

Chapter 7

The Phase Differential Equation

A loaded shopping trolley takes more effort to start and stop than an empty one. The biscuits at the far end of the aisle do not make it any more cooperative. This resistance to a change in motion is called inertia. We can calculate it. My question is whether what keeps matter together could also explain why it has that resistance.

In PDT, matter would consist of phase relationships that hold together. Speed up an object, slow it down or turn it, and that arrangement must respond while still existing. I propose that this helps explain inertia. It is an idea to test, not yet a calculation giving the answer.

Pushing also transfers energy to the trolley. When we stop it, that energy can pass into other forms. The trolley stays recognisable, but its motion changes. Our phase picture needs to connect with something as ordinary and measurable as that push.

How springs and batteries store energy before release

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 need not be a hidden liquid. A raised weight can fall because of its relationship with the Earth. A bent spring can straighten. A battery can undergo chemical changes. I want to know what each arrangement can do, rather than imagine an invisible substance sloshing about inside it.

PDT puts such relationships at the centre of the explanation. Stored energy is present before it is released. A spring need not unwind first. A charged battery need not wait for us to find the switch. I propose that the phase structures sustaining matter help explain this storage. Energy does not have to wait for a snap.

Why phase needs a rule and an energy scale

Imagine two reservoirs at different heights, joined by a pipe. Their height difference can drive water along it. But how much will flow? We need to know about the pipe too. A narrow pipe and a broad channel respond differently. That familiar engineering problem reminds me to examine the connection.

Phase needs the same care. A difference might move a light pattern, change stored energy or stay steady without causing a change. How do the parts affect one another? Before an angle tells us about energy, we need to know what arrangement it describes.

Figure 7.1 shows two possible ways energy could depend on phase. Both repeat after a full turn. Yet the same angle gives different energies in the two cases. Follow the curves and notice where they disagree. The phase reading alone cannot tell us which rule nature uses.

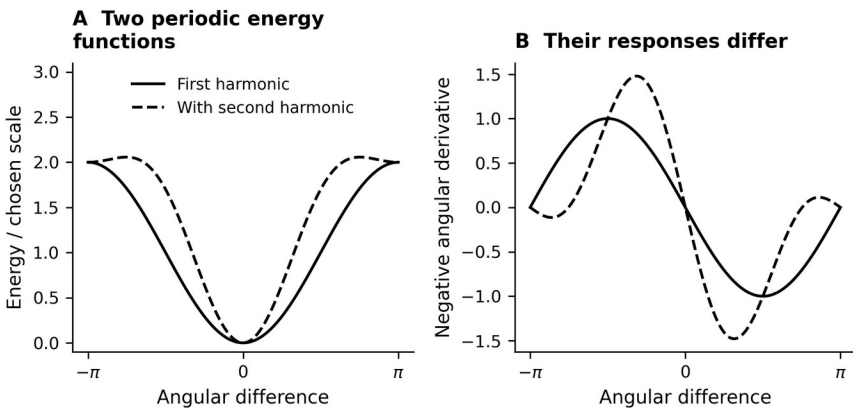


Figure 7.1 Two possible rules give different energies at the same angle. Both repeat after a full turn. Their slopes also imply different tendencies to return towards a preferred position, shown on the right. A model must explain which rule applies.

Think of a ball near the bottom of a bowl. Move it a little and it tends to roll back. An energy curve helps us picture a similar tendency in a phase relationship. But drawing the curve has not explained the physical cause. I cannot make a force by sketching a particularly convincing bowl.

We also need to know how much energy is involved. An angle tells us a position around a cycle. Energy is measured in joules. [2] The model

must explain how to get from one to the other. It is like using a map. A gap on the paper means little until we know the scale.

Read the next equation like this. Take a reference amount of energy and multiply it by a number that depends on phase. The symbols record that possible connection.

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

The reference amount is $m_0 c^2$. m_0 means a chosen reference mass, and c is the speed of light. F is the rule that turns the phase difference into a multiplier, a number without units. The curves above show possible rules. A fuller model may also have to include other encounters or changes that earlier events left behind.

F is a small letter with a large job. I must still explain its rule, why that rule fits and what sets the reference amount. The equation gives those answers somewhere to go. It has not worked them out for us.

How an energy gap changes the phase over time

Quantum mechanics already links phase and energy in a testable way. Two contributions with different fixed energies steadily develop a phase gap. A bigger energy difference makes it grow faster. [1] The constant $\hbar$, pronounced h bar, converts between the quantities. The equation records that connection.

