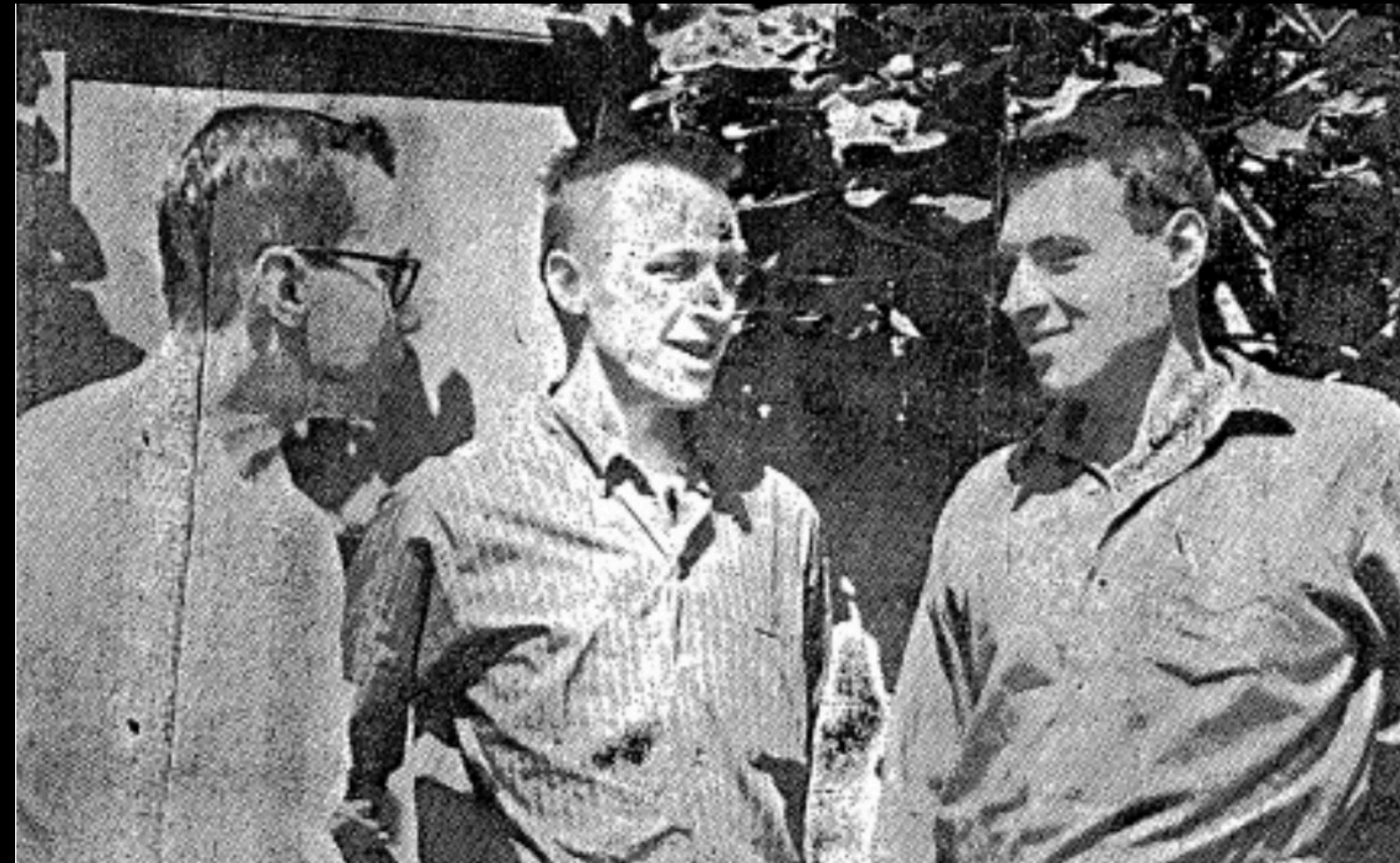
- Background: Evgeny Lifshitz, re Oppenheimer & Snyder
 - Viewpoint of distant observer
 - Viewpoint of observer on star's surface
 - “You cannot appreciate how difficult it was for the human mind to understand how both viewpoints can be true simultaneously,”
- Beckedorff:



