

Chapter 7

The Phase Differential Equation

A loaded trolley is harder to start moving than an empty one. It is also harder to stop. We call this resistance to a change of motion inertia. We can calculate it without knowing why matter has this property. If PDT is to explain what matter is, it should also help explain what we feel when we push the trolley.

In PDT, I picture matter as phase relationships that hold together. Changing an object's motion must be compatible with that organisation. I propose that inertia comes from its response to being reorganised while it continues to exist. That is an idea about the physical cause of inertia, not yet a calculation proving it.

Pushing the trolley also transfers energy. When we stop it, that energy can pass into other forms. The trolley remains recognisable, but its motion relative to the floor has changed. We need an equation that connects the proposed phase structure with changes of this measurable kind.

Where stored energy belongs

A raised weight can do work as it falls. A wound spring can turn a mechanism. A battery can power a lamp. These processes look different, but energy lets us compare how much is transferred when the arrangements change.

Energy is not a liquid hidden inside them. The arrangement matters. The weight's gravitational energy involves its relationship with the Earth. The spring stores energy because it is deformed. The battery's available energy depends on its chemical condition. In each case, we need to say what physical situation carries the energy.

PDT gives such relationships a central role. A spring can store energy before it unwinds. An excited atom has energy before it emits light. A battery can power a circuit before the switch is closed. I propose that the phase structures sustaining matter belong to the explanation of this stored energy. Energy need not wait for a snap before it has a place in the account.

A later event can release energy stored during preparation. Recall the detector. A small arrival triggers a much larger response because the apparatus supplies energy too. The event changes the arrangement and starts the transfer. It does not require the incoming particle to supply everything that appears in the output.

What turns a phase difference into an energy

Imagine two reservoirs at different heights. Their difference can drive water through a connecting pipe. But the height difference alone does not tell us the flow. A narrow pipe and a broad channel respond differently. We need to know the connection as well as the difference.

Phase is similar in this respect. A phase difference can shift an interference pattern, affect the energy of an arrangement or remain steady in a stable system. Its consequence depends on how the parts interact. We cannot turn an angle into an energy merely by giving it a symbol.

Figure 7.1 shows two possible rules relating phase to energy. Both repeat after a full turn, as a cyclic relationship should. But they assign different energies to the same angle. They also predict different responses when the angle changes. Phase alone has not chosen between the rules.

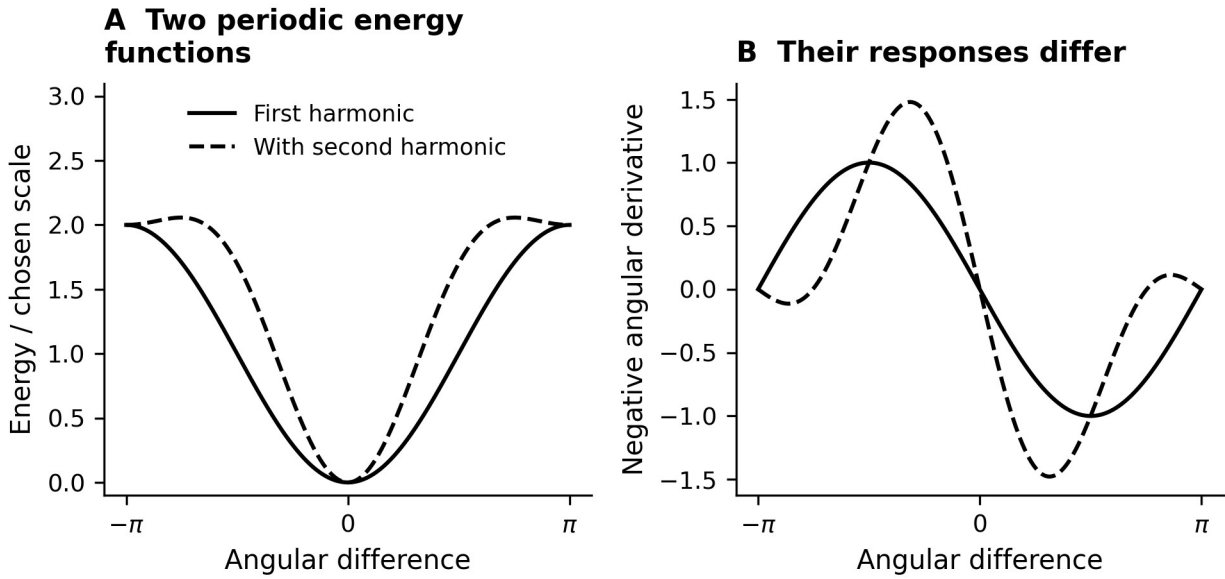


Figure 7.1 Two example rules give different energies for the same phase difference, while both repeat after a full turn. The right panel shows their restoring responses, calculated from the slopes of the energy curves. A physical model must specify which rule applies and why.

