Historical Approach to Physics according to Kant, Einstein, and Hegel

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History of Physics starts from Galileo Galilei.

Born in Pisa.

Made his name in Padua.
Galileo’s House in Padua.
He then moved to Florence at the invitation of the Medici family.

His tomb in the Santa Croce Cathedral in Florence

Galileo Museum in Florence
Inquisition of Galileo in Rome
Physics had its golden age during the 20th Century.

I started publishing my papers in physics in 1961, and I am still writing them. Thus, I am in a position to develop a historical view toward physics.

The question is whether Hegel is enough for future physics.

Why am I here to talk about the history instead of writing physics papers?
During this golden age, physicists were treated nicely. They developed a greed for quick money and fame. They are not different. They are humans.

We witnessed many rising stars. But they also fell down quickly. They are like Sakura (cherry) blossoms. They become shiny and brighten the world, but they disappear quickly.

We had many Sakura physicists in the past.
They are all bright people. Why did they fall and disappear? The reason is very simple. They were not able to find their places in the history of physics. **Creativity should be accompanied by continuity.**

- Abraham, David, Joseph the carpenter.
- Jesus was creative enough to be the only son of God. Yet he needed a continuity from David.
- From the first page of the New Testament.
When we do quantum mechanics, we do Shroedinger’s wave mechanics, but Heisenberg invented quantum mechanics. Heisenberg established continuity.

Schroedinger’s wave mechanics in 1926

Heisenberg’s uncertainty principle in 1927
Human History: before or after Jesus

Physics History: before or after Einstein

Was Einstein alone?
Einstein and Hegel were born in the kingdom of Wurttenburg, Germany. Not many people talk about Hegel’s influence on Einstein.

Einstein Monument in Ulm. Hegelhaus in Stuttgart.
Einstein’s Houses

Einstein-Haus in Bern. There, he formulated his theory of relativity in 1905.

Photographer named Orren Jack Turner took these photos in Princeton.

Einstein in 1947.
Photo in the public domain.

One young man in 1961, the day before he became a PhD.
Einstein studied Kant’s writings when he was very young. His thinking was heavily influenced by Kant when he formulated his theory of relativity.
It is not clear whether Einstein studied Hegel, but his theory of relativity represents a transition from Kant to Hegel.

Einstein (1879-1955)  Hegel (1770-1831)
Hegel was influenced by Kant. How? It is easier to explain this in terms of Einstein. Hegel was not a physicist.

Kant (1724-1804)  Hegel (1770-1831)
Since Einstein liked Kant so much, I went to Kaliningrad (Koenigsberg) to see how Kant formulated his philosophy.

Kant’s grave in Kaliningrad. I was there in 2005.

Kant Museum is in this church building in Kaliningrad. Kant’s grave is not inside the church, because he did not believe in Jesus.
Kant spent 80 years of his entire life in Koenigsberg. His thinking was affected by the city’s environment.

Flat defenseless lands

Lagoon. Venice of the Baltic Sea
Many different views in one place. The city had to accommodate all of them.

<table>
<thead>
<tr>
<th>Land</th>
<th>Sea</th>
</tr>
</thead>
<tbody>
<tr>
<td>The defenseless flat Land allows anyone with a stronger army to come in and rule the place.</td>
<td>Like Venice, Koenigsberg served as a trading center for those different people in the Baltic world.</td>
</tr>
</tbody>
</table>
After World War II, the German city of Koenigsberg became a Russian city of Kaliningrad.

Two German sisters born in Koenigsberg before 1945.

Three generations of Russian ladies in Kaliningrad.
Many different people with different ways of looking at the same thing.

• The same thing could appear differently to different observers. This is what Einstein adopted for his relativity.

• However, Kant insisted that there exists an absolute thing, called Ding an Sich.
Einstein only partially consistent with Kant.

• According to Kant, Einstein should have an absolute frame in his relativity theory, but this is not the case.

• Einstein’s theory is more consistent with the oriental philosophy of Taoism where two opposite things can exist in harmony.

If the particle moves slowly, its energy-momentum relation is
$$E = \frac{p^2}{2m}.$$ 

If it moves with a speed close to that of light the relation is
$$E = cp.$$
While I was in Kaliningrad in 2005, I sensed that Kantianism was developed in the same manner as Taoism was developed in China.

- China was created by many different groups of people who came to the banks of the Yellow River.

- In order to communicate with different people, they used pictures – leading to Chinese characters.

- How about verbal communication. They sang to express their feelings. This is the reason why there are tones in spoken Chinese.
I was in Xian, China to confirm this China effect.

- It was a pleasure to have a photo with Chin Shi-Huang, who became the emperor 200 years before Julius Caesar attempted his emperorship in Rome.

- It was a great honor for me to have this photo with Emperor Chin.

- China was named after him.
What happened when they had different ideas?

