Curriculum Vitae for

Young Suh Kim

1 Educational and Academic Background

- 1954. Entered the Carnegie Institute of Technology in Pittsburgh, after high school graduation in in South Korea (1954).
- 1958. Entered the Graduate School of Princeton University after graduation from the Carnegie Institute of Technology, which later became Carnegie Mellon University.
- 1961. PhD degree in physics from Princeton University. Stayed at Princeton for one additional year as a post-doctoral fellow.
- 1962. Joined the faculty of the University of Maryland as an Assistant Professor of Physics. Faculty responsibilities included teaching, research, and administrative services.
- 2007. Became an Emeritus Professor of Physics, without formal duties to the University, and I was able to concentrate on research activitie since then.

2 Publications

Go to http://www.ysfine.com/yspapers/index.html.

2.1 Publications based on the PhD thesis at Princeton University.

- 1961. Dispersion Relations for Production Amplitudes,
  Phys. Rev. Lett. **6**, 313 - 315.
- 1961. Dispersion Relations for Production Amplitudes I,
  Phys. Rev. **124**, 1241 - 1248.
- 1961. Dispersion Relations for Production Amplitudes II,
  Phys. Rev. **124**, 1632 - 1638.

2.2 Most Notable Publications

- 1977. Covariant Harmonic Oscillators and the Parton Picture,
  with M. E. Noz,
  Phys. Rev. D **15**, 335 - 338.

- 1979. Representation of the Poincaré Group for Relativistic Extended Hadrons, with M. E. Noz and S. H. Oh,
  J. Math. Phys.**20**, 1341 - 1344.

- 1983. Gauge Transformations as Lorentz-boosted Rotations,
  with D. Han and D. Son,
  Phys. Lett. **131B**, 327 - 329.

- 1989. Observable Gauge Transformations in the Parton Picture,
  Phys. Rev. Lett. **63**, 348 - 351.

- 1990. Space-time Geometry of Relativistic Particles,
  with E. P. Wigner,
  J. Math. Phys. **31**, 55 - 60.

- 2019. Einstein's $E = mc^2$ derivable from Heisenberg's Uncertainty Relations,
  with S. Başkal and M. E. Noz,
  Quantum Reports **1 (2)**, 236 - 251.

- 2019. Poincaré Symmetry from Heisenberg's Uncertainty Relations,
  with S. Başkal and M. E. Noz,
  Symmetry **11 (3)**, 236 - 267.

2.3 List of books

- 1986. Theory and Applications of the Poincaré Group,
  with M. E. Noz,
  Reidel (Dordrecht, the Netherlands)

- 1991. Phase Space Picture of Quantum Mechanics
  with M. E. Noz,
  World Scientific (Singapore).

- 2015. Physics of the Lorentz Group,
  with S. Başkal and M. E. Noz,
  IOP Publishing (Bristol, UK) and Morgan & Claypool (San Rafael, California, USA)

- 2018. New Perspectives on Einstein's $E = mc^2$,
  with M. E. Noz,
  World Scientific (Singapore)

- 2019. Mathematical Devices for Optical Sciences, with S. Başkal and M. E. Noz, IOP Publishing (Bristol, UK)

- 2021. Physics of the Lorentz Group, Second Edition, with S. Başkal and M. E. Noz, IOP Publishing (Bristol, UK)

3 Most Important Career Accoutrements

Let us start with Einstein's $E = mc^2$. Einstein produced the energy-momentum relation valid for all possible speeds. This aspect of his special relativity is well known, and is given in the first row of the following table.

	Massive Slow		Einstein's Space-Time		Fast Massless
Einstein's $E = mc^2$	$E = p^2/2m$		$E = \sqrt{(cp)^2 + m^2c^4}$		$E = cp$
Wigner's Little Groups	S_3 S_1, S_2		Internal Symmetries	$\rightarrow$	Helicity Gauge Trans.
Kim, mostely with Younger Colleagues	Gell-Mann's Quark Model	$\rightarrow$	Lorentz-covariant Harmonic Oscillators	$\rightarrow$	Feynman's Parton Picture

In 1939, Eugene Paul Wigner published his paper on the little groups concerning the internal space-time symmetries [Ann. Math. **40**, 149 - 204 (1939)]. In Einstein's relativistic world, particles have internal space-time symmetries. When they are rest, they display intrinsic angular momenta in three directions. We call them "spins." They can spin in three different directions.

