

# Some preliminary thoughts on the invention of constrained Hamiltonian dynamics

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Austin College

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APS and AAPT

## Some of my recent work related to the roots of constrained Hamiltonian dynamics

- “Peter Bergmann and the invention of constrained Hamiltonian dynamics”, in *Einstein and the Changing Worldviews of Physics*, C. Lehner, J. Renn, and M. Schemmel (eds.) (Birkhauser, 2011), 247-258
- “Léon Rosenfeld's Pioneering Steps Toward a Quantum Theory of Gravity”, *Journal of Physics: Conference Series* 222.1 (2010)
- “Translation and commentary of Léon Rosenfeld's 'Zur Quantelung der Wellenfelder', *Annalen der Physik*, 113 (1930)”, Max-Planck-Institut für Wissenschaftsgeschichte preprint 381, available online at <http://www.mpiwg-berlin.mpg.de/en/resources/preprints.html>, to appear in the MPIWG Open Access book series
- “Léon Rosenfeld and the challenge of the vanishing momentum in quantum electrodynamics”, *Studies in History and Philosophy of Modern Physics* “, 363-373 (2009)
- “Rosenfeld, Bergmann, Dirac and the invention of constrained Hamiltonian dynamics”, in *The Eleventh Marcel Grossmann Meeting On Recent Developments in Theoretical and Experimental General Relativity, Gravitation and Relativistic Field Theories*, edited by H. Kleinert, R. Jantzen, and R. Ruffini (World Scientific, New Jersey, 2008) ISBN 978-981-283-426-3, 2467-2469

## The March quantum gravity interview marathon with Dean Rickles

Partially supported by the Center for the History of Physics of the American Institute of Physics. Transcripts will appear on the Center website

<i>Stanley Deser</i>	<i>Californian Institute of Technology</i>
<i>Cecile DeWitt</i>	<i>University of Texas at Austin</i>
<i>Ivor and Joanna Robinson</i>	<i>University of Texas at Dallas</i>
<i>Charles Misner</i>	<i>University of Maryland</i>
<i>Dieter Brill</i>	<i>University of Maryland</i>
<i>Louis Witten</i>	<i>University of Cincinnati</i>
<i>James Anderson</i>	<i>Stevens Institute of Technology</i>
<i>Joshua Goldberg</i>	<i>Syracuse University</i>



Stanley Deser with riff raff

10/07/11



Joanna and Ivor Robinson



Louis Witten

10/07/11



Contents - Book I. (1957/8)

Nov. 18	Feller, Fourier integrals and resolution of the identity Spitzer, Theory of galactic clusters. Evaporation of stars from cluster; disruption of cluster.
Nov. 19	Psychology, General reinforcers Relativity seminar Equations of motion (EIH etc.) Bergmann, Reln. between canonical and Land.Lif. En.mom. Invariant properties of field singularities Finkelstein's idea of spin without spin Already unified theory simplified by spinors Komar, scalar invariants
Nov. 20	Frankhouser (Biology) Heteroploidy
Nov 21	Coulomb potential in isospin formalism is tensor interaction
Nov. 22	Brueckner, Brueckner methods in solid state
Nov. 22	Philosophy seminar, discussion of "ought"
Nov. 27	N. Bohr, Man and atomic Physics
Dec. 2	Biology, mutations
Dec. 6	Smart, Free will (philosophy)
Dec. 9	Frankhouser, Genetic equilibrium
Dec. 10	Goldberger, Structure of nucleons
Dec. 11	Artin, Affine Geometry
Dec. 17	Hoyle, Supernovae
Jan 14	Bohr, superconductivity
Jan. 15	Moeller, Energy in gravitational field
Jan 16.	Mentzel, Physical processes in the sun
Jan. 21	IAS discussion on Heisenberg-Pauli theory Motion of charged bodies in General Relativity
Jan. 23	Feila, Biological Effects of Radiation
Jan 28	Relativity conference Finkelstein, Schwarzschild solution in new coordinates Lindquist, 2-body problem Anderson, True observables Araki, Amount of freedom in time-symm. initial val. prob DeWitt, Constraints Laurent, Rep. of group of gen. coord. trfns. Dehler, Work of Jordan's group
Jan. 31	Pauli, Talk at New York Meeting about Pauli-Heisenbg. Theory
Feb 5	Twaddle, Linguistics
Feb. 11	Haag, Ghosts in the Lee model Twaddle, Phonetics-consonants, vowel phonemes
Feb. 18	Misner, Normal curvature
Feb 17	Shannon, Information theory (3 Vanuxem lectures)
Feb. 18	Twaddle, Diphthongs
Feb. 20	Moeller, Experimental tests of General Relativity
Feb 24	Twaddle, Pitch loudness, duration
Feb. 27	Halpern, Method of moments in Q. M.
March 3	Twaddle, Non-English sounds Schwarzschild, Balloon photography of sun (sign X1)
March 5	Twaddle, Phonemes and morphemes
March 12	Klein, Q. M. and General Relativity (come-back of 5-dimensional model. Continued several weeks)
March 18	Relativity Seminar Deser, Schwinger's action principle to quantise gravity Komar, Invariants Klein, Eddington Relations