Foundations of Numerical Relativity

- Wheeler Exortations (1957 -): Explore Geometrodynamics

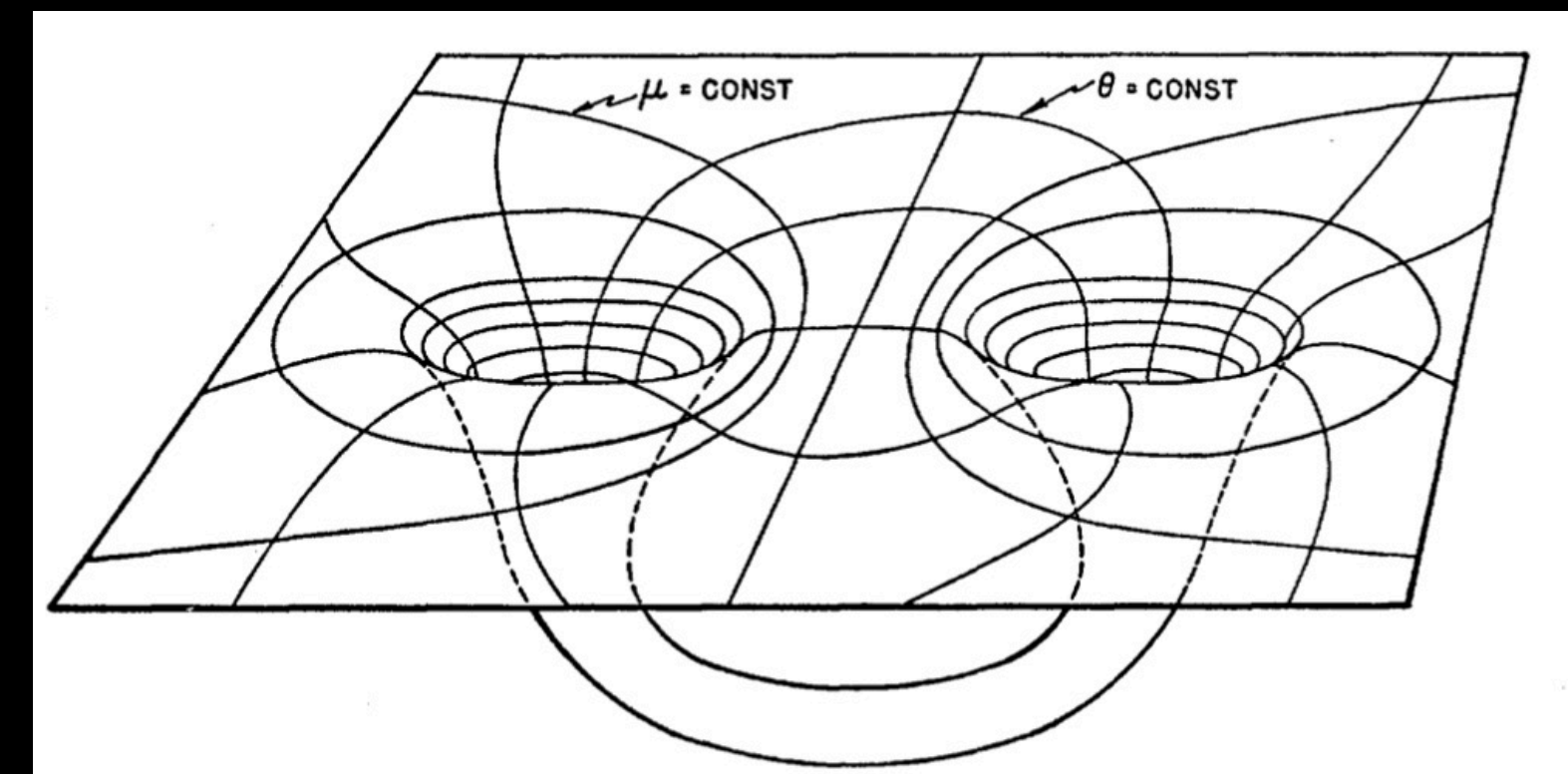
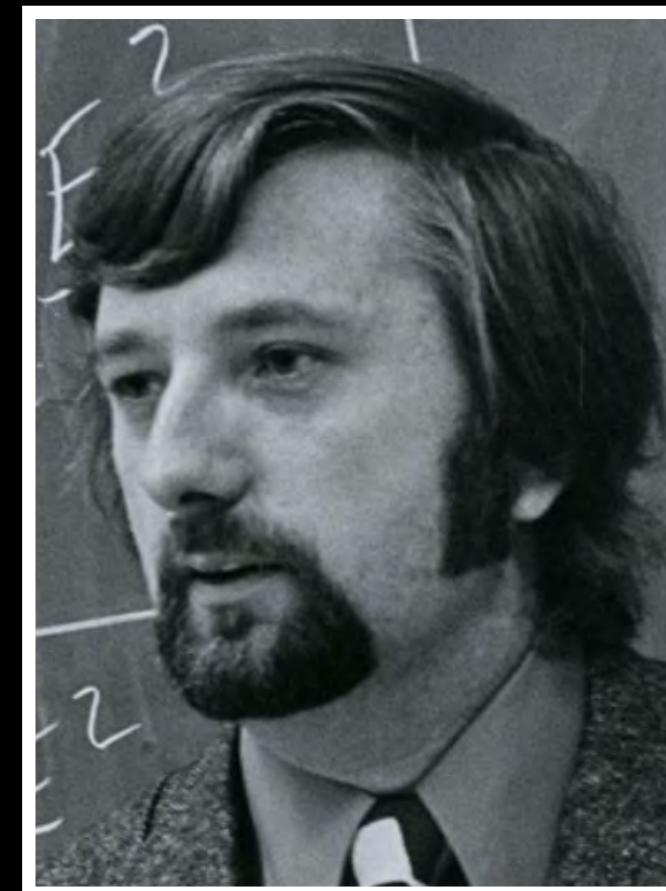
- Arnowitt, Deser and Misner: ('58-59) 3+1 decomposition of Einstein Equations



