1 Introduction

What's a "Crazy" Idea?

Have you ever wondered why so many of the ideas in modern science sound so crazy, and how to evaluate which of the current crop of crazy ideas might be true? This book will show you how you can sort out the more promising ideas without having to rely on the opinions of experts. As a physicist, I have always had an affinity for crazy ideas. Please don't misunderstand me. It's not that physicists are any crazier than anyone else. Despite the many unfortunate media portrayals of mad scientists you may have seen, some of us are reasonably sane. It's just that physics, by its very nature, is continually challenging the conventions of our commonsense world and revealing secrets about our universe that often seem fantastic to most people. Even physicists sometimes find their creations quite bizarre. One of the leading developers of ideas in modern quantum mechanics, Richard Feynman, used to tell students that they shouldn't worry too much if they don't understand quantum mechanics because it is so paradoxical that nobody *really* understands the subject. In fact, it's when you think you finally do understand quantum mechanics completely that you have probably got it wrong.

But, even the weirdest theories of science must pass one rigorous test or be discarded: their predictions must be in agreement with phenomena observed in the physical world. Well, at least that's the ideal. Sometimes developers of new theories find ways to modify the theories in order to keep them alive, even when their initial predictions don't work out. And sometimes scientists concoct theories incapable of being tested in their lifetime, or without the expenditure of billions of dollars to build the apparatus needed to test their ideas. (Despite the eagerness of scientists to promote employment opportunities for their unemployed colleagues, theorists do not intentionally seek ideas that will prove very expensive or difficult to test. It's just that most of the easy stuff has already been done.)

Scientists who develop crazy new theories have a strange relationship with their creations. On the one hand, they wish to promote them and convince their colleagues of the theory's validity—and possibly win fame, fortune, and respect in the process. Yet, in order to accomplish this goal, the developer of a new theory must do everything possible to prove the theory is *in*correct, find its flaws, and even make any weaknesses known to the community. Of course, this is the ideal situation. In reality, when it comes to their own pet theories, some scientists may act more as promoters than flaw-finders. But such actions often backfire among colleagues, who can be counted on to subject the new ideas to especially severe scrutiny.

Revolutionary new ideas in physics and other sciences are rarely accepted immediately by the scientific community. The high threshold against the acceptance of startling new ideas is not simply a matter of a resistance to change. The existing theoretical framework in most sciences was developed after passing many tests, and it should not be abandoned casually unless we are literally forced to do so because of conflicts with new observations. In contrast to the postmodernist view of science as a somewhat arbitrary collection of beliefs and methods, most scientists believe that science can progress to more correct conceptions of the physical universe. But, in order to progress to more valid theories, scientists cannot afford to abandon working theories without compelling evidence of their deficiency.

Not all theories can be proven right or wrong—some are simply untestable, or "unfalsifiable." Here are three examples of untestable theories: (1) inanimate objects have feelings, but they have no way to communicate them; (2) faster-than-light particles exist, but they have no interaction with ordinary matter; and (3) the world is only about 5,000 years old, but it was created to look as if it were 4.5 billion years old. We may choose to believe or disbelieve such untestable ideas, but they are outside the realm of science because they are not falsifiable.

The great majority of strange ideas that are testable are simply wrong. For every crazy idea that leads to a great revolutionary breakthrough, there probably are thousands that lead to blind alleys. Unfortunately, it may be only in retrospect that we can determine in which of these categories a new idea belongs. Science is forever a work in progress, so that scientific truth is always provisional (subject to future testing by experiment). Although there is no sure way to tell if a new absurd idea is right—in fact, no scientific theory can be *proven* correct—there are questions we should ask ourselves that may help sort out the more promising ones. Some key questions follow.

How to Tell If a Crazy Idea Might Be True

1. Is the idea nutty? I make an arbitrary distinction between the categories of "nutty" and "crazy" ideas. According to my definition, crazy (also: fantastic, weird, bizarre, strange, absurd) ideas are inconsistent with scientists' present theories and may have a bizarre element to them; but unlike those in the nutty (also: flaky, wacko, loony, ridiculous) category, they are not inconsistent with the most fundamental principles of nature, such as the law of conservation of energy, nor are they incoherent or internally inconsistent.

