

The Lyman-alpha line arises from re-forming hydrogen that had been ionized by radiation from the first galaxies, and so it probes the interaction between stars and their surrounding gas.

However, the complexity of interpreting the Lyman-alpha and 21-cm signals belies their humble origins in simple transitions of nature's most abundant element. The many radiative-transfer effects that alter the shape and strength of the lines as the photons pass from the galaxies, through the IGM, and into our telescopes are covered in enough detail to equip readers with a good working understanding of how the lines are produced and interpreted. That material is a valuable resource for students entering the field and looking ahead to the day, sometime later in this decade, when new facilities will apply those techniques on a massive scale.

True to its aim, the book introduces the relevant observations throughout. Particularly in its discussion of the Lyman-alpha and 21-cm techniques, the promised bridge to observations is soundly built and, for a fast-moving field, impressively up to date. By contrast, other promising techniques for detecting and understanding the first galaxies receive only bullet-point treatment. Just the last seven pages of the text concern the rich "fossil record" of the first heavy elements and the early mass function of stars preserved within long-lived stars in the nearby universe. The "ultra-faint" dwarf galaxies on the outskirts of the Milky Way, believed by many astronomers to be preserved remnants of the first galaxies themselves, are mentioned only in passing. Coverage of constraints from microwave and IR radiation backgrounds is also cursory. That matters because all those approaches provide insight into physical processes that are critical to the formation of the first galaxies but invisible in the hydrogen emission that is so thoroughly described.

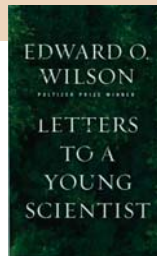
Students looking for an introduction to complementary avenues to the first galaxies will have to look elsewhere. But despite those omissions—the book's only real flaw—graduate students or senior undergraduates will find *The First Galaxies in the Universe* a thorough introduction to the topic. Interested professionals will find it a helpful entry point to the specialist literature on one of the most exciting frontiers in astrophysics.

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Letters to a Young Scientist

Edward O. Wilson
Liveright/W. W. Norton, 2013.
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Ant expert Edward O. Wilson alternates between autobiography and wise counsel to the readers of his *Letters to a Young Scientist* in order to convince them that they made the right choice. The book's primary intended audience is undergraduates or graduating high school students who have chosen to pursue science but remain doubtful that they can make a career of it. Wilson's prose appears to be in deliberate contrast with scientific biographies that emphasize the uniqueness and sometimes the peculiarity of their subjects; that type of biography may discourage readers away from science. By instead presenting his life to engage the reader's empathy, Wilson aims to encourage young people to pursue science. (The need for more young scientists can hardly be overstated.) He's quite convincing, successively demolishing many legitimate fears through charming anecdotes from his career. He is also remarkably modest, given his own accomplishments as a distinguished professor at Harvard University and a two-time Pulitzer Prize winner.

Letters to a Young Scientist is not merely a collection of platitudes. Perhaps the most persuasive sections are those in which the author challenges popular perceptions of what is needed to become a scientist. One example that might arouse some controversy in the physics community is the question of how much mathematics is needed for a scientist to be successful. Wilson argues—indeed, elevates to the level of a principle—that for any level of mathematical aptitude, an appropriate scientific discipline exists in which an aspiring scientist can succeed.

Conceding that physics and similar disciplines are inevitably quantitative, Wilson advocates that scientists in other, more qualitative disciplines collaborate with statisticians and mathematicians when they need to. However, I have found that even among physics majors, students' perceptions of their aptitude in math are often unduly negative. And judging from the reported problem of poor statistics in fields like medicine, there seems to be a need for better education in quantitative methods.

Wilson could actually have gone further and acknowledged that even within physics the level of mathematics required to succeed in particular subfields varies considerably. That variation is reason for theorists like me to work with others with different and equally valuable skills. But Wilson's advice might be unduly limiting in physics, given the successful efforts to improve pedagogy, notably through physics education research.

Perhaps the only really jarring section begins with the observation that "real scientists do not take vacations," which their significant others might be crestfallen to hear. Moreover, it's untrue. In some sense, I know what he means. For example, while cycling through the dunes of Cape Cod in Massachusetts last summer, I couldn't resist getting off my bike to inspect some moss that looked bioluminescent. It's hard for those of us who are passionate about science to switch off. But what concerned me was Wilson's immediate juxtaposition of that statement with his advice to seek jobs that minimize the required amount of teaching. That advice may resonate with some, but I dislike the implication—even if unintended, coming from a skilled lecturer—that real scientists don't like to teach.

Beyond the obvious audience, there is certainly value in the book to those further along in their careers. Many of us are tasked with teaching and advising students outside our field, so Wilson's ideas and stories could be a resource to help us do so effectively. Moreover, it's easy to find one's enthusiasm for science rekindled by the letters. I wrote this review in the middle of grant writing and during the October 2013 government shutdown; both experiences are likely to challenge the most committed person's perception of the glamor offered by the life scientific. Yet Wilson's fascinating descriptions of how careful experiments have uncovered the details of ant communication and social behavior proved a welcome antidote.

I hope that *Letters to a Young Scientist* will inspire other scientists to tell their own stories in a similar manner. The book, not surprisingly, focuses on biology, but much of the advice is transferable. Still, there certainly remains room for a book that specifically encourages students, particularly those from currently underrepresented groups, to pursue physics.

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