Gravity's Shadow: The Search for Gravitational Waves FREE

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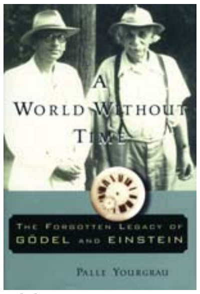

Everyone has been trying to make a buck during this celebratory year. True, Einstein and Gödel both stayed at the Institute for Advanced Study in Princeton, New Jersey, and because Einstein did not like to speak English, he naturally turned to his Austrian-born colleague and shared walks and conversations with him. But Yourgrau blows that contact way out of proportion, into a cosmic friendship. It simply wasn't so. Sorry. Pressed by his publishers, Yourgrau tried to keep the book on a popular level; thus almost no topic receives more than half a page of discussion. Anticipating readers' rather short attention span, with the publisher wisely setting the slim book in huge print, the author races through Vienna coffeehouses, Hilbertian mathematics, the Fregean logics, logical positivism of the Vienna Circle, Wittgensteinian philosophy, Heisenberg's uncertainty relations, the special theory of relativity, and as a bonus, the general theory of relativity and gravitation.

Nothing can be gained from this whirlwind tour except, perhaps, enough hearsay for small talk at the next party. For example, did you know that Gödel used to hide behind the furnace in the basement of his house? Did you know that he wore warm clothes even during the hottest summer, and that he ultimately died of malnutrition, caused by his paranoia? Is this what you always wanted to know? I doubt it. Aren't there any more serious topics in Yourgrau's book? Oh, yes. In order to explain Gödel's incompleteness theorem of 1931, Yourgrau actually invests more time (does it still exist?), but the reader is wisely advised not to be intimidated and, if bored, to just skip the hardly comprehensible technicalities: "You can admire the music without attending to the words" (page 59). Then why bother to read anymore at all?

The book's main thesis is simply balderdash. Yourgrau claims that Gödel proved time to be nonexistent (page 6): "He would make time disappear." How? Just because one solution of Einstein's field equations found by Gödel does allow closed timelike curves? The author's statement is a sensational blowup and ripe for the shredder. Yourgrau scolds Stephen Hawking for demanding that proper solutions of the field equations not exhibit the time-travel feature, yet nowhere does Yourgrau say that the Gödel solutions are simply inapplicable to our universe. All the above statements are made for the sake of sensationalism and allegedly to rescue Gödel from obscurity; the whole last chapter is a strange defense of Gödel against other philosophical interpreters of the mathematician, as if the broader public were interested in Yourgrau's excerpts of talks and quibbles at obscure philosophy conferences in Helsinki, Finland. I wonder how many readers will make it that far in the text.

Keen readers should look into *Kurt Gödel: Collected Works* (Oxford U. Press, 1986–2003), edited by Soloman Feferman and colleagues, if they want better information about his research. Biographies that are more straightforward than Yourgrau's include John W. Dawson Jr's *Logical Dilemmas: The Life and Work of Kurt Gödel* (A. K. Peters, 1997) and Torkel Franzén's *Gödel's Theorem: An Incomplete Guide to Its Use and Abuse* (A. K. Peters, 2005).

Not to be forgotten in *A World Without Time* is the author's take on the role of philosophers. Yourgrau outs himself as a philosopher but recommends, if you too are one, not to let anyone know, so as to avoid being caught up in embarrassing questions about the hows and whys of the universe and all the rest. It's better to say you are an architect, and leave it at that (page 164). Well, he must have had bitter experiences, and we all understand why by now.

Three of the book's seven illustrations gratuitously feature Gödel with his wife, Adele, a former nightclub dancer. If you can resist that temptation as well, don't get *A World Without Time*, and save yourself a lot of time—it does exist after all, and time is money, according to the pragmatists—money better spent elsewhere.

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Gravity's Shadow: The Search for Gravitational Waves

Harry Collins
U. of Chicago Press, Chicago, 2004. $100.00, $39.00 paper (870 pp.). ISBN 0-226-11377-9, ISBN 0-226-11378-7 paper

Gravity's Shadow: The Search for Gravitational Waves, by Harry Collins, is an account of the experimental search for gravitational waves, from the quest's beginnings around 40 years ago to the very recent past. Collins, a research professor of sociology at Cardiff University in the UK, is particularly concerned with the sociology of doing science and the growth from small-scale research to some of the current large-scale research projects. He also covers many aspects of the development and interpretation of gravitational-wave research in unprecedented detail. The book is impressive and contains material that will interest many scientists and other readers.

The book's 900-page mass may be a deterrent to some, but even individual chapters are unusually engaging. The gravitational waves referred to in Collins's book are traveling disturbances in spacetime, believed to be generated by accelerating masses in such astrophysical phenomena as a supernova outburst or a rapidly rotating and slightly asymmetrical neutron star. Gravitational waves are a long-standing prediction of Albert Einstein's relativity theory, but the expected observable effects on Earth are so minute that some physicists had thought these effects to be practically undetectable. Detection of the waves could be very valuable as a new tool for studying astrophysical processes, particularly those hidden by the absorption of the electromagnetic or other radiations emitted.

In the 1960s, Joseph Weber began publishing results of experiments involving measurements of small vibrations in large, isolated aluminum bars. He claimed some of the vibrations he observed were caused by gravitational waves. His claims stimulated a first generation of experimental attempts around the world to detect gravitational waves. A careful account of Weber's work, and of related experiments and interpretations elsewhere, forms an important part of Collins's book. The author describes interviews he had with Weber up to the physicist's death in 2000, as well as those with Weber's former graduate student Joel Sinsky, who provides some interesting experimental details.