For a particle moving with the speed of light, there is only one observable component of the spin, namely, parallel to the momentum. It is called the helicity. The perpendicular components are not observable. For many years, it was a challenge to explain why. With my two younger colleagues, I published, with my younger colleagues, the following paper.

- Gauge Transformations as Lorentz-boosted Rotations, with D. Han and D. Son, Phys. Lett. **131B**, 327 - 329 (1983).

In this paper, we showed that those transverse components of the spin become unobservable gauge degrees of freedom in the limit of zero mass and/or high speed.

When I told about this result to Professor Eugene Wigner [Nobel 1939], he became so happy that he invited me to publish papers with him. For this specific problem, I published the following paper with him.

- Space-time Geometry of Relativistic Particles, with E. P. Wigner, J. Math. Phys. **31**, 55 - 60 (1990).

This paper is an updated version of Wigner's original paper of 1939. This aspect of my work is specified by the arrow on the second row of the above table.

Let us now go to the third row. This row belongs to me and my colleagues. Since 1973, I have been publishing papers with Marilyn E. Noz on the harmonic oscillator wave functions which can be Lorentz-boosted. In other words, we resolved the issue of how the oscillator wave function appears to moving observers. This is an Einsteinian problem. We constructed this wave function and called it "Lorentz-covariant harmonic oscillator wave function," and published many papers on this subject.

If a proton is at rest, it is like a bound-state of quarks. However, if it moves with a velocity close to that of light, it appears like a collection of partons whose properties are quite different from those of the quarks. This phenomenon is called Feynman's parton picture. We showed that the covariant oscillator wave function can explain these peculiarities, and published a paper in 1977:

- Covariant Harmonic Oscillators and the Parton Picture, with M. E. Noz, Phys. Rev. D **15**, 335 - 338 (1977).

In 1989, after discussions with Professor Wigner, I was able to associate this quark-parton issue to Wigner's little groups and published the above table in Physical Review Letters:

- Observable Gauge Transformations in the Parton Picture, Phys. Rev. Lett. **63**, 348 - 351 (1989).

This aspect of my work is specified with the two arrows on the third row of the above table.

4 Important Research Results in Recent Years

. In 1962, I was fortunate enough to meet with Paul A. M. Dirac [Nobel 1933]. His advice was to study more about applications of Einstein's special relativity. He mentioned his own paper which he had submitted to the Journal of Mathematical physics, and which was published in 1963:

- P. A. M. Dirac, A Remarkable Representation of the 3 + 2 deSitter Group, J. Math. Phys. **4**, 901 - 909 (1963).

In this paper, he constructed the O(3,2) deSitter group starting from two harmonic oscillators. The harmonic oscillator is a language of quantum mechanics, while the deSitter group is the Lorentz group applicable to three space-like dimensions and two time-like directions.

While Einstein's relativistic space requires only one time dimension in addition to the three space-like dimensions, there is one extra time dimension in the O(3,2) space. I am quite excited about the possibility of converting the four operations involving this second time variable into into translations in the Einstein's four-dimensional space and time. Together with my colleagues, I published the following papers.

- Einstein's $E = mc^2$ derivable from Heisenberg's Uncertainty Relations, with S. Başkal and M. E. Noz, Quantum Reports **1 (2)**, 236 - 251 (2019).

- Poincaré Symmetry from Heisenberg's Uncertainty Relations, with S. Başkal and M. E. Noz, Symmetry **11 (3)**, 236 - 267 (2019).

The net result is that quantum mechanics and special relativity can be derived from the same set of equations.

In view of my recent activities, IOP (the Institute of Physics) of the United Kingdom invited me to write the second edition of my book entitled "Physics of the Lorentz Group," which I published with Sibel Başkal and Marilyn Noz in 2015. We are working hard on this project these days.