

Gravity's Kiss

The Detection of Gravitational Waves

Harry Collins

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In February 2016 the LIGO Scientific Collaboration (LSC) published its historic *Physical Review Letters* (PRL) paper describing the first direct observation of gravitational waves, generated by the inspiral and merger of two black holes. As one of the contributors, I was excited to read Harry Collins's account of the discovery. *Gravity's Kiss: The Detection of Gravitational Waves* picks up the story in September 2015, when the signal was first spotted by two postdocs in my research group.

Collins is a sociologist interested in how scientists reach consensus. In the early 1970s, he turned his focus to gravitational waves. After we formed the LSC two decades ago, Collins joined us with a unique goal: to study the zoo of physicists from "inside the cage." He never strayed far from the topic, and has published many papers and three full-length books about different aspects of our search.

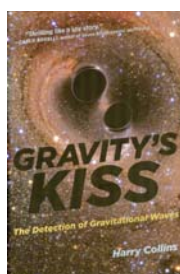
The first 10 chapters of *Gravity's Kiss* chronicle the five months from discovery to publication, but the narrative is so personal that it becomes myopic. Collins is not a historian. The story he tells revolves around his impressions and feelings, skips around in time, and is unbalanced and incomplete. By design or by accident, this is a spotty account.

Collins writes of the dozens of emails exchanged each day. But the LSC has over a thousand members and tens of working groups. The email traffic was two orders of magnitude larger than what Collins describes, and that was the tip of an iceberg. The real work of LSC was done away from Collins, in individual offices and labs, in video conference calls, and in countless face-to-face meetings.

Collins's limited perspective lends itself to misinterpretation and outright error. One example is his discussion of the back-of-the-envelope analysis in the discovery paper, where I appear as "one of the leading members of the community." *Gravity's Kiss* suggests that the analysis was added to the draft in mid-January 2016 and that the controversy

was settled with a handful of emails over the next two days. In fact, the analysis in question was added to the paper draft in mid-November 2015. Subsequent discussions about it extended over two months through hundreds of emails among dozens of people, several dedicated conference calls, and behind-the-scenes work by many.

I had hoped for something better.



Cardiff University, where Collins is a faculty member, has a large and active research group working on LIGO. But Collins never attended their frequent meetings to discuss the ongoing work. Moreover, he never interviewed or talked with any of the six members of the paper coordinating team who forged the consensus expressed in the PRL paper and the dozen companion papers.

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Collins is not a physicist, but a central theme of his work is how physicists become convinced of their own findings. Over four decades he has built up a good understanding of the science and an insider's knowledge of the specialized jargon. But without hands-on contact with the instrument or data, he can only judge if something is correct via human interactions.

For this reason, *Gravity's Kiss* fails to touch the core of how and why we are convinced. Collins observes the superficial aspects of our work, such as the collaboration-wide presentation of draft papers. But he misses the key point: that those involved are reporting first-hand knowledge based on direct personal experience. Over two decades, we designed and built the optics and electronics that constitute the length sensing and control systems. We spent countless hours commissioning the detectors, characterizing subsystems, hunting down and fixing noise sources, and writing and testing the analysis codes that found and characterized the events. All of that is absent from Collins's own experience and from his analysis.

Collins sometimes adopts the point of view that science is a matter of social convention and agreement. I do not agree. I

believe that other intelligent beings in the universe know that $2 + 3 = 5$ and that a proton has about the same mass as 1836 electrons. Although I realize that social conventions play a role in how we discover the truth, I believe that the natural world and its laws exist independently of us.

The final four chapters address the aftermath of the discovery, its reception by the scientific community, and the transition of gravitational-wave science from speculative to real. For many of us, the discovery was deeply satisfying, but for Collins it was tinged with disappointment. The black holes that merged were a factor of two closer than necessary for confident detection; the strength and clarity of the signals and their match to prior theoretical predictions were entirely convincing. So Collins was cheated of the interesting and instructive debate that he had spent his lifetime preparing for.

Instead, Collins goes to great lengths to criticize our decision to keep the discoveries a secret until publication. I personally did not agree with all aspects of that decision. For example, as a member of the detection committee I argued that the second unambiguous "Boxing Day" event we observed should have been

mentioned briefly in the *PRL* paper. But I disagree that this was a "deception" whose real purpose was power and control. Collins was satisfied that the event was real within a few weeks. But he did not coauthor the papers, and those of us who did needed time. The credibility of a claim has a lot to do with the details. If they are incorrect, or not internally consistent, it indicates a lack of critical thought and reflection that makes the findings less credible.

Collins chides the LSC for "relentless professionalism" because getting the details right slowed down publication of the results. But his book would have benefited from more of that obsession. Despite my initial excitement, I found *Gravity's Kiss* quite difficult to finish. I think that is in part because of the shortcomings I have described and in part because of the abundant typos, the endless quotations from Collins's previous books, and the long-winded prose.

Gravity's Kiss chronicles an important scientific event and captures the excitement and debate that ensued. But if sociologists want physicists to take them seriously, they need to do better than this.

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Introduction to Modern Magnetohydrodynamics

Sébastien Galtier

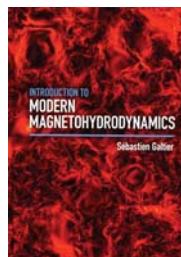
Cambridge U. Press, 2016. \$74.99 (288 pp.). ISBN 978-1-107-15865-8

Magnetohydrodynamics, or MHD, is the study of electrically conducting fluids, usually plasmas or liquid metals, in which the magnetic field plays a dynamical role. Hannes Alfvén's Nobel Prize-winning research in the 1940s showed that in a highly conducting fluid, magnetic field lines impart elasticity to it through the Lorentz force. MHD has a wide range of applications in geophysics, planetary science, and astrophysics, and it is also of great importance for magnetic confinement fusion and metallurgy.

Sébastien Galtier's textbook, *Introduction to Modern Magnetohydrodynamics*, offers a wide-ranging, general primer on

MHD and its various applications. Derived from a graduate course taught by the author at the Université Paris-Saclay, the book is well suited for graduate students in physics, mathematics, and engineering. Many sections are accessible to advanced undergraduate students in those disciplines as well, but some topics in the second half of the book, and many of the exercises, are more suitable for graduate students.

Introduction to Modern Magnetohydrodynamics is divided into four parts, each of which is followed by a modest number of useful exercises with worked solutions. The book contains a generous



helping of diagrams and graphs that illustrate the text's concepts and results. A wealth of photographic images and snapshots from numerical simulations help to illuminate MHD's historical background and its various applications.

In part 1, "Foundations," Galtier introduces the physics of plasmas and derives the basic equations of MHD. He shows how those equations imply conservation laws for mass, momentum, energy, and helicity, and he discusses the consequences of the induction equation for the preservation of the flux and topology of the magnetic field. The Hall effect is included here because of its importance at length scales smaller than the ion inertial length.

Part 2, "Fundamental Processes," begins with a discussion of linear magnetohydrodynamic waves. In addition to the classical Alfvén and magnetosonic waves, the author describes the whistler, ion-cyclotron, and kinetic Alfvén waves