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The Jazz of Physics FREE

The Jazz of Physics.. Stephon Alexander 272 pp. Basic Books, New York, 2016. Price: $17.70 (hardcover). ISBN-13 9780465034994.

Thomas F. Jordan

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BOOK REVIEWS

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The Jazz of Physics. Stephon Alexander. 272 pp. Basic Books, New York, 2016. Price: $17.70 (hardcover). ISBN-13 9780465034994. (Thomas F. Jordan, Reviewer.)

This is a physicist's personal story. It tells how the author's enthusiasms for physics and jazz grew hand in hand and supported each other as he developed understanding and skills for both. Similarity in mathematical structures between music and physics is one theme that runs through the book. A parallel theme is improvisation, learned from jazz and applied to physics research, being ready to make creative contributions, with an ability to play well and to make good choices of what to play.

Human dimensions of physics research are brought out. There are anecdotes about teachers, mentors, and coworkers who helped Alexander find his way into physics, and people who helped him similarly in jazz. Physicists Leon Cooper, Robert Brandenberger, Chris Isham, Lee Smolin, Faye Dowker, Jim Gates, Gerry Guralnik, Michael Peskin, and Joao Magueijo alternate with jazz musicians. Comparisons in the back and forth are insightful and delightful.

The book jacket proclaims the promise of "the secret link between music and the structure of the universe." There is no such thing. Readers may have different opinions about what in the book comes closest. Is it that sound waves from quantum fluctuations amplified by inflation, the first music, helped form the structure in the universe that produced galaxies and stars? Or is it in the analogous ways that symmetry and symmetry breaking determine the character in both music and physics? Or in the differences that resonances make? Or is it how Feynman path-integral quantum mechanics is like a jazz musician knowing all the possible ways a solo can sing out between the points where it begins and ends in the ensemble?

A lot of physics is covered. Sketches of it are provided that support the central story lines. I would not want to try to learn the physics just from what is in this book. It is too thin and goes by too fast. It would be good to read this book along with other reading in cosmology or a course in cosmology. It would add understanding of the motivations and goals of the people involved and the relations between their different ideas and projects.

Stories from the book could enliven the teaching of a course in cosmology; the book's good index would facilitate that. Parts of the book could be good reading for someone going into physics or thinking about it. Parts on different subjects can be read separately. They do not build together to an overall climax. The delight is in the details. The story does not reach a point of conclusion. The author is still young.

The book got me thinking. Is music unique in its potential to relate to physics? During my grade-school years, I took violin lessons from an aunt who taught music at the college level. There were also architects in the family. A drawing board, T-square, and triangles were some of my early toys. I think my tendency to focus on spatial organization has more effect on my work in physics than my sense of music does. I do not try to replace algebra with geometry, but when I do algebra I feel that I'm working with spatial locations, moving things to the places I want them in the equations.

The book quotes Einstein about how important music was to him. Newton was more attentive to architecture and geometry than to music. He felt that in his laws of motion and gravity he was finding and describing a part of God's plan for the universe. He devoted substantial time and effort to deduce and draw a floor plan for the Temple of Solomon, thinking that it must be a model for the universe that would reveal significant aspects of God's plan. He wrote the Principia in the form of classical geometry.

What abilities did evolution create that we use now to do mathematics and physics? If we knew, could we improve our teaching by helping students identify and exercise those primal skills? Brain scans are starting to tell us the areas of the brain that are used and the uses that are related. Professional mathematicians thinking about mathematics use areas of the brain that are the same for different people and are an amplification of sites activated in nonmathematicians by thinking about numbers and space.[1] These areas are not the same as areas used for language. Thinking about different physics concepts uses different sets of brain areas that are the same for different people.[2] Playing or listening to music uses several different brain areas that are used for other things as well. Musician's brains become exceptionally well developed in a number of ways. But there appear to be brain circuits that are just for music.[3]

[1]Marie Amalric and Stanislas Dehaene, "Origins of the brain networks for advanced mathematics in expert mathematicians," Proc. Natl. Acad. Sci. **113**, 4909–4917 (2016).

[2]Robert A. Mason and Marcel Adam Just, "Neural representations of physics concepts," Psychol. Sci. **27**, 904–913 (2016).

[3]Sam Norman-Haignere, Nancy G. Kanwisher, and Josh H. McDermott, "Distinct cortical pathways for music and speech revealed by hypothesis-free voxel decomposition," Neuron **88**, 1281–1296 (2015); Natalie Angier, *New Ways into the Brain's Music Room* (New York Times, New York, 2016).

Tom Jordan is Professor Emeritus of Physics at the University of Minnesota, Duluth. He taught junior-senior and graduate courses in quantum mechanics, electrodynamics, classical mechanics, general relativity and cosmology, and statistical and thermal physics and, with that foundation, worked his way down, reading lots of popular books, and taught cosmology for liberal education. His two books on quantum mechanics have been republished by Dover. His research in quantum mechanics continues.

BOOKS RECEIVED

Exoplanetary Atmospheres: Theoretical Concepts and Foundations. Kevin Heng. 289 pp. Princeton U.P., Princeton, NJ., 2017. Price: $65 (paper) ISBN 978-0-691-16698-8.

Principles of Magnetostatics. Richard C. Fernow. 311 pp. Cambridge U.P., New York, 2016. Price: $140 (hardcover) ISBN 978-1-107-16112-2.

Supersymmetry, Supergravity, and Unification. Pran Nath. 537 pp. Cambridge U.P., New York, 2017. Price: $94.99 (hardcover) ISBN 978-0-521-19702-1.