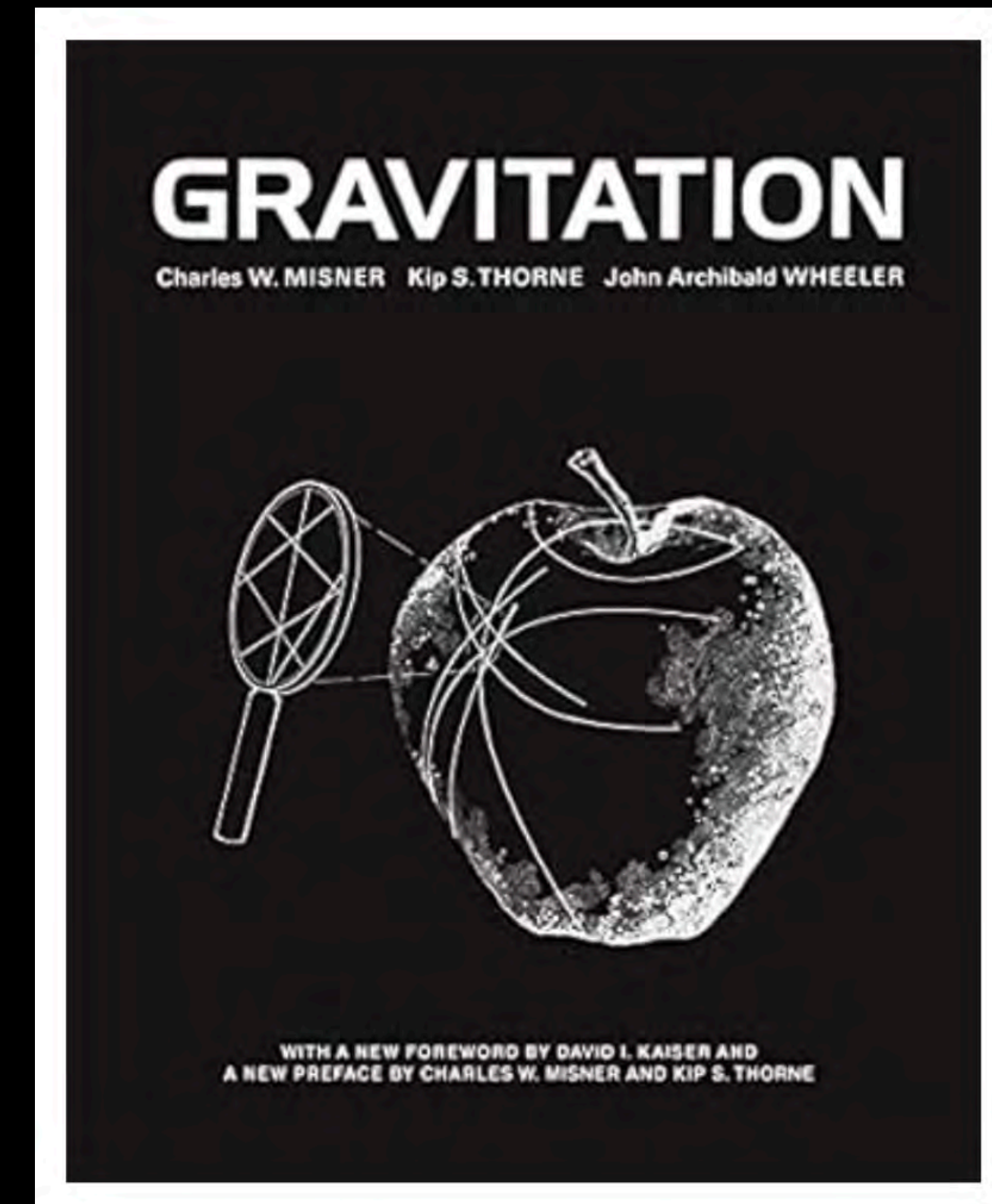
- Misner (1960): *Wormhole Initial Conditions*

