

Walking the Loop

A Quick Guide to Holonomy — the plain-language primer

Supplemental companion. Working Draft v0.2 · 2026 · CC BY 4.0 Matthew “Bear” Schulz · Independent Researcher · ORCID 0009-0000-0956-5743

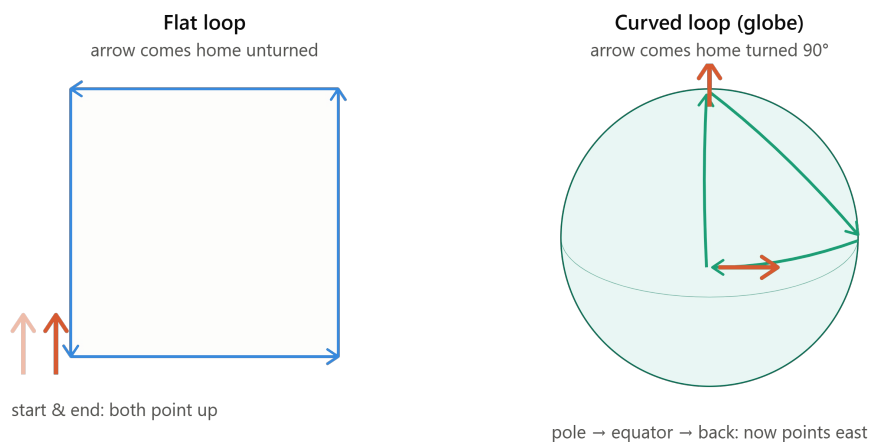
This primer exists because the instrument it accompanies travels across fields that do not share a vocabulary. An astronomer, a crystallographer, a geologist, and a molecular biologist can all use a loop-holonomy reader — but each calls its pieces by different names. What follows is the shared intuition, built from one everyday example, in plain terms. No equations are required to follow it.

1. The one idea, in a sentence

If you carry something that can point — an arrow, a compass, a sense of “which way is up” — all the way around a closed loop and back to where you started, it can come home **turned**. How much it turned, and in which direction, tells you something real about the space you walked through. That turning is **holonomy**. Everything else is detail.

2. Flat versus curved — where the turning comes from

Here is the whole idea in one picture. Walk an arrow around a loop **on a flat surface** and it comes home pointing exactly the way it started — no turn. Walk the *same kind of loop on a curved surface* — a globe — and it comes home turned. The turning did not come from the *shape* of the loop. It came from the **curvature the loop enclosed**.



[Illustration slots 1 & 2 — the turned arrow, and the globe triangle — placed.]

You can do the globe version with your hand on any ball. Start on the equator, point your arrow **north**, and walk:

1. Straight up to the North Pole, never twisting the arrow in your hand.
2. Straight back down to the equator — but a quarter of the way around the world from where you started.
3. Along the equator back to your starting point.

Your arrow now points **east**, not north. You never twisted it. You walked “straight” the whole way. The 90° of turn is the holonomy of that loop, and it is exactly the curvature the triangle enclosed.

The lesson that matters: *it is not the shape, it is the enclosed curvature.* A circle and a square that enclose the same curvature give the same turn. A flat loop — any flat loop, circle or square — gives **zero** turn. This is the whole engine, and it is why the instrument reads *what a loop contains*, never the loop’s outline.

3. Winding — the whole-number channel

There is a second thing a loop can tell you, and it comes in **whole numbers**. Ask a simple question: as you walked your loop, how many times did you circle around a particular point? Zero times, once, twice — never one-and-a-half times. You cannot go around something a fractional number of times and come back to your start. That count is the **winding number**.



[Illustration slot 3 — winding 0 / 1 / 2 — placed.]

Whole-number channels are precious because **noise cannot fake them**. A measurement can drift, wobble, and blur — but it cannot make a loop go around one-and-a-half times. So when the signal you care about lives in a winding number, small errors in the data leave the answer untouched. That is the heart of why this instrument reports *structure*, not *magnitude*: the structure is quantized, and the quantized part is the part that holds still.

4. A loop-walk — putting it together

A **loop-walk** is just this: choose a closed loop through your data, carry a pointer around it, and read what comes home — the turn (holonomy) and the count (winding). The data can be anything with a direction at each place: the way stars drift across the sky, the way the ground creeps between GPS stations, the way a crystal's grains are oriented, the way a molecule's backbone threads through itself. Different substrates, one reading. You are always asking the same question: *did the pointer come home changed, and by how much?*

5. The earthquake junction — a walk you can feel

Here is the example most people already half-know. We all hear that tectonic plates **rub, push, pull, and slide** past each other, and that we cannot predict earthquakes. Both are true. But we *can* measure the tension and strain building in the ground — and a loop-walk is how you read that build-up as a **rotation**.

Picture a ring of GPS stations around a fault junction, each one a marker that inches along as the ground deforms. Draw a loop through them and carry your pointer around it. When the junction is quietly loading strain, the pointer comes home **turned** — the loop encloses the twisting the fault is storing. When the strain releases, the turn changes. You are not predicting the quake; you are reading the state of the rock the way a pressure gauge reads a boiler. The plates' push-and-slide becomes a number you can watch.

[Illustration slot 4 — the loop grid: a ring of stations with the loop drawn through them.] [Illustration slot 5 — the fault-junction walk: the pointer carried around the junction loop, coming home turned.]

This is the softest on-ramp to the whole instrument: everyone already believes the plates are moving; the loop-walk just shows you the rotation they carry.

6. Why one instrument, many worlds

The same three ideas — enclosed curvature turns a pointer, winding counts in whole numbers, a loop-walk reads both — work wherever the data has a direction at each place. That is why a single instrument can travel from the

sky to the ground to a crystal to a molecule without changing its question. The substrates could not be more different; the reading is the same.

[Illustration slot 6 (optional closer) — one arrow, three worlds: the same turned pointer shown over a patch of sky, a fault map, and a lattice, to make “one instrument, many substrates” land in a single image.]

A note on what’s ahead

There is more the loop-walk can read — finer sky structure, and other substrates now being scoped — but those are down-the-road work, and this primer keeps to the settled core. If you want the full instrument and its receipts, see the main paper this primer accompanies. If a loop-walk in your own field sounds worth a try, that is exactly the kind of collaboration this is written to invite.

Walking the Loop is a plain-language companion, released CC BY 4.0. Reuse it, teach from it, remix it — attribution appreciated, permission not required.