Dan MacIsaac, Column Editor, Physics Department, SUNY-Buffalo State University, Buffalo, NY 14222; macisadl@buffalostate.edu

WebSights features announcements and reviews of select sites of interest to physics teachers. All sites are copyrighted by their authors. This column is available as a web page at PhysicsEd.BuffaloState.Edu/pubs/WebSights/. If you have successfully used a physics website that you feel is outstanding and appropriate for WebSights, please email me the URL and describe how you use it to teach or learn physics—macisadl@buffalostate.edu.

• *Smartphone camera physics resources*

https://www.phys-l.org/archives/2024/2_2024/msg00018.html
https://www.degruyter.com/document/doi/10.1515/aot-2021-0023/html
https://www.pcmag.com/news/the-iphone-15-pro-max-has-a-tetraprism-camera-what-the-heck-is-that
https://lensreview-en.xyz/apple-iphone-15-telephoto-lens-120mm-f2-8/
https://wp.optics.arizona.edu/jsasian/wp-content/uploads/sites/33/2018/11/Mobile-phone-lenses-JS.pdf

A tour-de-force posting on smartphone camera (SPC) optical and electronic physics was recently made to Phys-L by Weber State Professor Emeritus John Sohl. Our modern pocket devices contain up to five integrated cameras and rangefinders whose data are combined to produce remarkable results from an incredibly thin form factor, and are wonders of recent technical innovation. The first review document from De Gruyter, "Smartphone imaging technology and its applications" by Blahnik and Schindelbeck at Zeiss, is an extensive summary introduction to SPC design and attendant technologies such as stabilization and detectors, and particularly the tiny, short multielement (typically 5–8 plastic aspherical lens elements with antireflective coatings) camera modules found in smartphones. Sohl further notes that modern GRIN (GRadiated INdex of refraction—elements manufactured with varying indices of refraction by manipulating the lens material) elements are used in some new cameras and recent consumer optical devices, and some recent SPC designs include prismatic periscopes. Finally, Prof. Sasian's slides include comparisons of multiple smartphone camera module patents. There's a lot more here than the Gaussian lens equations. Also, the future appears to be image correction and synthesis from multiple cameras and exposures using software, including AI.

Edited from a phys-l.org posting by John Sohl.

• *Physics in finance: Veritasium's "The trillion dollar equation"*

hhttps://tinyurl.com/WS-VeritasiumFinance
https://www.imdb.com/title/tt1615147/

As a fan of Derek Muller's physics YouTube channel "Veritasium," I was very pleased to watch his new video presentation on the thoroughly intertwined history of finance and physics. In approachable undergraduate language, this 30-minute video reconstructs the development of the Nobel-prize winning Black–Scholes/Merton financial risk equation, describing how a partial differential equation revolutionized the finance industry by more accurately pricing risk in trading, for example, exchange-traded options (puts and calls on derivatives), over-the-counter derivative securities, securitized debt, and credit default swaps (think about the movie "Margin Call"). Muller also reviews some of the history of scientists and mathematicians dabbling in financial markets, including Sir Isaac Newton's stock losses trying to predict the "madness of people," and Greek philosopher Thales of Miletus successfully buying call options on olive presses in 600 BC. The video presents how call and put options function, plots profit and loss on options, and presents risk equations and the related analyses for trading options as investing tools.

Next, Muller presents Louis Bachelier's late 1800s work pricing options at the Paris Bourse, which introduced the idea of random walks producing normal distributions of probability as his PhD thesis under Henri Poincaré, illustrated in the video with a Galton board. As a physicist working in finance, Bachelier realized that his radiation of probabilities actually reproduced Joseph Fourier's 1822 partial differential equation modeling heat radiation from high- to low-temperature regions. Five years later, Einstein unwittingly would reproduce the mathematics of the random walk in his analysis of Brownian motion and diffusion, supporting the existence of atoms and leading to direct calculation of diffusion constants and Avogadro's number.

Muller then introduces mathematical gambler Jim Thorpe and card counting—using "dynamic or delta hedging" practices to limit risk by owning some stocks (not just options) in some cases, and more accurately adding "market drift" to a random walk. This was later overtaken by the more accurate Black-Scholes/Merton partial differential equation incorporating random walks plus market drift into Bachelier's equation relating prices of contracts to assets, accurately pricing options for trading, and developing whole financial industries. Muller discusses how airlines hedge fuel price risks using Black-Scholes/Merton options trading, and briefly addresses market stability and options. Finally the video discusses Jim Simons's use of big data and machine learning by a team of mathematicians and physicists earning money finding hidden nonrandom movements of the market.

There is a mildly annoying product sponsorship placement in the video, but the video does a nice job of demystifying finance and physics, and should be of interest to our students.