- Hahn & Lindquist (1963): *2-Body Problem in Geometrodynamics*

- DeWitt; Eppley & Smarr; ...



A Few Remarks about Writing *Gravitation* (MTW)



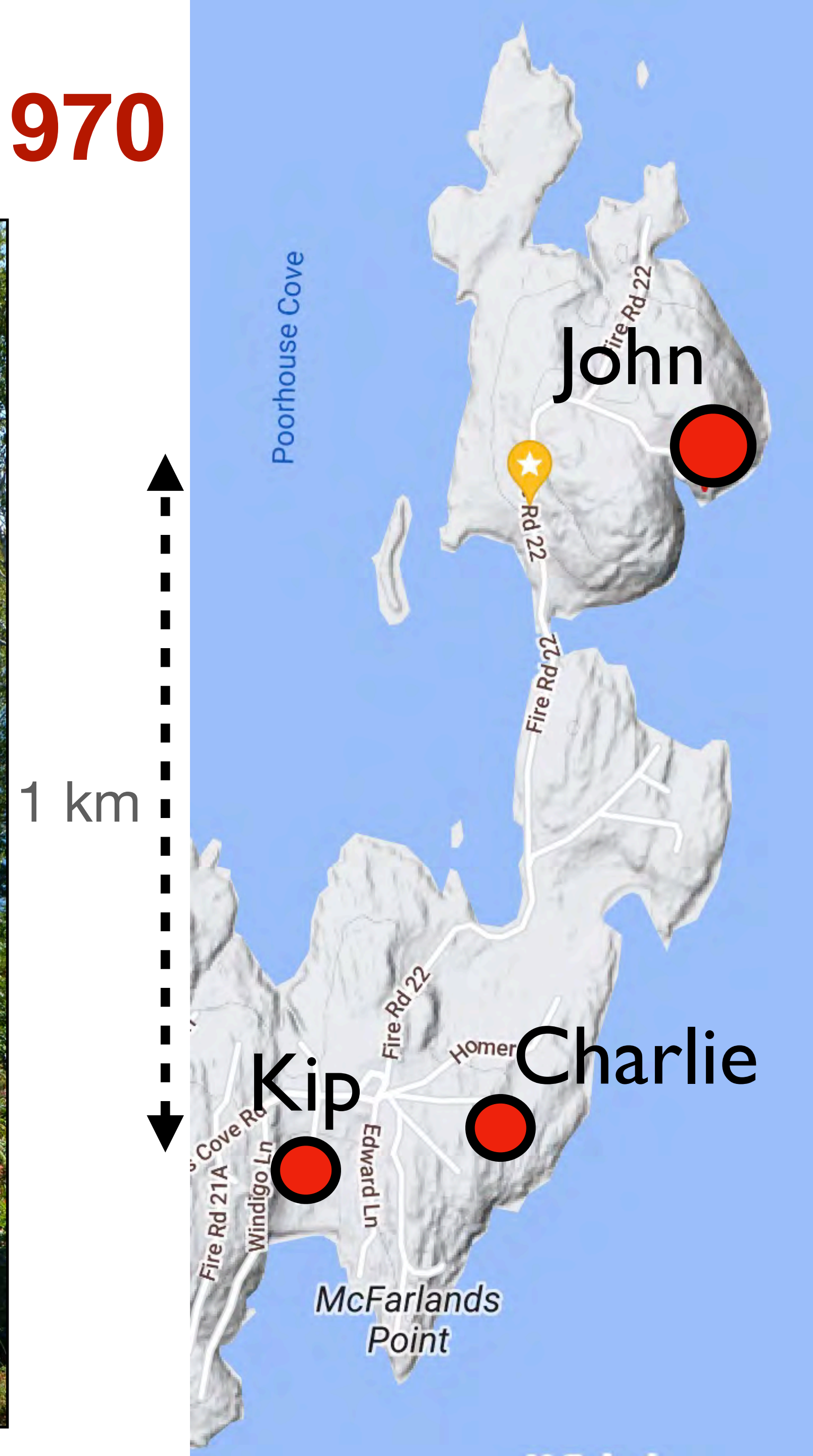
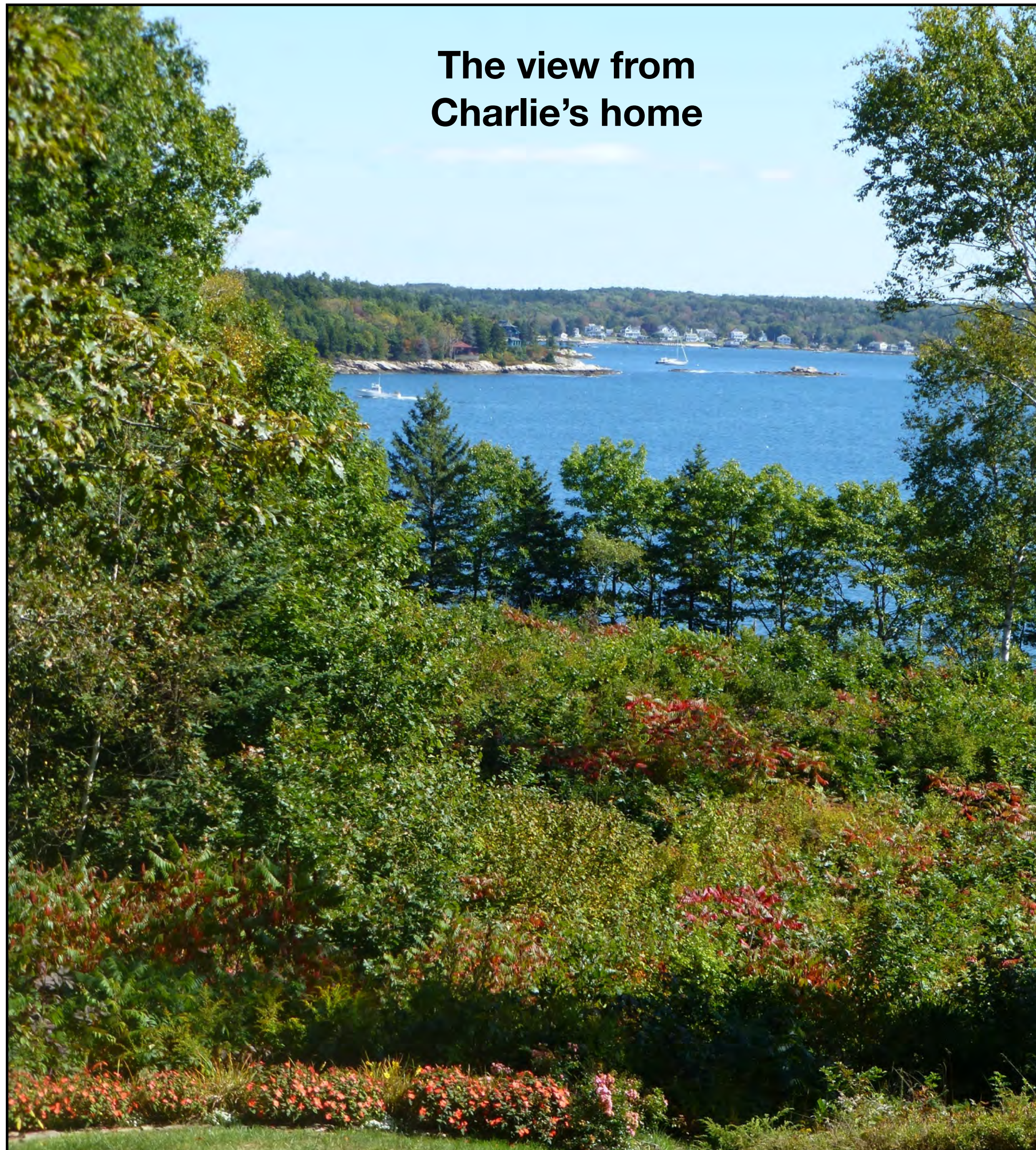
For Detailed Discussion,
including remarks by Charlie,
see MTW50

