Special Notes for Cosmology Reading Group

From Zoom meeting 6/17/24 Dave

About What is Real, Adam Becker book. I thought this was a very rich and motivating book .

Next: {Gather up a list of outstanding questions from group}.

Peter's suggestion: Classic Book.

The Structure of Scientific Revolutions: 50th Anniversary Edition (and 4th Edition), Thomas **Kuhn** (with new 31 page introductory essay. Total length 256 pages, original 1962, Paperback ~ $14. I went ahead and ordered it for me. CU's Allan Franklin had insisted that we all read that book. Becker mentions **Kuhn** on pg 166 and 181. **Audio Kuhn**: https://www.youtube.com/watch?v=fV-vh9y_TQs&t=27s

And. A suggested book from Barry 6/17 zoom meeting: Chris Bernhardt (Author) Quantum Computing for Everyone, Illustrated Edition Paperback ~$15. Amazon has no sample pages – but I found a few at https://pdfcoffee.com/quantum-computing-3-pdf-free.html

The free online course in Bohmian mechanics has moved to here:

[Towler] About Mike Towler: { https://vallico.net/mike_towler/} , "Pilot-wave theory, Bohmian metaphysics, and the foundations of quantum mechanics," 2009, COURSE: see lectures and slides section under https://casinoqmc.net/pilot_waves.html Cambridge UK with eight sessions of slides.

If you read the prose around the equations in the slide lectures, it is very rich in philosophy, history and physics. {Versus: Textbooks on Bohmian mechanics that are very expensive $$}.

... led Bell to his famous inequality which - contrary to popular belief - can be taken as evidence *for* the pilot-wave theory, rather than as a disproof of it.

… Nonlocal Lorentz-invariant Wheeler-Feynman electrodynamics is a good counterexample to Lorentz invariance requiring nonlocality.

I've always wanted **audio/video** of the great physicists but haven't had much luck finding old ones: Here are some newer ones. Quantum Theory, Consciousness & the Implicate Order, **David Bohm** https://www.youtube.com/watch?v=_wy9kS8ob2Y , https://www.youtube.com/shorts/piRr3BGx51k

Erwin **Schrödinger** - "Do Electrons Think?" (BBC 1949)
https://www.youtube.com/watch?v=hCwR1ztUXtU

Interview with Yakir **Aharonov** https://www.youtube.com/watch?v=oGdHLlPW9ps

John Bell video interview "**John Bell** - Indeterminism and Nonlocality (1990)" He died 10/1/1990.
https://www.youtube.com/watch?v=3l9HtG-VZCU (fuzzy, but more clarity at 29 minutes).

Niels Bohr Audio: https://www.youtube.com/watch?v=in_0q09Dj0k hour "Niels Bohr - Atoms and Human Knowledge (Public Lecture 1957)." A pleasant middle tone but stumbling gate. Maybe he is smoother in German or Danish.

Werner **Heisenberg** speaking about atomic physics in German
【AI colorized】https://www.youtube.com/watch?v=CvZayXHvJm0

Interview with Louis **de Broglie**, 1967 (French with English Subtitles)
https://www.youtube.com/watch?v=stRrf4DB_3Y&t=97s

We wanted a nice example of Bell's theorem – better than the Becker Roulette wheels example, so:
I found the classic Scientific American proof of Bell's theorem "The Quantum Theory and Reality," Bernard d'Espagnat. 1979, 23 pages.
https://static.scientificamerican.com/sciam/assets/media/pdf/197911_0158.pdf

Another one: https://courses.physics.illinois.edu/phys419/sp2018/lectures/Lecture19.pdf
Bell's inequality. The quantum world is stranger than we can imagine. {some similarity to the roulette wheels example in Becker}.
Also: **American Journal of Physics (teaching, AJP): https://fisicapaviaeducational.it/wp-content/uploads/2017/04/AJP.pdf** "A simple proof of Bell's inequality," Lorenzo Macconea)
& https://faraday.physics.utoronto.ca/PVB/Harrison/BellsTheorem/BellsTheorem.pdf

Our BOOK:
p 18 **Measurement** Problem? Wikipedi: "In quantum physics, a measurement is the testing or manipulation of a physical system to yield a numerical result." This has never been perfectly clear to me because many measurements result in a "collapse" along with the destruction of a photon – it is gone! But, the "projection" of an electron spin into a Stern-Gerlach spin-up state is also called a measurement even though it may not yet be detected and can have more future projections (present information has not yet presented to an "observer.") A helpful definition is: "an interaction with an external object whose outcome is dependent upon the value of the state." – a change of state.
P 24: Einstein made the **aether** go away? Dogma. Lorentz version still works as a separate interpretation, and Bohmians like it. And, in 1915, Einstein decided he had been premature about dismissing it because the space-time metric $g_{\mu\nu}$ has qualities of an aether. Both Einstein and Dirac continued to play with the aether idea for decades. Positivism didn't want anyone talking about that.
P 36: now that we have femtosecond lasers, we can see quantum jumps and chemical reactions as gradual transitions. (Nobel Prize)
P 110: Bohm theory nonlocal – each particle in "configuration space" depends on what the other particles are doing (because they are entangled). Also Schrodinger waves functioning for more than one particle are in configuration space. That makes it very hard to talk about a single particle's wave, and that was a very important reality concern for Schrodinger. But Zeilinger did experiments to show how despite being hidden, it can still reveal itself via statistical data correlations.
P 148 **Contextuality** is important – never been clear (to me) until now – as mentioned in Zoom:
Comment on Contextuality in quantum mechanics: Phillippe Grangier (smooth step-by-step introduction) https://arxiv.org/pdf/2406.05169 "The Two-Spin Enigma"
P 206 Clauser Experiment: excited Calcium atoms do a two-step double decay from $4p^2 1s^o$ to $4s^2 1s^o$ with two photons having the same angle of polarization: a $|\Phi^{\pm}\rangle = |0,0\rangle \pm |1,1\rangle$ Bell state. Clauser's overall struggles are fascinating (and then a Nobel prize).
P 229 DECOHERENCE an example is the buckyball double slit test interference visibility.
https://www.researchgate.net/publication/251170703_Wave-particle_duality_of_C60_molecules

267 **Zeilinger**: For his Nobel prize see
https://www.nobelprize.org/prizes/physics/2022/zeilinger/lecture/

A list of 554 of his publications: https://www.iqoqi-vienna.at/fileadmin/Institute/IQOQI-Vienna/IMG/team/zeilinger-group/Publications_Anton_Zeilinger.pdf --from 1971 to 2024 I'd sure like to see them summarized by importance sometime.