Near a preferred arrangement, a small displacement can produce a tendency to return. Elsewhere on a curve, the response can differ. Reading the curves this way connects the angle with something the system does. The interaction supplies that connection, just as the pipe affects what happens between the reservoirs.

We also need a scale. An angle measured in radians does not carry units of energy. Energy is measured in joules. [2] To connect them, the model must supply a physical scale as well as a response rule. Otherwise we know an angular position but not what energy to assign to it.

One simple model can write the energy as follows. It multiplies a reference energy by a function of the phase difference.

$$E = m_0 c^2 F(\Delta\Phi)$$

The reference energy is $m_0 c^2$. Here m_0 is a reference mass and c is the speed of light. F is the rule, or function, that tells us how the energy depends on phase. Its value has no units. The curves above illustrate what such a rule might look like. A more complicated system could also depend on position, other interactions or information retained from earlier events.

The equation is compact because F contains work still to be done. A model must tell us what F is, why it has that form and what fixes the scale. Writing the expression does not derive those ingredients. It shows where a proposed phase structure would have to connect with a measurable energy.

A phase and energy link we already know

Quantum mechanics already connects phase with energy. Two contributions with different fixed energies build up a phase difference as time passes. Their energy gap sets the rate. A constant called the reduced Planck constant, written $\hbar$ and pronounced h bar, converts energy multiplied by time into a phase angle. [1]

Suppose the energy gap stays constant and we start the relative phase at zero. The standard quantum rule gives the accumulated phase change as

$$\Delta\phi = -\frac{\Delta E t}{\hbar}$$

ΔE means the second energy minus the first. The letter t is the time elapsed. Divide their product by $\hbar$ to obtain the phase change. The minus sign follows the usual convention for quantum phase. Figure 7.2 shows the physical result of this changing comparison.

We can prepare contributions, let them evolve and then bring them together in an instrument. Their changing relative phase changes the chance of each output. Repeating the experiment with different waiting times reveals a pattern. Its rate tells us about the energy gap.

$$\Delta\phi = -\Delta E t/\hbar \quad T = 2\pi\hbar/|\Delta E|$$

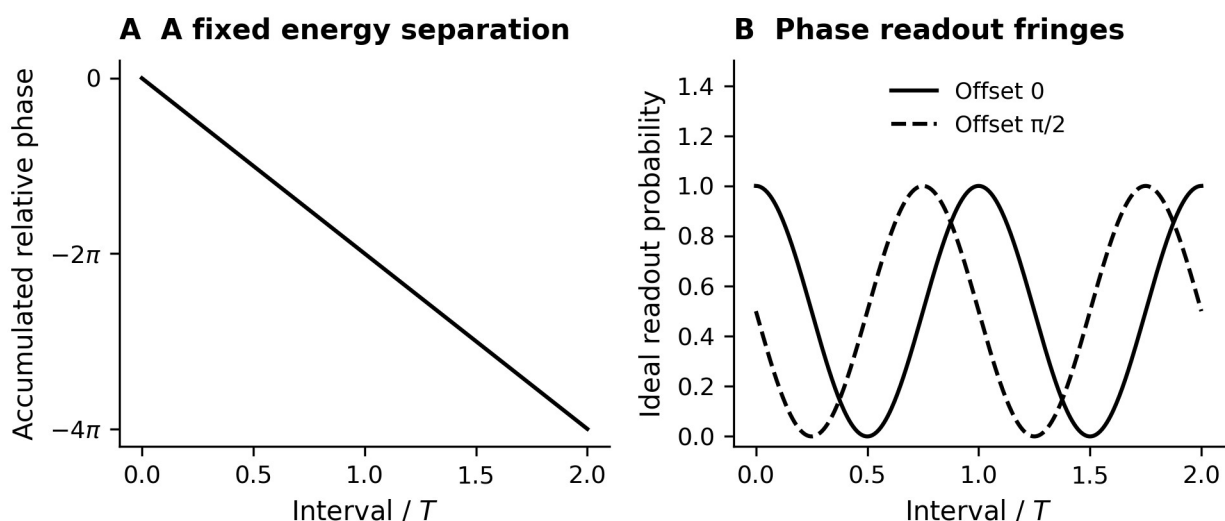


Figure 7.2 Contributions with different fixed energies accumulate relative phase. A balanced readout converts that changing comparison into an oscillating detection probability. An apparatus offset shifts the pattern but leaves its period unchanged. This is the standard quantum relationship for a constant energy gap.

The instrument does not watch a tiny pointer inside a particle. It reveals the comparison through repeated results. A common phase shift applied to the whole state would not give this signal. The measurable effect comes from the relative change between contributions.