<https://www.youtube.com/watch?v=a-4-IPBNV60>

Summer 1969 - Summer 1970

- Intense, near 100% effort on book - leading to First Preliminary Edition in September 1970
- Whenever two of us expected to be together, the third was obligated to try to join, at least for a few days
- We met, and wrote and revised in — among others —
 - Princeton U. , Princeton Institute for Advanced Study, U. of Maryland, Caltech, U. Texas Austin, National Airport Washington DC, Dublin Ireland, Kyoto (Japan), USSR (Moscow, Kiev, Leningrad), ... and Maine
- Particularly memorable: Summer 1970 in Maine

Maine - July & August 1970



Johnny &
Charlie



Kip
Linda
Bret
Kares



Susanne



Benedicte
Francis
Tim
Chris

Summer 1969 - Summer 1970

- For each chapter:
 - One of us wrote first draft.
 - Circulated to other authors ... at least three times around (nine revisions) ... until converged, and for many chapters you cannot guess correctly who wrote the first draft
 - Sent out for typing whenever the manuscript got too messy.

Charlie First Draft of a Chapter on Gravitational Waves

P. 24 - we must give $\frac{1}{2}$
END - in IV form the dimensionless part of the
as 2 degrees of freedom in grav. field -

3/1

MTW book

Part 7 Gravitational Waves

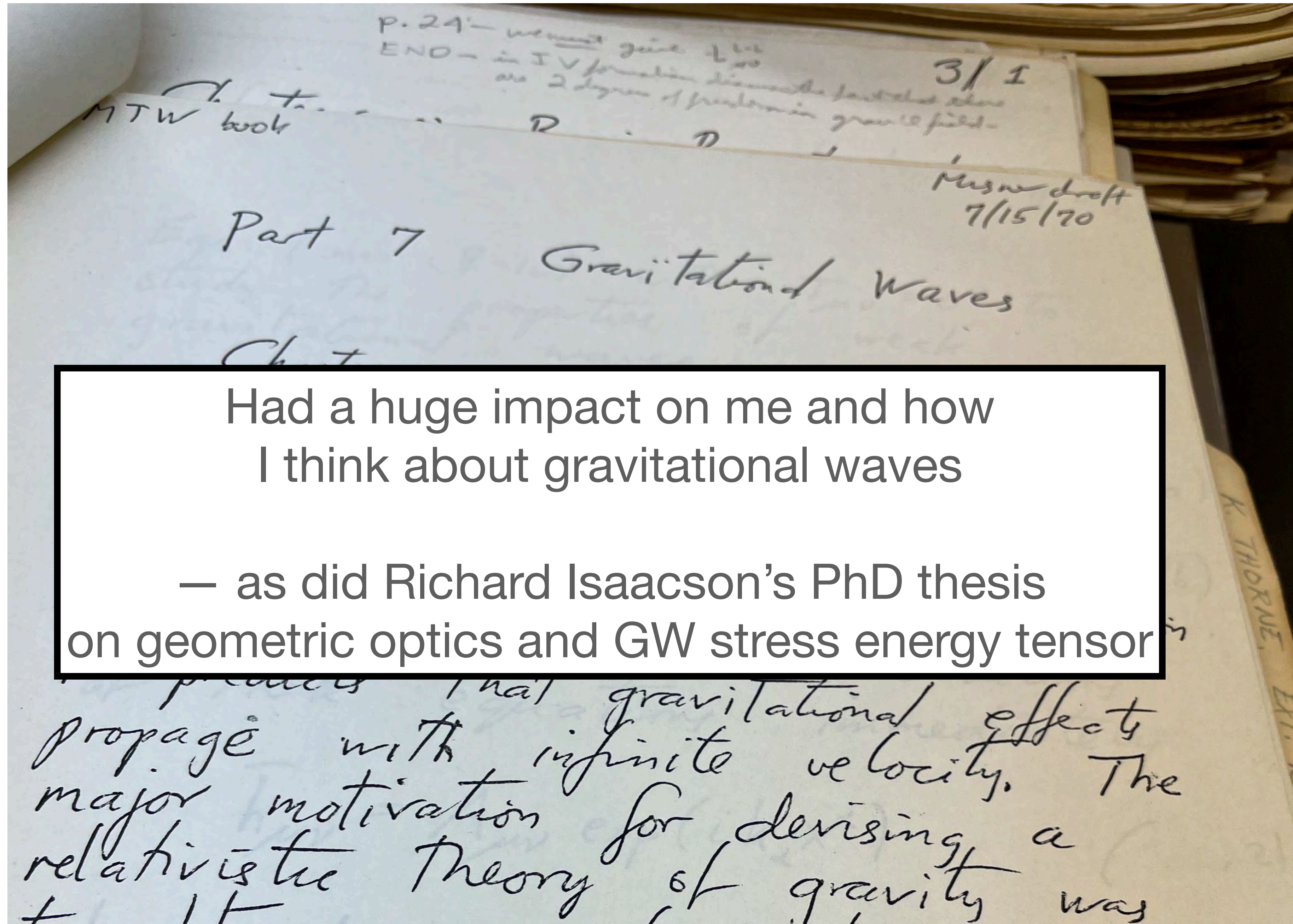
Chapter w Propagation of Gravitational Waves