Taken all together, I think the parts of the book that deal with Weber give the best account of his work I have read. The author's experiences with Weber are in good accord with my own. Collins paints a fascinating picture of a scientist who has had an enormously stimulating and overall beneficial influence on the field despite the fact that his interpretations of his own results are now nearly universally regarded as erroneous. Weber's work did demonstrate a possible way of looking for gravity waves, and it triggered the development by other groups of more sensitive versions of bar gravity-wave detectors, including several operating at low temperatures to reduce thermal noise. Experiments that use bar gravity-wave detectors continue, but they are largely being superseded by a different technique using laser interferometers, an approach that is revolutionizing the field.

The basic idea behind the newer approach is to look for the relative motion of two or more separated masses by using a sensitive optical interferometer rather than by studying the two ends of one bar. The advantage is that the masses can be placed kilometers apart so that a gravitational wave induces larger relative motions. The problem, however, has been to obtain the unprecedented sensitivity required from optical techniques. A succession of new ideas, combined with technical developments in lasers and low-loss mirrors and practical laboratory experiments over baselines of tens of meters, demonstrated that the technique would have great promise if expanded in scale. The expansion would require correspondingly large high-vacuum systems, which would increase the overall cost significantly and could change the nature of the research from that of a small research group to that of a larger entity, such as a consortium that constructs and operates a large accelerator.

Such growth did occur in a particularly dramatic way at Caltech, where laser interferometers were being developed. The change had unfortunate effects for all concerned. I was personally involved, having been invited to lead the research at the institute and having originated several of the key optical and other techniques used. In my view, Collins, who devotes a small chapter to that particular situation, has done a careful job of summarizing some of the sociological problems that arose during that time and the overall effects on the management and execution of the research. He has refrained from giving full details but has summarized enough to give an impression of the extent and seriousness of the disturbances that took place. What is more important is the final outcome: The project, called the Laser Interferometer Gravitational-Wave Observatory (LIGO), led by Caltech and MIT, is now a major research endeavor involving several hundred collaborators around the world. It looks as though LIGO, in its current, initial form, has a reasonable chance of allowing researchers to observe gravitational waves.

For the next stage in the project, researchers have proposed plans to further significantly enhance the chances of detecting gravitational waves. Similar or slightly smaller projects in Europe and Japan are in operation, under construction, or proposed.

Gravity-wave detection is a good topic for Collins to use in examining the sociological aspects of certain types of scientific research. The author has done a very careful and responsible job. I do not completely agree with all of his conclusions or interpretations, but that is to be expected in a book of this scale. Although *Gravity's Shadow* is indeed dense, Collins has made it more readable by including anecdotal accounts of his experiences in visiting some of the scientists and experimental sites. He spent many years on his effort, attending numerous specialist conferences and interviewing a large number of the researchers involved. The book will be valuable to readers who desire a detailed account of this growing field and its sociological aspects, and to those interested in the history of science. It will also be helpful to students and others who wish to get firsthand accounts of what experimental physics can be like in practice.

I do not know of any other book quite like *Gravity's Shadow*. Collins has publicly announced his plan to produce a sequel when gravity waves have been unambiguously detected on Earth. I hope he does not have too long to wait.

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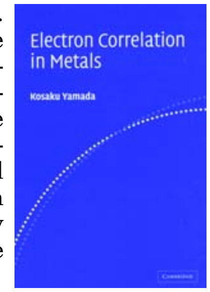
Electron Correlation in Metals

Kosaku Yamada
Cambridge U. Press, New York, 2004. $100.00 (245 pp.). ISBN 0-521-57232-0

Kosaku Yamada's book covers various topics in metal physics in which electron correlations play an important role. Starting with the free-electron gas and Fermi-liquid theory, the author discusses the Kondo effect and the Anderson and Hubbard models, with the goal of describing the physics of heavy fermions and superconductivity in the cuprates, ruthenates, and organics.

The positive features of *Electron Correlation in Metals* are its treatments of diagrammatic techniques for the different topics. The negatives are that the book's discussions are limited to perturbative techniques, without any critical analysis of when that approach may be valid for those same topics.



In the first part of the book, the author introduces the essential formalism of Green functions and response functions and, in chapters 4 and 5, gives much of the algebraic details for the single-impurity Kondo and Anderson Hamiltonians. For the Kondo problem, he also offers a brief discussion of scaling theory.

In the second part, chapters 6 through 9, Yamada turns to models relevant to heavy fermions and high-T_c superconductivity. Unfortunately, this part is where the book has its biggest lacunae: Many aspects of the phenomena are not well understood and are likely beyond the reach of perturbative diagrammatic methods. Yamada, however, seems convinced that a combination of superconductivity mediated by spin fluctuations (FLEX approximation) can describe the entire phenomenology of the high-T_c cuprates.

The beginning sections of chapter 9 are rather flawed and unmotivated. The first section, on high-T_c superconductivity, starts out with "We explain the mechanism on the basis of Fermi liquid theory," which is a surprising statement because the system, in the normal state, shows considerable experimental evidence for a breakdown of Fermi-liquid theory. It is crucial for the reader to recognize that solving the problem of high-T_c superconductivity means understanding the physics of doped Mott insulators in the strong-correlation regime. The book's singular focus of describing electrons that interact via spin fluctuations is really only valid at high doping. In the case of heavy fermions, Yamada does not mention recent developments in non-Fermi liquid behavior near quantum critical points.

Given the fact that beautiful data from angle-resolved photoemission spectroscopy experiments are available, Yamada could have used the information to illustrate the tight binding model and its parameter values in chapter 9. Later in the chapter, the