2. Who proposed the idea? This one is tricky. Sometimes scientists in a particular field may gain a reputation for being mavericks who continually come up with oddball theories. This fact should not be a deterrent to carefully examining their ideas, unless the ideas often fall in the nutty category. Crazy new ideas sometimes come from outsiders who may bring a fresh perspective to a field. Entrenched leaders in some fields may have developed a reliance on a collection of generally accepted assumptions and rules of thumb, without any firm underlying theoretical basis. In such cases, it is important that outsiders do their homework and become aware of what is really known and not known. Only very rarely can outsiders who are complete amateurs do their homework well enough to make a contribution to a highly developed field of science.

Conversely, you shouldn't be overly impressed if the proposer of a crazy idea has eminent scholarly qualifications—even including a Nobel Prize. Sometimes Nobel laureates venture into fields far from their original area of expertise, and they may feel free to develop provocative ideas, which other less eminent (but perhaps more knowledgeable) scientists would not pursue. One infamous example would be the theory that intelligence is a genetic trait of races, and that the differences between blacks and whites on IQ tests reflect these genetic differences. This theory was promoted by William Shockley, who shared the Nobel Prize in Physics for developing the transistor. Needless to say, Shockley's expertise in physics gave him no special insights into the basis of human intelligence, although it may have given his theory more visibility than it deserved.

3. How attached is the proposer to the idea? When proposers of crazy new ideas are rebuffed by their peers, they sometimes develop obsessions about their idea and refuse to abandon them, even when proven to be incompatible with observation. The negative reaction of peers stimulates the proposer to do everything possible to prove colleagues wrong, even if it means being insufficiently critical about the merits of the idea itself. A key indicator here is the proposer's selectivity in paying great attention to facts that may support the idea, but paying scant attention to facts that refute it.

4. Does the proposer use statistics in an honest way? According to the Nineteenth-century British prime minister and novelist Benjamin Disraeli, "There are three kinds of lies: lies, damn lies, and statistics." Statistical claims are often made in support of theories that are completely erroneous, either because of deliberate falsification, unconscious bias, or ignorance in the proper use of statistics. One needs to be continually on the lookout for such misapplications of statistics. This is probably the surest way to spot crazy ideas that are wrong.

5. Does the proposer have an agenda? Some areas of science are far removed from politics, but others are not. In particular, in such areas as the environment and human health, the political biases of proposers may play a large role in how honestly they deal with a controversial idea. In such cases, the source of the researchers' funding may supply important clues as to their political biases. Proposers who are strongly motivated by political biases often put forth ideas that uniformly fall into one particular ideological category, such as liberal or conservative.

6. How many free parameters does the theory contain? Physicists sometimes say that with enough free parameters, they can "fit an elephant." The fewer free parameters a theory contains, and the more specific its predictions, the more confidence we can have in it if those predictions should come true. A theory with a great many free parameters may be able to adjust those parameters to obtain agreement with experiment, no matter what the outcome.

7. How well is the idea backed up by references to other work? Some proposers of new controversial ideas tend to cite heavily their own previous work and ignore related work done by others. Science is built progressively on the work of many scientists. As Isaac Newton wrote in 1675, "If I have seen further it is by standing on the shoulders of giants." It is not sufficient that a theorist demonstrate familiarity with other relevant work and cite it in any publication. We must also verify that the cited references, in fact, state what the proposer claims, and the degree to which it is claimed. We should be highly suspicious when the proposer of a new theory claims that others have demonstrated something, when the references cited in fact make no such claim or perhaps merely suggest it *could* be true.

8. Does the new idea try to explain too much or too little? Some crazy ideas purport to explain virtually everything in a given field, but in the process they invoke a number of new concepts or raise even more unanswered questions than they answer. A theory of everything that cannot actually calculate anything, or make definitive predictions that allow it to be tested, does not seem very promising.

9. How open are proposers about their data and methods? In many fields, particularly those where patents and potentially large sums of money are at stake, researchers may be secretive about their data and methods—at least until their results are published. Even when monetary motivations are absent, researchers may still be secretive initially so they can be sure to establish their priority involving some important discovery. But in other cases, when researchers remain highly secretive even after their results are published, they create the impression that they have something to hide, and would prefer that others not try to replicate their results.

