Review
of
Quantum Optics
by
M. Scully and M. Suhail Zubairy

I read this book to teach myself quantum optics. Since I read it as a self-study text, I will review it from that perspective.

I didn't find this to be a good pedagogical book. It is the first quantum optics book that I read, and I didn't get much out of it. Thinking that perhaps the problem was inadequate background, I then read from cover to cover Elementary Quantum Optics by Gerry and Knight. Although there are some problems with the latter which are addressed in a separate review, it did make more sense.

With Gerry/Knight under my belt, I returned to reread Scully/Zubairy. It didn't make much more sense the second time than the first.

The presentation of Scully/Zubairy is often sloppy and too diffuse. Like too many physics texts, it doesn't always carefully define all its symbols, and it frequently sneaks in important assumptions without explicit mention. It demands a lot of guesswork from the reader.

For example, Chapter 1 tells us that

"as we will discuss in [Chapter 4], the probability of exciting an atom ... is governed by [formula (1.5.12)]".

This is a crucial formula, one of the most important in the book. If the reader turns ahead to Chapter 4, he does reassuringly find it in equation (4.2.4). The impression given is that it has somehow been derived in the intervening 100-odd pages. But it hasn't, so far as I have been able to discover.

Is this crucial formula a new assumption of quantum optics, or does it somehow follow from established quantum-mechanical principles? The reader is left to guess. Readers who are satisfied to accept unmotivated statements on authority may be happier with this book than readers who seek a fundamental understanding of the logical structure of the subject.

I was particularly interested in the Hanbury Brown and Twiss experiment treated in Chapter 4, so I read that chapter particularly carefully. Indeed I read it very carefully several times, but I was forced to consult other sources to understand this experiment. I think that the text's treatment omits important, non-obvious assumptions and contains some errors. However, study of other sources finally convinced me that the text's final result, equation (4.1.26), is probably correct. (Incidentally, I think that the treatment of this important experiment in Gerry/Knight is also inadequate).

Figure (4.6) which purports to be a diagram of this experiment contains a component which produces a "delay time", but the text's analysis never explains the purpose of this component. From other sources I've learned that the delay

time is extremely important for some variants of this experiment. This is fairly typical of the text's haphazard approach.

Chapter 20 discusses a "quantum eraser" experiment whose result is so startling that Scully and Zubairy cite Jaynes as considering it a paradox, a "violent irrationality" (as Scully and Zubairy paraphrase Jaynes). It certainly seems that way to me, and I would very much like to understand this experiment better.

Scully and Zubairy never make clear if this is an actual experiment which has been performed, or a "thought experiment". Surely the exposition of such remarkable claims should be more explicit.

They present a calculation which is claimed to "resolve the 'Jaynes paradox'". I was disappointed that I could not follow this calculation because its exposition is far too vague. In particular, they obtain their main result, equation (20.3.5), under the assumption that "the interaction Hamiltonian ... depends on symmetric combinations of the field variables, so that only the symmetric state ... will couple to the fields". This might be convincing if they had ever defined their "interaction Hamiltonian", but the reader is left to guess at which interaction Hamiltonian they might be using.

I cannot recommend this book for readers who are not experts in quantum optics. I cannot judge whether it might be useful to experts.