- In order to manage many different ideas, they divided them into two groups. This is how they developed Yang (plus) and Ying (minus) concepts. Those two elements are in harmony in this world. If this harmony is broken, you are trouble – this is the starting point of Chinese medical science.

- Americans developed a two-party system in their democracy. This is one form of Taoism.
While I was in Kaliningrad for three days in 2005,

- I noticed that there was a considerable overlap between Kantianism and Taoism, because they share the same type of geographical origin.

- However, I was not the first one to recognize this similarity.

- Fredrich Nietzsche once said Kant was an oriental philosopher. I am still curious about how Nietzsche came to this conclusion. Do you know?
Einstein was not looking for the absolute frame of reference. Instead he derived a new conclusion from two contrasting observations.

Energy-momentum relation

\begin{align*}
\text{Slow} & : & E &= \frac{p^2}{2m} \\
\text{Fast} & : & E &= c p \\
E &= \left( m^2 c^4 + c^2 p^2 \right)^{1/2} \\
E &= m c^2 \text{, when } p = 0.
\end{align*}
On mechanics and electromagnetism, Einstein unified the covariance and formulated his relativistic mechanics.

Newton’s mechanics with Galilei covariance

Maxwell’s Electromagnetic theory with Lorentz covariance
Einstein was influenced by Kant, but his theory of relativity leads to Hegelianism.
Einstein thus developed his Hegelian approach to physics.

- Comet = open orbit
- Planet = bound orbit
- Newton formulated the law of gravity, and developed the second-order differential equation relating acceleration to force. He combined the open and closed orbits into one entity.
- Newton was Hegelian!
James Clerk Maxwell combined Electricity and Magnetism to produce Electromagnetic waves (for your wireless phones). **Hegelian process!**

Other names in this field include

- Coulomb, Ampere, Bio-Savart.
- Michael Faraday.
- Electromagnetic Induction.
- Transformers.
- Thomas Edison attempted to construct a wireless communication device using Faraday’s induction.
Max Planck (1853-1947)

- Low frequency radiation.
- High frequency radiation.
- Planck combined two different formulas into one.
- In so doing, he introduced Planck’s constant.

Hegelianism at work.
Bohr and Heisenberg

- Discrete energy levels of the hydrogen atom. Standing waves – like violin strings.
- Waves or Particles.
- Combine them. Heisenberg’s Uncertainty Principle.

Hegelianism at work!
Weinberg, Salam, Glashow

- They combined
- Electromagnetic and weak interactions.
- In so doing, they defined the role of the Higgs (God) particle.
- Another Hegelian process.
It is a pleasure to tell you that Weinberg and I had the same advisor at Princeton. Weinberg was four years ahead of me. He received his degree in 1957. The advisor’s name was Sam Treiman. A very handsome man.
More about Einstein

- It took Newton 20 years to extend his gravity law to extended objects.

- Einstein formulated the Lorentz transformations for point particles.

- Einstein never worried about Lorentz-boosting of the hydrogen atom. It is not possible even now to think about the hydrogen atom moving with a relativistic speed.
Internal Space-time Symmetries

J.S. Bell’s Picture of the Lorentz boost. Circular orbit becomes squeezed along the longitudinal direction,

Leopold Infeld: Replace the orbit by a standing wave before making a boost.
Eugene Wigner's 1939 paper spells out how to construct the internal space-time symmetries in Einstein's world.
Not many people understand this paper, but I do, and I wrote a book on this subject with Marilyn Noz. This is the reason why I able to approach Wigner and produce the following photos, spelling out Einstein’s genealogy.
Wigner paper was also Hegelian.

- For a slow particle, the symmetry is like the three-dimensional rotation group – spin degrees of freedom.
- For a fast/massless particle, it has its helicity degree of freedom, and gauge degree of freedom.
- Wigner’s paper combines them. Thus, it is Hegelian.
Evolution of Hydrogen to Proton.

- The proton was a point particle when Einstein was alive.
- It is now a bound state of three quarks.
- Unlike the hydrogen atom, the proton is a charged particle. It can thus be accelerated. This causes current excitements coming from CERN.
Gell-Mann and Feynman

- In 1964, Gell-Mann proposed the quark model. The proton is a bound state of the quarks, like the hydrogen atom.

- In 1969, Feynman observed that the fast-moving proton looks like a collection of partons.
Quark model and Parton model

- The proton appears different when it moves with a speed close to that of light.

- In order to answer this question, we have to construct a model of quantum bound states which can be Lorentz-transformed.
The last question of the 20th Century: How to combine quantum mechanics and relativity.

For scattering problems (open orbits), quantum field theory and Feynman diagrams provide satisfactory answer.

For bound state problems, we should learn how to deal with standing waves.
Dirac and Feynman

In Poland (1962).

Two contrasting personalities

• Unlike Feynman, Dirac was interested in localized entities. He was interested in bound states.

