

\* Sci Amer Feb, 2001, Wheeler pg 68-75  
 \* PT, Dec 1976 pg 23-27  
 Ref: JSP 73(11) 999-1008 (2005)

- 1) Classical Newtonian Mechanics
- 2) Maxwell's Equations
- 3) Maxwell-Boltzmann - stat mech

particles = particles  
 Light = waves

getting classical mechanics from  $10^{23}$  particles

1900

BB radiation  
 ultraviolet catastrophe

Planck's Quantization!  
 $h$

Light = waves + particles

1900  
 Max Born

U. Göttingen  
 Germany  
 it was scribble for (note-taker)

1905 photo-elect

Einstein's Light Quantization

1905 Special Relativity  
 A. Einstein

$e^-$ 's = particles + waves!

David Hilbert  
 "greatest mathematician of 20th century"

1912 Bohr Model of Atom

$L = nh$  ... orbital  
 get all discrete

Spectroscopic Experimental results

\* But, no real mechanism

or deeper understanding of standing waves & so on.

So Big? ?

call it old Quantum Theory.

Also hung with Klein (later Heisenberg)

Minhowski died @ 44 ruptured aorta  
 said "physics is too hard for physicists"

1916 A. Einstein General relativity

In any case, BORN, intellectual center of world & Prime for Break thru!

Quiet until

1921

1921

Born @ Göttingen → prof has 2 student assistants

1) Wolfgang Pauli

2) Werner Heisenberg ⇒

↑ Big rep as smart

on loan from Sommerfeld who was lecturing in U.S.

1925 ⇒ Heisenberg a star

in Copenhagen to understand

old Quantum Theory; returns to Göttingen gets Hay Tower attack so retreats to resort island = Helgoland in North Sea Sea relief. Returns to Göttingen & has beginnings of Q.M.

According to ATP Author, Heis. is one who took the HUGE Step from Bohr Atom to Quantum Theory!

Sept 1925 paper: on a quantum-theoretical interpretation of kinematic and mechanical relations  
Tough to read, lots of assumptions!

Heisenberg

gives paper to Born.

Born, physically & mentally tired -- gives it to

his student Pascual Jordan (Brilliant)

They see Messy math @ linear algebra & matrix mechanics!