Linearized Theory.
The most fundamental objection to Newtonian gravitation is that it predicts that gravitational effects propagate with infinite velocity. The major motivation for devising a relativistic theory of gravity was

Musgrave draft
7/15/70

K. THORNE, EX. 10

Charlie First Draft of Chapter on Gravitational Waves



Had a huge impact on me and how I think about gravitational waves

— as did Richard Isaacson's PhD thesis on geometric optics and GW stress energy tensor

propagate with infinite velocity. The major motivation for devising a relativistic theory of gravity was

Kip First Draft of a Chapter on Global Methods

CHAPTER 34
GLOBAL TECHNIQUES, HORIZONS, AND SINGULARITY THEOREMS

34-1

34.1 Global Techniques

Until the 1960's, computations in gravitation theory used local techniques almost exclusively: The Einstein field equation describes how the stress-energy T at a given event generates curvature G at that same event. When reduced to differential equations for the metric, $G = 8\pi T$ relates $G_{\alpha\beta}$, $\partial G_{\alpha\beta}/\partial x^\mu$, and $\partial^2 G_{\alpha\beta}/\partial x^\mu \partial x^\nu$ at each given event to $T_{\alpha\beta}$ at that same event. The solution of these differential equations is effected, on a computer or in any initial-value type analysis, by integrating forward in time from event to event to event. The nongravitational laws of physics are obtained by invoking the equivalence principle in a local Lorentz frame at each individual event in spacetime. To build up an understanding of the global structure of spacetime, one performs local computations at each event, and then patches the local results together to form a global picture.

Why this great reliance on local analyses? Because the laws of gravitation physics take on particularly simple forms when stated locally.

That gravitation physics is also subject to powerful and simple

CHARLIE REWRITING KIP REWRITING JOHN

and everywhere locally Lorentz in character ("local Lorentz character of this Riemannian geometry").
^{What mathematics gives}
~~To endow spacetime with all these physical properties?~~
straightforward. ^{A metric?} ~~One need only introduce a metric that is locally Lorentz (§13.2 and 13.6). All else then follows.~~ ^(In particular) the metric destroys the stratified structure of Newtonian spacetime, as well as its gravitational potential and universal time coordinate. But not destroyed are the deepest features of Newtonian gravity:
Newtonian gravity: (1) the equivalence principle (as embodied in ^{the description} ~~of free-fall motion~~); and (2) spacetime curvature (as measured by ~~tidal effects~~ ^{§13.5}). The skyscraper of vectors, forms, tensors (Ch. 9), geodesic parallel transport, ~~and~~ covariant derivative, ^{and} curvature (Ch. 11) ~~has rested on crumbling foundations~~ -- ~~the Newtonian physics are used by geodesic law based upon Newtonian physics.~~ ^{But with metric now on, the} ~~needed to choose the geodesic law.~~ ^{Now} ~~The~~ whole skyscraper ~~is moved~~ ^{is transferred} to new foundations without a crack appearing. Only one change is necessary: the geodesic law ~~is to be chosen~~ ^{must} be selected in a new, ~~way~~ ^{relativistic way} based on metric (§§ 13.3 and 13.4). ~~Resting on metric foundations, ^{spacetime} curvature acquires additional and stronger properties (the skyscraper redecorated and extended), which ~~are~~ ^{are}~~