Content page of Dieter Brill's  
Stephens Meetings Notebook

Contents - Book II (1958-1959)

Apr. 17	Sherr, Direct interaction
May 6	Bleuler, Nuclear structure
	Summary of Phys Rev <u>110</u> , 236 (rotating body & poln. of 1
May 8	Marshak, Galactic acceleration
May 20	Calculation of Sargnac expt with dielectric
May 21	Schwarzschild, stratosphere observation
May 29	Krotkov, Motion of Jupiter
June 4	Rocking ship
	Karren, Spin in General Relativity
	Talk with Bondi on gravitational waves
Aug 3 ff	Varenna meeting
	Heisenberg, Elementary Particles
	Pauli, spin & statistics
	Wightman, Holomorphy domains
	Pauli, Group structure and elem. Part (report on GÜrs)
	Goldhaber, Results on beta <del>decay</del> - interaction
Sept. 24	Lindquist, 2-body problem
Sept 26	Moffat, Equations of motion from field equations
	Fletcher, Conservation laws
	Wheeler, structure of universe
Oct. 7	Pais, Elem. particles
Oct. 7	Misner, on Takeno's plane gravitational waves
Oct 15	Rosen, fuzzy lightcone
Oct. 16	Dicke, Principle of equivalence
oct 20	Urey, Origin of meteorites
	Euwema, Neutrino processes
Oct 21	Telegdi, Beta decay of free neutrons
Oct 28	Relativity conference
	Pirani, definition of energy
	Baldwin (?) Spherical waves in linear approx.
	Dirac, Hamiltonian form of grav'l field equs
	Misner, variational princ, coord, condns.
Oct 29	Harrison, Exact 3-variable solutions in Gen. Rel.
	Fox, Knot theory (Math club)
Nov 5	?(Misner?) Many faces of Schwarzschild
Nov. 7	Steinberger, beat decay of $\pi^-$ meson
Nov 10	Dirac, Quantization of Relativity
Nov 13	Cronin, Parity violation in Hyperon decay
Nov 14	Wightman, Field theory seminar (theory of distributions)
	Wigner, Low-energy nuclear physics
Nov 19	Dirac, cont.
	Klauder, Feynman sum yielding Fermi statistics
Nov 20	Bender, gyromagnetic moment
Nov 21	Wightman, cont.
Nov 24	Dirac, cont.
	Wightman, cont.
Dec 9	Vanuxem lecture, Interior of the earth
Dec 10	Lindquist, non-singular Schwarzschild
Dec 16	Relativity Seminar
	Flabanski, new derivation of Eq. of Motion.
	DeWitt, Remark on space-like description
Jan 6, 1959	Kalabi, some theorems
Jan 13	Bertotti, Pfaff problem in Rainich theory