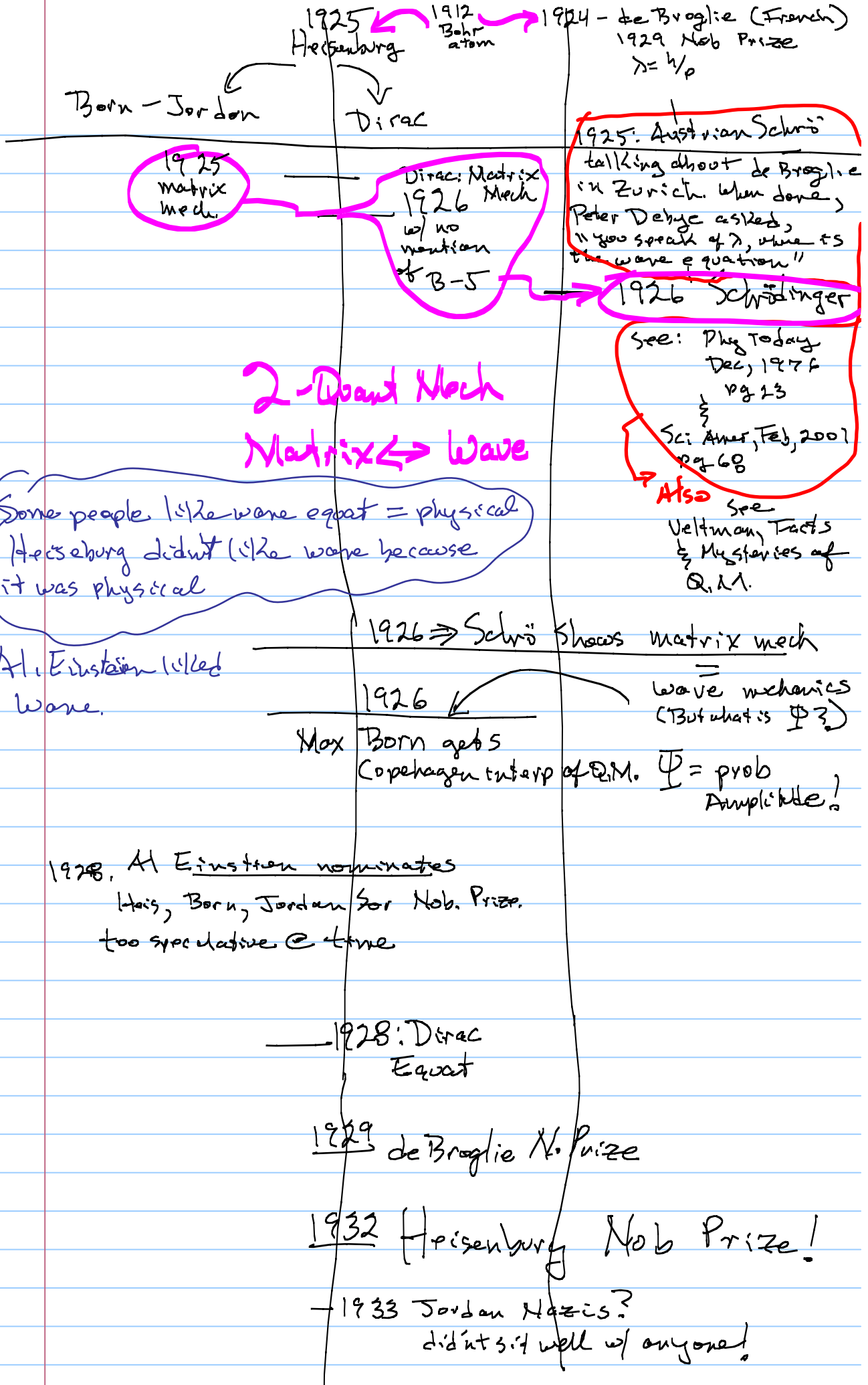
publish in 1925

Acknowledges Heisenberg's HUGE Step; This paper is essence of matrix mechanics

Dirac sees Heisenberg talk

w/o knowledge of Born-Jordan

recognizes too that all Heisenberg's Sundry work is Matrix mechanics



2-Quant Mech  
Matrix ↔ Wave

Some people like wave eqn = physical  
Heisenberg didn't like wave because it was physical

Al Einstein liked wave.

1933 Dirac + Schrödinger ⇒ Nob. prize

Big Controversy?

what about Born-Jordan  
Bad Sealings

1935 ⇒ EPR

1948 = QED & Renormalization

Feynman

Schwinger

opt. ⇒ To

1945 nuc Bomb

1947 transistor

1954 ⇒ Yang-Mills  
Gauge Theory

1934 Born Nobel Prize Alone  
No Jordan

for prob Amplitude =

prob interpret of Q.M.

1963

Feynman, Schwinger

to K

Nobel Prize

QED

1960 LASER invented

1964 John Bell: EPR  
No Local Hidden  
variables  
is: Bell's Inequality

1973 Electroweak  
unification!  
 $\phi, W^-, W^+, Z^0$   
predicted

1975 Tau lepton

1982 Main Aspect:  
Bell's Inequality  
Einstein wrong  
Spooky Action  
is here! Quantum  
Right!

1983 Discovery of  $Z^0$

1987 High Temp Superconductivity

1995 Discovery of Top Quark

My thesis!

My CERN work

My PRL w/ Dave

1993 Quantum teleportation

1995 Theory  
BECs

2000 Hint of Higgs

Next?

SUSU

Decolonisation

Caribbean Unification

TOE