

# A new foundation for geometric phase

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Geometric phase was first discovered by Sivaramakrishnan Pancharatnam in 1956, and rediscovered by Michael Berry in 1984. In the 39 years since geometric phase became widely known, over 10000 research manuscripts have been published dealing with its features, how one can calculate it, and how instruments can be constructed to take advantage of it. However, until this year not one of these papers was able to present a visualization – a physical model – of how geometric phase arises. That is, researchers have been content to work on how one might calculate the geometric phase in a given system, without developing a physical model of it.

We provide an introduction to our work on filling in this gap, and show that despite the overblown mathematical language of so much of the geometric phase literature, the physical mechanism that generates geometric phase is simple: it is an expression of the Harmonic Addition theorem in mathematics, which gives the location of the wave peak for a sum of multiple waves. Not only does this clarify what geometric phase means and how it can be used, but this simple model also allows several features that have never before been possible in the literature: defining geometric phase for any arbitrary wave, and defining the relationship between a wave's geometric phase, and the measured phase shift obtained by an interferogram measurement.

## Short Biography:



**Nathan Hagen** is a Professor of Optical Engineering at Utsunomiya University. He obtained his PhD in Optical Sciences from the University of Arizona in 2007, and worked for 5 years as the principal scientist at the successful startup Rebellion Photonics, Inc. His research focuses on spectral imaging, polarization, and optical system design.



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