Content page of Dieter Brill's  
Stephens Meetings Notebook





Jim Anderson

10/07/11

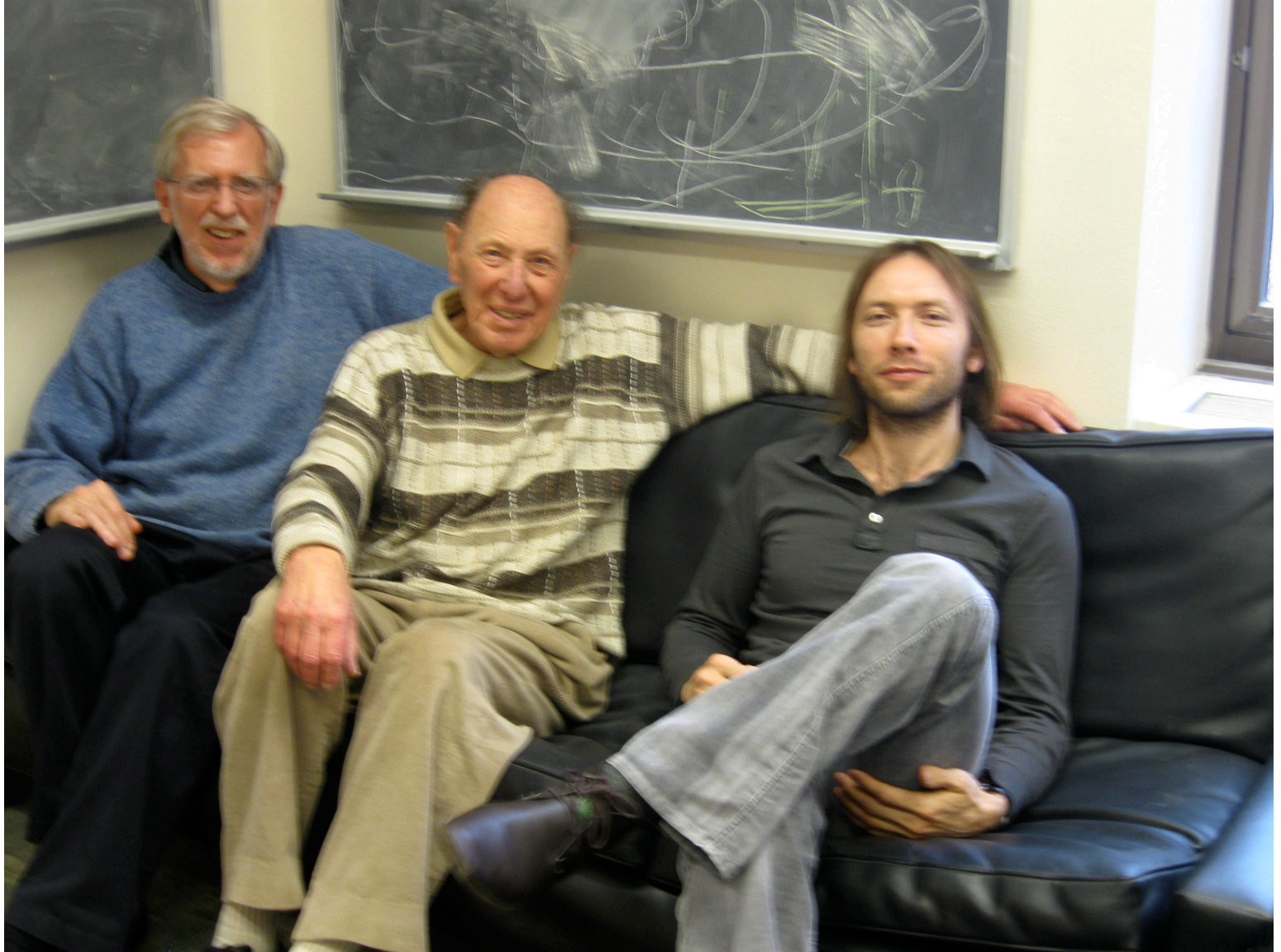




Stevens Meeting - 1959

10/07/11





Josh Goldberg

## Four (relatively) independent roads to constrained Hamiltonian dynamics

- Rosenfeld: 1929 - 1930
- Dirac: 1949 - 1950
- Bergmann: 1949 – 1951
- Arnowitt, Deser, and Misner: 1959 - 1962

### Later developments

- Dirac: 1958 - 1959
- Komar and Bergmann: 1972

## Some of my recent contributions regarding the group theoretical significance of constrained dynamics

- “Revisiting observables in generally covariant theories in the light of gauge fixing methods”, *Physical Review D*, 084015 (2009) (with J. Pons and K. Sundermeyer)
- “The issue of time in generally covariant theories and the Komar-Bergmann approach to observables in general relativity”, *Physical Review D*, 12402 (2005)