

Llewellyn Hilleth Thomas

1903 - 1992

An Underappreciated Polymath

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This talk is based on a biographical memoir prepared for the National Academy of Sciences in 2009 and is available (along with many other memoirs) at

[www.nasonline.org/site/PageServer?
pagename=Memoirs_A](http://www.nasonline.org/site/PageServer?pagename=Memoirs_A)

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Memoir Frontispiece

(be brief, JD)

EARLY YEARS

Born of Welsh descent in London, England on October 21, 1903, the oldest of five children.

Father: London public health officer

Mother: homemaker and tutor of LHT

Home Schooled ($0 < \text{age} \leq 7$):

reading, writing, arithmetic, elementary geometry, history

$7 < \text{age} \leq 11$, **private school**; voracious reader

11 < age ≤ 18, Scholarship at **Merchant Taylor's School**
- Latin and Greek, and an hour of mathematics every day;
after age 15, the **science curriculum**: physics, chemistry,
mathematics, including

J. J. Thomson's *Elements of Electricity and Magnetism*

J.H. Jeans's, *Mechanics*

W. F. Osgood's, *Calculus*

≥ 18 - Scholarship to **Trinity College, Cambridge**

Attended lectures by

C. G. Darwin, J. E. Littlewood, Geoffrey I. Taylor,

R. H. Fowler, A. S. Eddington, E. A. Milne,

J. Larmor, and others

Thomas sailed through Trinity and Cambridge University (1921-1924) effortlessly with scholarships and then

B. A. with first class honors in mathematics and distinction in applied mathematics, 1924

Began research with Fowler just as RHF went off to Copenhagen

In 1924 - 1925, **Still old quantum theory**

Research on the **passage of charged particles through heavy elements** using Hartree's calculations of struck electrons' energy levels and Bohr orbits (two LHT publications in 1927)

COPENHAGEN 1925-1926

Traveling Fellowship to Bohr's Institute in Copenhagen

Copenhagen was alive with the new quantum mechanics, but by his own admission, Thomas was “always slow in accepting new ideas and understood nothing of this for four or five years.”

Nonetheless, pursuing his own course, he invented the **statistical model of the atom** - electron distribution and screened potential that scale as $Z^{-1/3}$ - because he wanted those things for his calculations of the passage of charged particles in matter. (Fermi came a year later)

Thomas factor, Thomas precession, Relativistic spin motion

Other major discovery was the relativistic correction to spin-orbit coupling in atoms - the famous factor of 1/2 and much more

- Pauli; Uhlenbeck and Goudsmit send paper to Bohr.
- Bohr & Kramers, Christmas 1925 - U & G must be wrong.
- Thomas suggests relativistic effect may explain.
- Kramers pooh-poohs the idea, but Thomas comes back two days later with it all worked out!
- **Letter in Nature**, early 1926, but
- Much further work and **big paper in Phil. Mag.**, Jan 1927

Back to Cambridge, Fall 1926 - 1929

Immediately elected a Fellow of Trinity College

Seven papers to his credit and not yet age 24!

Ph.D. in 1927

Teaches and does research for 2-3 years

Most physicists know Thomas only for his *annus mirabilis* :

- **Thomas-Fermi atom**
- **Thomas Precession and the Thomas factor**

BUT THERE IS MUCH MORE



C. G. Darwin, L. H. Thomas,
Gregory Breit
(probably in 1926-27,
Copenhagen ?
[AIP Emilio Segrè Visual Archive]

*(be brief, JD;
5 minutes to go!)*



L. H. Thomas, 1929

((don't linger, JD))

1930 - 1946, Ohio State University and Ballistic Research Laboratory ('43-'45)

- LHT begins Asst. Prof. Job at Ohio State, Fall 1930
- Full professor, 1936
- Research of LHT and his 10 or more MS & PhD students:
atomic & nuclear physics, astrophysical applications of fluid dynamics, quantum theory of solids and complex molecules, numerical methods,
- Among Thomas's 24 papers from 1929 to 1942 were some collaborations with students. One notable student was **Leonard I. Schiff** (MS, 1934).