10. How well does the idea agree with common sense? I just put this one in to trick you! Common sense, while it may be a good guide for coping with everyday life, is not a good guide for deciding whether strange theories might be true. Einstein came up with relativity theory only by rejecting many commonsense views of space and time that turned out to be inapplicable to the realm of very high speeds, of which we have no experience in our everyday life. On the other hand, certain precepts of common sense may serve as a very good guide—for example, we could ask if there is a much simpler explanation than the one given by the proposer. If someone were to claim that his ability to walk on a bed of hot coals without getting burned demonstrates the existence of some extraordinary psychic power, we should have grave doubts. The laws of physics offer a simple explanation for this phenomenon without invoking any psychic power. The idea of finding the simplest explanation for a set of facts is known as applying "Occam's razor," named for the fourteenth-century English philosopher William of Occam. If two theories purport to explain some phenomenon, it is reasonable and economical to choose the simpler of the two, *other things being equal.*

The preceding questions aren't the only tests one can use to separate the wheat from the chaff when we try to make sense of highly controversial or crazy ideas, but they are a good start. We will try to use these techniques in sorting through some of the crazy ideas in this book. A big part of the fun in going through a crazy idea is trying to figure out for oneself how likely it is to be true. With most of the ideas in the book, I do have a definite opinion, but I will try not to reveal it too soon so that you can make your own assessment. I won't reveal here what fraction of the crazy ideas I ended up supporting or opposing. However, at the end of each chapter I do give a completely subjective estimate of the probability that the idea is true. I have also provided a table in the epilogue to the book giving my rating for each of the nine ideas. You will also find listed here my subjective rating scheme of zero to four "cuckoos."

Why This Particular Set of Crazy Ideas?

Many ideas in science seemed crazy at one time but are now regarded as being settled, either having been laid to rest (as in the case of cold fusion) or firmly established (as in the case of plate tectonics, which grew out of an earlier "crazy" theory of continental drift). The boundary that separates the "settled" from unsettled controversies is probably a blurry one, as the existence of die-hard adherents of cold fusion demonstrates. Nevertheless, I wanted to explore here crazy ideas involving scientific controversies that are far from being completely settled.

Although I am a physicist, it seemed worthwhile to cover a wide range of ideas in various scientific areas, particularly issues relating to the environment and human health—two areas of great public concern. (Crazy ideas in the areas of health and the environment are covered in chapters 2 through 5, while those in the area of the physical sciences are covered in chapters 6 through 10.) The human health category had its own particular challenges. Nowadays we are used to so many reversals in what is considered good or bad for us that it was difficult to come up with something really outlandish that could also be true. Regarding possible topics in the social science area, there are many crazy ideas that one should approach only with great trepidation. The one I chose was the hot-button issue of guns and gun control. As it turned out, my analysis of the research on this particular issue put me on the opposite side from where I started out politically.

Virtually all the ideas in this book involve crazy ideas in the sciences, including the social sciences. There are lots of other crazy ideas in other areas that one could have looked at, but the nice thing about ideas in the sciences is that they can be supported or refuted by data. That's part of the point of this book: to help you develop methods—through the use of lots of examples—whereby you can learn how to test the validity of crazy ideas by carefully analyzing the data supposedly supporting them.

In the interest of full disclosure I confess I have a strong affinity for one of the nine crazy ideas: I have done some original research on the subject of tachyons—hypothetical particles that travel faster than the speed of light. Because of this research, I would be extraordinarily pleased if tachyons actually do exist, and my predictions as to how to confirm their existence should bear fruit. Thus, I cannot claim to be completely objective on that particular idea. Nevertheless, even though I may be a tachyon enthusiast, I have also tried to be a tachyon critic, searching for flaws and weaknesses wherever they exist. (In a number of cases, my opinion about an idea's validity changed more than once while looking into it.)

This book is intended for the general reader who has an interest in science. Most of the chapters require little math background, but the last two are probably the most challenging in that respect. Because the topics are essentially independent of one another, feel free to read them in any order. This book could conceivably also be useful in a college-level course on "Crazy Ideas in Science." The point of such a course would be not simply to explore the ideas—as interesting as some of them might be—but more importantly, to develop techniques to better sort out what credence to give controversial claims. Such a skill is crucial in helping an informed citizenry examine rationally the key science and policy questions that face us as a society. For the good of society, we should base policy choices on the best science available, whether or not it happens to agree with what we wish might be true. In this age of the information superhighway, it is no longer possible to take the position of the nineteenth-century bishop's wife, who upon learning about evolution, remarked: "Oh, my dear, let us hope that what Mr. Darwin says is not true. But, if it is true, let us hope that it will not become generally known." If you're ready for a wild ride through the wacky world of weird science, put on your thinking cap, and fasten your seat belt.