• Dirac’s papers are like poems, but he never drew figures to do physics, unlike Feynman.
I had an audience with Dirac in 1962.

Nicodemus and Jesus

I was a confused young physicist

- I was confused because many of my friends were becoming famous so quickly, and I felt I was left behind.

- I asked Dirac what I should do, like Nicodemus asking Jesus.

- Dirac’s answer was American physicists do not understand Lorentz covariance well, and I should study this subject.

- I then studied his papers. I translated his poems into cartoons (Feynman’s talent).
Paul A. M. Dirac. How to combine quantum mechanics with relativity. His papers are like poems, but contain no figures. It is thus fun to translate those poems into cartoons.

Cartoon version of Dirac’s papers

Quantum Mechanics

\[ \begin{align*}
\text{t} & \quad \text{c-number} \\
\text{z} & \quad \text{Heisenberg Uncertainty} \\
\text{Dirac 1927} & \quad \text{Time-energy Uncertainty}
\end{align*} \]

Lorentz Covariance

\[ \begin{align*}
\text{t} & \quad \text{Dirac 1949} \\
\text{z} & \quad \text{(1973)}
\end{align*} \]

In the Real World

- Proton Form Factor
- Feynman’s Parton Picture

Lorentz-covariant Quantum Mechanics

Paul A. M. Dirac
Then this combination leads to an interpretation of Feynman’s parton picture.

- Gell-man’s quark model (for slow protons) and Feynman’s parton model (for fast proton) leads to a Lorentz-covariant picture of quantum bound states.

Again, this is a Hegelian process.
Further contents of Einstein’ $E = mc^2$. Hegelian!!

<table>
<thead>
<tr>
<th>Energy Momentum</th>
<th>Massive Slow</th>
<th>between</th>
<th>Massless Fast</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E = \frac{p^2}{2m}$</td>
<td>$E = \sqrt{m^2 + p^2}$</td>
<td>$E = p$</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spin, Gauge Helicity</th>
<th>$S_3$</th>
<th>$S_1$</th>
<th>$S_2$</th>
<th>$S_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little Groups</td>
<td>Gauge Trans.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quarks Partons</th>
<th>Quark Model</th>
<th>(Covariant Phase Space)</th>
<th>Parton Model</th>
</tr>
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</table>

Energy-momentum relation

Slow

$E = \frac{p^2}{2m}$

Fast

$E = cp$

$E = (m^2 c^4 + c^2 p^2)^{1/2}$

$E = mc^2$, when $p = 0$. 

QUARKS

PARTONS
We need three elements.

Two contrasting persons:
Hegelian

Wigner: historical continuity
Three Graces of Greece

A Woman consists of three elements.

1. Beauty
2. Charm
3. Creativity
Thomas Aquinas

- Holy Trinity
- 1. Holy Father
- 2. Holy Son
- 3. Holy Ghost
Montesque

Three branches of government.

1. Executive
2. Legislative
3. Judicial
Another set of Three

- Conic sections
- Ellipse
- Parabola
- Hyperbola
Newton’s Set of Three

<table>
<thead>
<tr>
<th>Scattering</th>
<th>Bound States</th>
<th>Space/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMET</td>
<td>PLANET</td>
<td>GALILEI</td>
</tr>
<tr>
<td>NEWTON</td>
<td>BOHR</td>
<td></td>
</tr>
<tr>
<td>HEISENBERG, SCHRODINGER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEYNMAN</td>
<td><strong>STEP 1</strong></td>
<td>EINSTEIN</td>
</tr>
<tr>
<td><strong>STEP 2</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Orbits

1. Hyperbolic
2. Parabolic
3. Elliptic
Internal Space-time Symmetries, according to Wigner.

- Elliptic (massive particles)
- Parabolic (massless particles)
- Hyperbolic (imaginary mass)

I wrote many papers on this aspect of physics, including those with Wigner.
We used to think there are only plus (+) and minus (-) charges.

He found there are three.

In so doing he found the quark model with three fundamental quarks.
Sets of Three Elements

• The physicists kept inventing sets of three elements, leading to the standard model.

• This requires the Higgs boson. Most of the physicists think this particle is found.
Hegel was based on two elements.

• In the future, we need THREE.

The post-Hegelian philosophy of THREE is needed for understanding modern physics.
I would like to thank

Raffaele Pisano for inviting me to the conference.

Salvatore Esposito for introducing me to the audience.
Photos in this presentation are mostly from my album and from the public domain.

• The portrait of Einstein and Wigner is by Bulent Atalay.
• The conic section and the standard-model elements are from the Wikipedia.
• The photo of Dirac and Feynman is from the Caltech photo library.
• The photos of Heisenberg, Schroedinger, Gell-Mann, and Feynman are from the AIP Segre Visual Archives.
• The photos of Jesus and Nicodemus are from the Picture Bible (David Cook Pub. Co.).