

Introduction

A mug sits on the table. It looks reassuringly uneventful, especially when it is holding hot tea. Yet its particles are busy, it exchanges heat with the room, and the world around it keeps changing. Through all that activity, it remains a mug. We normally take this for granted and get on with breakfast. This book asks what makes that ordinary achievement possible.

We are used to describing a universe made of things. Atoms make materials, stars gather into galaxies, and objects interact. It is a useful picture. My starting thought is that a thing may itself be a pattern of relationships that keeps going through change. Phase Differential Theory, or PDT, explores that possibility and asks whether it can also help explain how particular events happen.

What phase adds to the picture

Phase tells us where something is in a repeating cycle. Picture two swings moving backwards and forwards. They may reach the top together, or one may be part of a swing ahead. Comparing their positions within the cycle gives us a phase difference. In physics, such comparisons help explain how waves strengthen or cancel one another when they meet.

PDT asks whether these relationships could help build the physical things we usually start with. Perhaps an object lasts because its repeating activities maintain a dependable pattern. That does not mean everything must move together. The question is whether the relationships can keep working as conditions change. Later chapters will make the idea more precise, one step at a time.

This is a substantial proposal. Giving phase a central role is useful only if it helps explain the world we measure. I am interested in whether the conditions that let an object hold together could also help explain an encounter that changes it. Staying the same and producing something new may have more in common than we usually suppose.

Why I keep asking what makes it happen

Quantum mechanics is complex, both mathematically and conceptually. Its calculations work extraordinarily well. Even so, I want to understand why its rules take the form they do. The PDT foundations recover some familiar mathematical features under stated assumptions, including a route to the usual quantum odds. Those conditions matter. We still need to explain how a physical process produces individual events and the right pattern of results over many trials.

The phrase ‘Shut up and calculate!’ captures an attitude sometimes associated with teaching quantum mechanics. David Mermin used it in 1989 when discussing its interpretation, and later criticised his own phrase as too dismissive. [1] Calculation deserves its success. I am simply the sort of person who also wants to look inside the engine. Knowing what an instrument will report makes me more curious about how that report comes about.

Imagine a particle reaching a detector. Quantum theory calculates the chances of different readings. The apparatus then leaves one particular record. That record can open a shutter, trigger another measurement or sit there until someone comes back in the morning. I want a physical account of how one event becomes something that the next event can depend on.

In PDT, I call the proposed step into one actual event a phase snap. During an interaction, conditions may rule out possible ways forward. The survivor proposal assumes that, when just one allowed continuation remains, it becomes the event. That is a starting rule, not something proved merely by naming it. We must explain what rules out the alternatives and when the required single survivor exists.

Here, allowed must mean permitted by the physical law governing the encounter. We cannot wait for the answer and then declare it the only one that was allowed. The law must do the work. It must also explain the balance of results across repeated experiments. Otherwise we would have given the mystery a new name and left it sitting on the same laboratory bench.

This connects the event with the question of what lasts. A record matters because it survives long enough to affect something else. A detector can make that record without anyone watching. Reading it

later is another physical interaction. Conscious experience raises further questions, but we should not mistake an account of a measuring instrument for a complete explanation of being conscious.

The book follows this thought into time, gravity and the wider universe. How do clocks let us compare changes? How do matter and the distances we measure fit together? Could the same starting picture help explain how cosmic structures form? Each subject brings its own demands. A common idea earns its place by meeting those demands, with calculations and observations we can check.

How to follow the argument

Read the explanations in words first. Use the figures to picture the connections, and return to an equation when you want a closer look. You do not need to master the symbols before turning the page. The ideas will appear in different settings as we go. A familiar example can make sense of something that looked rather forbidding on its first appearance.

The six appendices offer extra routes into the detail. Appendix A sets out the central commitments and what would count against them. Appendix B looks at quantum mechanics, including probabilities and measurement. Appendix C examines gravity, inertia and curved spacetime. Appendix D turns to cosmology and the observations any proposed explanation must meet. You can consult them as questions arise or return after the main chapters.

Appendix E explores connections with Alan Watts and his thoughts about individuals and the surrounding world. It also considers consciousness, while keeping the additional assumptions about experience visible. A philosophical connection can be illuminating without being a physical demonstration. Appendix F introduces the notation and selected results from the PDT Foundations papers R00 through R13. Readers interested in the mathematics may find it a useful starting point before Appendices A to D.

Throughout, I distinguish established physics, results that follow from the PDT assumptions, and my own proposed interpretation. A proof tells us what follows if its assumptions hold. Experiments help us find out whether nature agrees. The foundations do not yet select one complete physical law that explains every phenomenon discussed here. Keeping that boundary clear lets us see both what has been achieved and what still needs work.

My aim is to make this picture understandable enough for you to examine it. Agreement is optional. Curiosity is useful. If the book leaves you looking at a familiar object and wondering a little more about how it keeps being itself, we will already have a good question to discuss.

Bridge to Chapter 1

Let us begin with something physics does brilliantly. It predicts what instruments will show. But does knowing the odds tell us what makes one particular result happen? Chapter 1, Prediction Without Understanding, takes that question to a detector and then brings it back to the things around us. Keep the mug nearby. It still has a part to play.

References and further reading

- [1] N. D. Mermin (2004). Could Feynman Have Said This? *Physics Today*, 57(5), 10–11. <https://doi.org/10.1063/1.1768652>.