John

Kip

Charlie

**First Preliminary
Edition
September 1970**

Kip S. Thorne

First Preliminary Edition
September 1970

GRAVITATION

Charles W. Misner

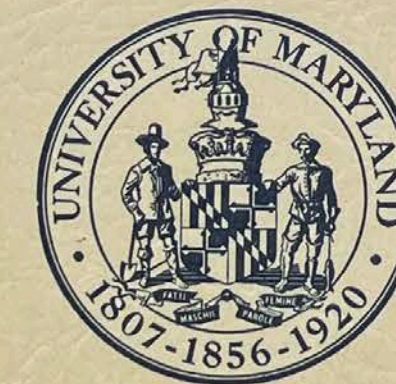
Department of Physics and Astronomy, University of Maryland

Kip S. Thorne

Kellogg Radiation Laboratory, California Institute of Technology

John Archibald Wheeler

Joseph Henry Laboratories, Princeton University



UNIVERSITY OF MARYLAND
DEPARTMENT OF PHYSICS AND ASTRONOMY
COLLEGE PARK, MARYLAND

Motivation for Dedication

Letter from John - 25 January 1972

I would like to "... take up and expand on ... a theme that you sounded, Charlie, at the end of your chapter on ... Mixmaster cosmology, about the interest of the public in science. I must say I am upset every time intellectuals set themselves up on pedestals as objects of worship rather than as servants of the larger public..."

In that vein he proposed this dedication

Dublin Sunday 25th June 1972

Dear Charlie and Kip - Among the items to be supplied in what Aidan Kelly calls "front matter" is a dedication*. I have taken the liberty to take a try at one, and enclose it. To dedicate the book to our wives or our parents or both would have been just and would have been happy; but to serve the world's work I wonder if it might not do still more good to take up and expand, as I have tried to do here, a theme that you sounded, Charlie, at the end of one of your chapters, if I remember right the one on mixmaster cosmology, about the interest of the public in science. I must say I am upset everytime intellectuals set themselves up on pedestals as objects of worship rather than as servants of the larger public; and you spoke well to this theme. Anyway look at what I have

This book is dedicated
To the humble old lady
Sweeping the walk with her broom
The eager child,
And all who with their love of truth
Take from their own wants
By taxes and gifts,
And now and then send forth
A dedicated servant out of their number,
To forward the search
Into the mysteries and marvelous simplicities
of this strange and beautiful Universe
Our home.

This book is dedicated
~~To the humble old lady~~
~~Sweeping the walk with her broom~~
~~The eager child,~~
To
And all who with their love of truth
Take from their own wants
By taxes and gifts,
And now and then send forth
A dedicated servant out of their number,
To forward the search
Into the mysteries and marvelous simplicities
of this strange and beautiful Universe
Our home.

DR. KIP S. THORNE

Alameda
Monday evening
28 November

Style - Air mail
to Kip - Thanks!
J-3 Dec
Xerox for you

Dear John

As I sat outside with the sun on my back all weekend, I kept thinking of you — standing, facing into the sun, on the shore of the gulf of California 2 years ago.

Charlie & I would like to propose a little change in the dedication. We feel that ~~the~~ the point of the dedication would come across more forcefully if the first 4 lines were deleted, thus:

This book is dedicated
~~To the humble old lady~~
~~Sweeping the walk with her broom,~~
~~The reflective father and mother,~~
~~The eager child,~~
To
And all who with their love of truth
Take from their own wants
By taxes and gifts,
And now and then send forth
A dedicated servant out of their number,
To forward the search
Into the mysteries and marvellous simplicities
Of this strange and beautiful Universe,
Our home.

Kip - I approve this change. - Regards - John
3 Dec 72

B.S. I have sent directly to Evan Gillespie the comments on Fig 20.2 + Box 25

Concluding Remarks