Start with no phase difference and keep the energy gap fixed. The standard quantum rule then gives

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

ΔE is the energy difference and t is how long we wait. Multiply them, then divide by $\hbar$ to find the phase change. The minus sign sets its direction. If the symbols feel busy, keep the simple result. A bigger energy gap or longer wait gives a bigger phase change.

We can let the contributions change for a chosen time, then bring them together. Their phase difference affects which exit is more likely. Repeat with different waiting times and a pattern appears. How quickly it repeats tells us about the energy gap.

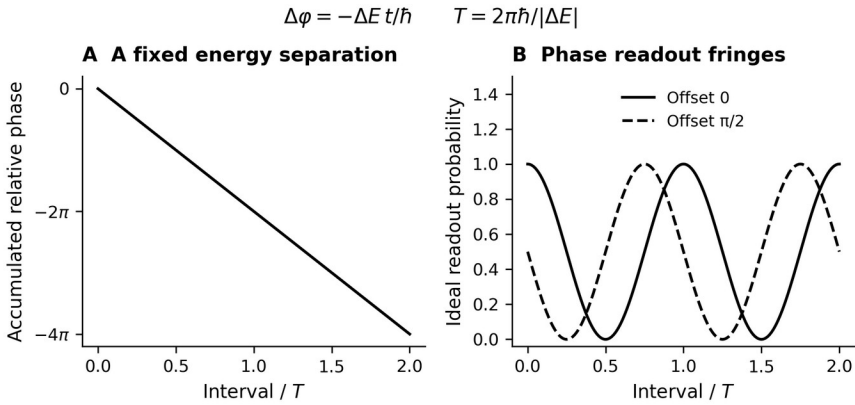


Figure 7.2 A fixed energy gap makes the phase difference build steadily. When the contributions meet, the detection odds rise and fall. Shifting the apparatus setting moves the pattern without changing how quickly it repeats. This is an established quantum effect.

The instrument is not filming a tiny pointer in a particle. We see the comparison through many results. Moving the phase of the whole state together would not create this signal. The changing gap between the contributions is what matters.

This is why phase keeps drawing me back. Quantum mechanics already uses it to describe energy differences accurately. Could phase relationships also explain the matter that has the energy? I want to understand what exists, as well as calculate how its quantum description 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.

Could the structure of matter explain inertia

Being still does not mean nothing happens inside an object. It means the whole object is still relative to something else. Einstein's equation links its rest energy to its invariant mass. [3] Invariant means that this mass stays the same even when observers disagree about the object's motion.

$$E_0 = mc^2$$

E_0 is the rest energy, m is the mass and c is the speed of light. PDT proposes that this energy belongs to the structure sustaining the object. Parking the trolley does not switch off the matter it is made of.

Could the same structure explain inertia? If I push the trolley, can PDT tell me how much its motion changes? That is the sort of answer I want. The supermarket keeps the question honest. A theory of matter must eventually connect its attractive ideas to an ordinary, measurable push.

Inertia is different from friction. In empty space, an object can keep moving steadily without a continuous push. Inertia concerns changing that motion. The proposed response inside matter need not mean damage or heating either. Acceleration does not have to break the object.

Put the trolley in a steadily moving train. From a seat beside it, the trolley is still. From the platform, it is moving and has energy of motion. Its invariant mass is the same in both descriptions. Nobody has changed the trolley by changing seats. PDT must preserve that agreement while explaining what the observers measure.

Neither observer needs to be declared truly at rest. Relativity already tells us how their measurements fit together. A phase explanation must respect those results. It cannot quietly bring back a special state of absolute rest.

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 give definite mass relationships. The measured electron mass can set a reference; the challenge is

calculating the others relative to it. Entering every measured mass separately makes a catalogue, not an explanation.

Where the energy goes when an event happens

Energy must be followed through a snap, from what the parts held beforehand to the record, heat and signal afterwards. The light coming on is only part of the account.

Include the source, detector and relevant surroundings. A sudden event can transfer or transform energy, but a snap is no free energy voucher. The whole account must balance.

A small arrival can trigger a large response using stored energy. The response depends on the prepared apparatus as well as its trigger.

How does the system change, eliminate an ending and realise a survivor? Where does energy go? Naming one step cannot answer the others.

From a detector mark, swings pictured phase, a chair tested persistence, and a clock exposed one reading's limits. The trolley brought us back to a push. Ordinary equipment has led to a large question.

Bridge to Chapter 8 and Part II

Now we have to build. Part II begins with Chapter 8 and the starting rules of PDT. We will ask what follows when those rules work together, what can last and what must change. I have shown you why I want to take this route. Next I must show what it can support. Keep the chair and the trolley in mind. The foundations have to carry more than an appealing idea.

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>