This established connection encourages my interest in phase. Quantum mechanics already uses it to describe energy differences accurately. PDT asks a further question. Could phase structure help explain the matter that has the energy, as well as describe how its quantum state changes?

An energy value alone cannot explain the structure. A spring and a raised weight can release equal amounts of energy through very different processes. Their construction explains how the transfer occurs. A useful PDT model would need to provide that sort of physical explanation for matter.

What mass would mean in this picture

An object at rest can still have activity inside it. At rest means that the body as a whole is not moving relative to the chosen frame. Einstein's equation connects its rest energy with its invariant mass, the mass that does not change when we describe the body from different frames. [3]

$$E_0 = mc^2$$

E_0 is the rest energy, m is that mass and c is the speed of light. In PDT, I propose that rest energy belongs to the structure sustaining the object. The body does not lose its internal organisation just because it is sitting still on the floor.

I then ask whether the same organisation explains inertia. If changing the motion requires the structure to respond, could that response account for the mass we measure when we apply a force? The idea must eventually produce the correct relationship between force and acceleration. The trolley gives us a familiar test of what the explanation has to achieve.

This resistance is not friction. A body moving steadily through empty space needs no continuous push just to keep moving. Inertia concerns a change of motion. Nor does the proposed reorganisation necessarily mean damage or heating. An intact structure can respond to acceleration without being permanently harmed.

Put the trolley in a steadily moving train. Relative to the carriage, it is at rest. Relative to the platform, it moves and has kinetic energy. Its invariant mass is the same. PDT must preserve this distinction. The language of phase must not quietly introduce an absolute state of rest.

The train and platform observers describe the same body from different frames. A phase account must agree with the relationships between their measurements that relativity already gets right. I am seeking an explanation of that behaviour, rather than a hidden preferred frame.

So the push on the trolley raises a deeper question. Could the response we call mass come from the organisation that lets matter keep existing while its motion changes? If so, an ordinary push would tell us something about the structure of matter as well as the movement across the floor.

Different particle structures should then have definite relationships between their masses. We can use the measured electron mass to set one reference scale. The harder task is to calculate other mass ratios from the model. Inserting each measured mass separately would not explain why the masses differ as they do.

A phase circle alone cannot provide that calculation. What PDT offers here is a proposed connection between a particle's continuing identity and its response to acceleration. I suspect that both depend on the same organisation. Showing that quantitatively remains part of the work.

Keeping account of an event

Energy also helps us follow a snap. Before the encounter, energy is available in particular parts of the arrangement. Afterwards, the detector may have stored a record, emitted heat and sent a signal. We need to account for those changes together.

That means including the source, detector and relevant surroundings. An abrupt event may transfer energy or change its form. Calling it a snap cannot produce an unexplained extra supply. Any proposed mechanism must fit the energy accounting of the whole encounter.

The detector also shows why the size of a response need not match the size of its trigger. Stored energy can drive a large change after a small arrival. What happens depends on what the prepared apparatus can do, as well as on what disturbed it.

Several pieces of the explanation must therefore work together. A limit tells us when a possibility becomes impossible. The dynamics tells us how the arrangement changes. The realisation principle connects one surviving possibility with an actual event. Energy accounting must describe the resulting transfers. None of these jobs is done merely by naming the others.

This is the role of the phase differential equation in the proposal. It should connect a specified phase structure with a measurable energy or response. Its short form becomes useful only when the model supplies the physical ingredients behind it.

Part I began with one mark on a detector. We have followed the question behind that mark into a proposed picture of matter. I see objects as phase relationships that keep holding together, and events as interactions that settle what happens next. I am asking whether the same picture can explain the resistance we feel when we push something.

The appeal lies in finding a common explanation for familiar things. A solid body lasts. A detector leaves a record. A clock keeps a count. PDT asks how those behaviours could arise from relationships that remain organised through change. The mathematics must show whether this idea can reproduce what we observe.

Bridge to Part II and Chapter 8

Part II develops the proposed foundations more carefully. Chapter 8 sets out the starting principles and asks how relationships could join into lasting structures. It then gives us a basis for examining the central claim more closely. How could an interaction rule out alternatives and leave one definite event?

References and further reading

[1] Feynman, R. P., Leighton, R. B., and Sands, M. (1965). The Feynman Lectures on Physics, Volume III, Chapter 8, The Hamiltonian Matrix. Addison-Wesley.
https://www.feynmanlectures.caltech.edu/III_08.html

[2] Bureau International des Poids et Mesures (2026). The International System of Units, 9th edition, updated in 2026. <https://doi.org/10.59161/AUEZ1291>

[3] Einstein, A. (1905). Ist die Trägheit eines Körpers von seinem Energieinhalt abhängig? Annalen der Physik, 18, 639–641. <https://doi.org/10.1002/andp.19053231314>