Special mention:

Radiation fluid dynamics, including **radiative viscosity** (stellar interiors, nuclear explosions)

Three-nucleon problem (still relevant today in other fields)

Isochronous, variable-sector cyclotron (beats relativistic effects of simple $\omega_B = ecB/E$) Many nuclear and medical machines, 50-500 MeV

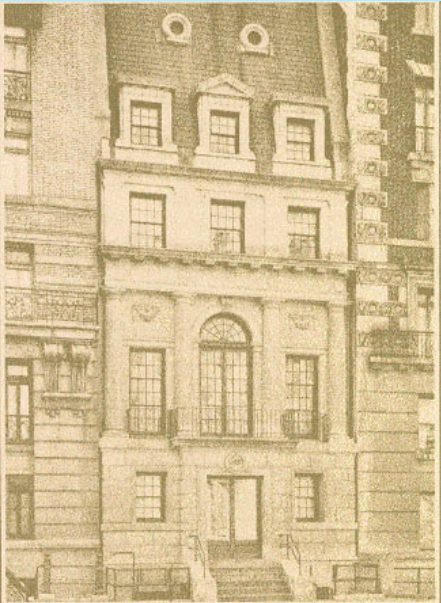
1943-45, Ballistic Research Laboratory, Aberdeen Proving Ground, Maryland

LHT worked on internal ballistics; explosions
(colleagues: G. Breit, S. Chandrasekhar, E. Hubble,
J. Mayer & J. L. von Neumann, I. I. Rabi)



Llewellyn H. Thomas was an early recruit to the staff of the Watson Lab.

612 W. 116th Street



1946-1968, IBM Watson Lab and Columbia University

Third staff member to be hired
(as “technician”), Watson Lab,
and
Unpaid Professor, Columbia U.



Thomas and **Wallace J. Eckart**,
Director of Watson Lab, at work

(be brief, JD)

- Thomas was described by Watson Lab colleagues as brilliant but unwordly and orthogonal to the buttoned-down IBM orthodoxy.

Stories, perhaps apocryphal, abound:

One is that, hearing about the formal IBM atmosphere engendered by Mr. Watson before he arrived, Thomas showed up for work in black tie and tails!

Another is that he was observed riding home on the subway lecturing to a colleague in a loud voice on the intimacies of Gegenbauer polynomials!

- LHT had a huge influence on the **physics**, **mathematics**, and **machine design** principles and **hardware** of the Watson Lab.
- He conceived the **magnetic core memory** in 1946, two years before others. He invented **electromagnetic delay lines** for data storage.
- Eckart once wrote in an annual report, **“Perhaps there should be a box on the organizational chart labeled L. H. Thomas.”**

Personal Research

(be brief, JD)

- Relativistic particle dynamics
- Hydrodynamic flow
- Computation of statistical charge densities
- X-ray scattering factors for the whole periodic table and several degrees of ionization

In the field of computation and computers, he published internal reports and journal articles on **numerical methods, software, hardware.**

(be brief, JD)

THOMAS AT COLUMBIA

Taught regularly at Columbia - General relativity, Group theory, Quantum mechanics, Relativistic quantum theory, Magnetohydrodynamics, Mathematical methods.
Research supervisor of at least 6 Ph.D. students

Not an inspirational instructor, but his vast knowledge of mathematical physics made him known in the Physics Department as **“the sage of 116th Street.”**

(skip?)

Thomas's 1954 foray into the public arena

- Paper at American Rocket Society meeting
 - **ingenious and inexpensive countermeasures against** a large hostile spy satellite akin to a **pet project advocated by Wernher von Braun.**
(story in Time magazine, May 3, 1954)
- **Unwelcome McCarthy-era inquiries**, “Who is this alien at the Watson Lab and what is he up to?”
- Thomas then felt his lack of US citizenship began to interfere with his ability to consult for the government.
- **He became a naturalized US citizen in 1957.**

(no time ?)

1968 - 1976, North Carolina State University

Upon leaving the Watson Lab & Columbia, Thomas became a Visiting University Professor in Physics and Mathematics at NCSU. He taught, did research, and supervised one MS student, while playing his role as an encyclopedic scholar.

The Physics Department considered the presence of him and his wife as profound stimuli to the intellectual and social life of the department.

He retired from NCSU in 1976 and died in Raleigh on April 20, 1992.

(be brief, JD)

Honors, Awards, (Memberships, Family)

(No time; read the NAS memoir)

At Cambridge - Isaac Newton Studentship; Rouse Ball Travelling Fellowship; 1851 Exhibition Scholarship; elected Fellow of Trinity College in 1926; **honorary Cambridge D. Sc. in 1965.**

In US - Elected to the **National Academy of Sciences**, 1958 (one year after becoming a citizen); **belatedly** awarded the **APS Davison-Germer Prize** in 1982 “for his early pioneering contributions to the theory of the spin-orbit interaction in atoms and to the statistical model of atoms.”



1930

I hope that I have shown you that there is much more to this brilliant polymath named **Llewellyn Hilleth Thomas** than “just” spin-orbit coupling and the Thomas-Fermi atom.



1950-60s

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